The Ancient Past of Keatley Creek

Volume I: Taphonomy

Edited by Brian Hayden

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Cover: The cover was designed by the Simon Fraser University Instructional Media Centre. It features the broken top of a zoomorphic maul recovered from HP 93 by a private collector about 20 years ago. The head of the maul is still in a private collection. Bone buttons, archaeologically excavated from HP 105, are also shown.

Keatley Creek Pithouse Village

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Preface

Brian Hayden

This is the final report of the Fraser River Investigations into Corporate Group Archaeology Project, a project that has lasted for 13 years. This has certainly been one of the great intellectual and collaborative undertakings of my lifetime. I trust that readers will recognize in the many contributions that make up this report, the remarkable interweaving of many divergent disciplines, lives, and perspectives into a united interpretation of the social and economic organization of a prehistoric community on the Northwest Plateau. This report is special for a number of reasons. Firstly, the nature of the archaeological remains at Keatley Creek are in my estimation, one of our most important national and world heritage treasures. The site is extraordinary in terms of its size for people following a hunter-gatherer way of life (with an estimated peak population of 1,200–1,500). The large houses are extraordinary for pithouses and the preservation of organic remains and stratigraphy is excellent.

Secondly, this report is special because it seeks one of the most elusive entities archaeologists have sought from the beginnings of their systematic exploration of the past: notably, the basic social and economic and political organization in specific prehistoric societies. How did this organization mold the lives of people on a day to day basis? There have been many professional archaeologists who have said that such questions cannot be answered. There have been many others who adamantly maintain that such questions can be answered. However, while both sides have reveled in pronouncements, few archaeologists have successfully demonstrated how even basic aspects of social or economic organization can be reconstructed from the remote past.

This report demonstrates that with determination, collaboration, and a little luck, a fairly detailed reconstruction of past social and economic organization is certainly possible. This was the goal of the project from the beginning: to understand the social and organization of unusually large houses (residential corporate groups). The results have sometimes been surprising and intellectually exhilarating, as the following chapters document.

Third, as alluded to above, this report is remarkable for the unusual breadth of data and disciplines that have all contributed to making this report a landmark study in prehistoric archaeology. While I originally defined the basic problem orientation of the project, I have had the good fortune to have been aided from the outset by a remarkable team of collaborators, excavators, and analysts in specialized fields. I consider the substantial success of this project to be a tribute to all of them. Many of the authors of the following chapters helped plan the excavation and analytical strategies to be pursued from the outset of the project, and many were on the first field crew that tested the first housepits in a hesitant and hopeful manner, unsure as to whether we would find any intact or recognizable living floor deposits upon which much of the fate of the project depended. Diana Alexander, Karla Kusmer, Dale Donovan, Dana Lepofsky, and Mike Rousseau were all members of that first field crew and planning committee. They helped modify our strategy as new realities confronted our initial idealistic models, and they continued their involvement in the project over the years in analyzing the overwhelming amounts of material recovered. I consider this final report on the work at Keatley Creek as one of the best examples of what collaborative, interdisciplinary archaeology can produce.

Fourth, this report is special because it substantially increases our depth of understanding in the study of complex hunter-gatherers. Complex hunter-gatherers have become very prominent in the theoretical domain of archaeology in the past two decades because they now appear to be the key to understanding most of the important cultural developments of the last 30,000 years of prehistory, including the emergence of prestige technologies, economic-based competition, private ownership, socioeconomic hierarchies, slavery, domestication of plants and animals, sedentism, and many tangentially related phenomena. This report also provides a major contribution to the systematic and detailed study of site formation processes which have rarely been documented in any thorough or systematic fashion.

Finally, this report is special because substantial parts of it have been built upon an in-depth understanding of the living descendants of the prehistoric Plateau peoples. We were priviledged not only to read early ethnographic accounts of traditional Plateau lifeways as recorded by James Teit and others, but also to be able to work with a number of elders from the surrounding First Nations communities. From them we learned a great deal about traditional practices and especially how resources were used. This valuable information constituted a study of traditional resource use that was exceptional in its coverage and documentation of traditional lifeways. This study was published by the University of British Columbia Press under the title of: *A Complex Culture of the British Columbia Plateau* (Edited by B. Hayden). I certainly would like to extend my very deep gratitude to everyone in the native communities that aided us in this work, and especially to former Chief, Desmond Peters, Senior, of Pavilion.

The quest to recover past social and economic organizations on the Plateau has been long and arduous, and it has led to many unexpected ventures, both geographical and intellectual. I have been constantly surprised by new facts, new relationships, new perceptions, new conclusions, and new questions. However, the quest has never become dull or boring. If anything, it has been too interesting and too captivating. At times, it has been difficult to hold all the threads together in order to make a coherent fabric of the past at Keatley Creek and to create coherent theoretical images of the past. However, the main themes have remained clear and resilient. The venture has been a wonderful growing experience, even if I have at times been exhausted by the endeavor.

I am confident that as a result of the excavations at Keatley Creek, the new conceptual, methodological, and theoretical approaches that I and the other analysts have developed will stimulate further advances in the exciting area of documenting and understanding past social and economic organization. However, many of the advances that we associate with this project have been fortuitous and serendipitous. I certainly did not foresee or plan for all of them. Many of the advances were developed by interested students and analysts who became intrigued by the project and developed their own innovative ways of looking at the data. Once again, I must acknowledge my very good fortune in having such interested, dedicated, and talented individuals involved in this project. It is above all, they who have made it successful.

Acknowledgements

I apologize for anyone who helped in the project and whom I have forgotten to acknowledge.

Of utmost importance for the success of this project has been the good will and cooperation of the people that have generously permitted us to excavate on their legal and traditional lands: Mr. J.E. Termuende of the Diamond S Ranch, and the Pavilion (Ts'qw'aylaxw) Indian Band. The Fountain (Xaxli'p) Indian Band has also provided substantial support. More than anyone else, Desmond Peters, Senior, of the Pavilion Band, has been a mentor of our research in the area and has been invaluable in providing information on traditional culture. In the creation of this project, Dr. Arnoud Stryd was both an inspiration and a generous advisor. Morley Eldridge has provided many seminal ideas and data. Trevor Chandler, in particular, has been a constant supporter. We have always been warmly welcomed by the people in the Lillooet region whether in meetings, at gatherings, on ranches, on reserves, in museums, or in stores; and we are grateful for their interest, their hospitality, and their friendship.

Many professionals have provided advice, comments, and suggestions throughout the research and the writing of this report. I would particularly like to

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In addition to the many authors that have helped produce this final report, I would also like to thank the many crew members and volunteers that contributed their time and expertise to help gather, process, and organize the basic data upon which everything else rests. There have been many scores of individuals involved in this aspect of the project, and I am grateful to them all.

Due to the vicissitudes of funding, there have been many agencies involved in the financing of this project. By far, the bulk of the funding has come from the Social Sciences and Humanities Research Council of Canada (and its predecessor, The Canada Council). Additional financing has been provided by the SSHRC Small Grants Committee at Simon Fraser University, the President's Research Committee at Simon Fraser University, the Simon Fraser University Special Research Projects Fund, the Simon Fraser University Publications Committee, The McLean Foundation, and the British Columbia Heritage Trust. I gratefully acknowledge the support of all these agencies.

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INTRODUCTION AND DATING

Chapter 1

The Opening of Keatley Creek: Research Problems and Background

Brian Hayden

Introduction

The Fraser River Investigations into Corporate Group Archaeology project (FRICGA) began in 1985 with a simple question: why unusually large housepits occurred in the Lillooet area of the British Columbia Interior Plateau. With hindsight, this was an ambitious undertaking, one fraught with massive data collection and many collateral problems. In the 1960's and 70's, Arnoud Stryd (1973) had pursued the elusive nature of prehistoric social organization in the same region, only to be overwhelmed by the magnitude of the undertaking. He did, however, establish important baselines that enabled the present project to proceed much further.

The project has brought many of us into contact with a very remarkable culture and its mysteries, probably one of the most complex prehistoric hunter/gatherer cultures in the Western Hemisphere. Our original research goal has confronted us with new problems and new ways of dealing with prehistoric remains that have been both challenging and extremely rewarding. Why dogs were domesticated, how to speciate salmon vertebrae, what prehistoric resource exploitation was like, and how to chemically identify different chert sources are only a few of these problems. In addition to these questions, we have also had to deal with much larger issues such as why the large, complex communities around Lillooet were so different from other hunter/gatherer bands that were much more egalitarian and nomadic, with no more than 25–50 members. In contrast to simpler hunter/gatherers, some of the Lillooet communities housed well over 1,000 people living in seasonally sedentary houses with pronounced wealth differences and hierarchies.

The Lillooet region turned out to be an ideal location for dealing with all the above and many more archaeological issues. The Lillooet region is relatively simple to model in terms of environments and resources. It is also a semi-arid area where the preservation of bone and botanical remains is good. The prehistoric housepit architecture used in the region makes it easy to identify and analyze individual households. There is a vigorous native tradition in the area which is part of the same culture tradition that we were investigating. The region also abounds with spectacular geography and engaging people which makes an enjoyable place to work.

The goal of this chapter is to describe the research history and goals of the project, to describe the selection of the site and its context, to describe the general cultural sequence at the site, population estimates for the site and the region, and to set out the assumptions, theoretical orientations, methods, and techniques of investigation that enabled us to reach conclusions about the prehistoric social and economic organization of the residential corporate groups at Keatley Creek.

Organization of the Volumes

The report is organized into three volumes. Each volume has a separate thematic focus, these are: taphonomy, socioeconomic organization, and excavation documentation. This organization is somewhat different from traditional archaeological site report formats where all the information pertaining to a given type of material such as lithics or fauna is presented together in a single chapter or section. Given the complexity of the database at Keatley Creek and the complexity of the issues being addressed, it was thought that a traditional type of material-focused organization would make it difficult for readers to follow all of the related arguments, models, and issues related to the central themes of the research at Keatley Creek. We therefore chose to structure the organization of these volumes around the major research questions at the site, especially site formation processes and prehistoric socioeconomic organization. For those accustomed to the more traditional material-focused organization of site reports, this may at first seem somewhat awkward since some of the information on lithics, for example, is presented in all three volumes. However, after reading a few chapters, and especially with some judicious use of the table of contents and indexes of the volumes, readers should be able to orient themselves sufficiently to find any type of information that they are interested in. We also have included frequent chapter cross-references to direct readers to other relevant data or interpretations in the report.

Volume I

Because questions of taphonomic biases, disturbance, mixing, and basic issues of accurate identification of the origins of sediments must be dealt with prior to any consideration of artifactual patterning, the first volume deals with general formation processes at the Keatley Creek site. Chapters include sediment analyses, microfabric analyses, faunal taphonomy, botanical taphonomy, lithic strategies and source identifications, and specific comparisons of rim to roof to floor formation processes. Background chapters on basic geological, environmental, climatic, typological, and dating issues are also included in this first volume.

Volume II

The second volume deals with evidence for social and economic organization at the Keatley Creek site. Overall differences between housepit assemblages are dealt with as well as differences in the internal organization of space and domestic groups. Prestige artifacts are analyzed, including the large assemblage of domesticated dogs from HP 7. In addition to botanical, faunal, chemical, and lithic patterning, this volume contains an ethnographic summary of accounts of pithouse life, an analysis of architecture and heating strategies, an overall synthesis of what the socioeconomic organization of the Keatley Creek community was probably like, and an evaluation of the results of the Fraser River Investigations into Corporate Group Archaeology project.

Volume III

In order to present as full a picture of the data upon which the previous and the following interpretations are based, relatively detailed reports of all the test trenches and extended excavations are presented in the third volume. The third volume also contains a description of the lithic typology used by the project, an illustrated catalog of all the modified bone tools from the site, and a special analysis of unusual scapula tools at the site. The intention is for this volume to be used as a kind of reference book, similar to a dictionary. It should be consulted whenever any questions about excavation or stratigraphic details of a housepit arise from reading analyses or interpretations in the other volumes.

Research Questions

The main focus of our research—why unusually large, multi-family structures occur—is an inherently interesting problem for archaeologists who aspire to understand what life was like prehistorically and why cultures change. These are some of the original aims of processual archaeologists. Large multi-family structures, which I will refer to as "residential corporate groups," only appear to occur in special circumstances prehistorically, and they constitute one of the clearest indications of basic changes in social structure that archaeologists have been able to recover (Hayden and Cannon 1982). Moreover, the formation of certain types of residential corporate groups may be related to the development of socioeconomic inequalities, or at least, one distinctive evolutionary line of such social developments (Hayden 1995).

From the outset, it was clear that in order to understand why the housepits in the Lillooet region were so large (some being 20 m in diameter), it was also going to be necessary to understand the social and economic organization of the inhabitants of these structures in far greater detail than had hitherto been attempted. Not all archaeologists were convinced that this was feasible given the common perception that housepit deposits were so culturally churned and mixed over long periods that uncontaminated living surfaces would be impossible to identify or isolate (Fladmark 1982; Wilmeth 1977). Fortunately, Arnoud

Stryd had more encouraging counsel that spurred the project on and ultimately led us to demonstrate the basic integrity of the deposits in most housepits.

Thus, from a relatively simple question emerged many research facets that had to be dealt with. These subsidiary facets included:

1) The separation of site components into more or less contemporaneous components;
2) The detailing of site formation processes in order to determine what the contents of different deposit types represented and whether living floors could be identified, and if so, the degree of mixing involved in their formation;
3) The recovery and identification of artifact patterning on living floors, and the interpretation of the meaning of this patterning;
4) The identification of individual domestic groups within structures and the identification of artifacts associated with each group;
5) The generation of meaningful typologies for monitoring behavioral patterns on living floors;
6) Understanding how the large winter village sites with large housepits fit into the rest of the settlement pattern of the community, and especially what this might mean in terms of storage practices, and other materials brought to or taken away from the winter settlements;
7) Understanding the resource base of the community and houses;
8) Understanding the socioeconomic organization of the large, medium, and small structures in the winter villages, including the problem of determining *how much*, if any, inequality existed; Sanger (1971:255–6) and Stryd (1973:90) both thought that there was greater inequality prehistorically than in historic accounts; how could such notions be tested or even evaluated?
9) Monitoring any changes over time in any of the above; and
10) Examining the possible role of climatic change.

There are still other collateral aspects to be considered, but the ten listed above are some of the major issues that had to be dealt with. Other theoretical areas of interest include understanding the development of ownership rights over goods and resources, the domestication of dogs, warfare, the emergence of metal and prestige item use, and reasons for historical changes in local cultures.

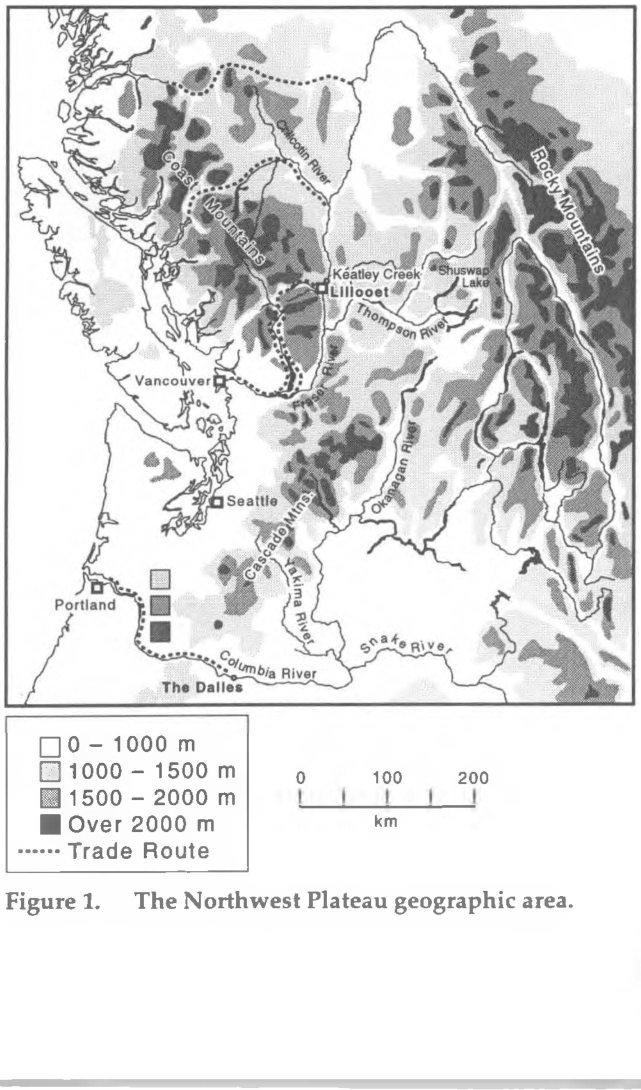

Figure 1. The Northwest Plateau geographic area.

Site Selection

Investigating larger than average housepits can be carried out at many sites on the Northwest Plateau (Figs. 1 and 2). However, I reasoned that if there were critical differences between normal households and

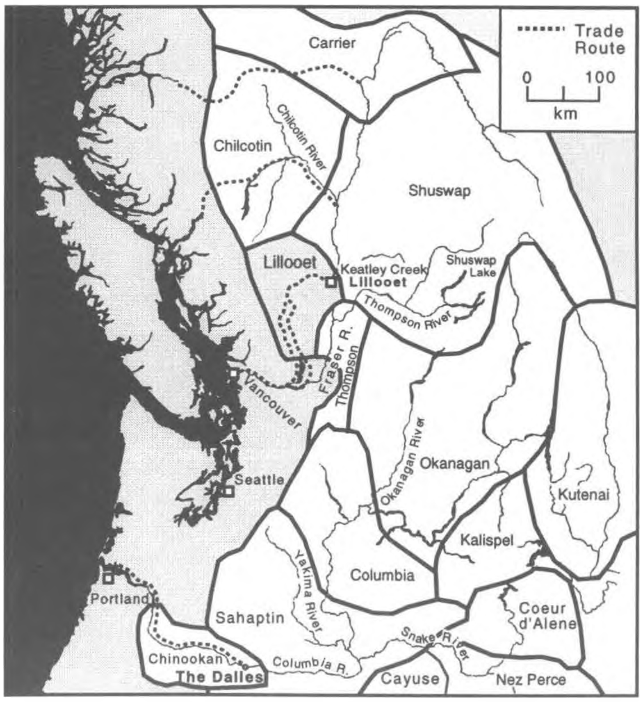

Figure 2. The Northwest Plateau culture area and its major ethnic divisions (from Hunn 1990).

residential corporate groups in the social and/or economic arenas, the largest housepits would present the most extreme archaeological expression of social and economic differences. Given the difficulty archaeologists generally have in recovering socio-economic information at this level, the most extreme case with the largest housepits, thus, seemed the best place to start.

Morley Eldridge had brought the existence of very large Interior housepits to my attention and argued that the prehistoric cultures in these areas were probably quite complex. With a small pilot grant in 1984, I asked Anne Eldridge to undertake a survey of all recorded housepit sites in British Columbia in order to determine where the largest structures were located. From this initial research, two areas stood out: the Farwell Canyon area near the confluence of the Chilko and Fraser Rivers, and the Lillooet region. The Lillooet region had by far more numerous examples of sites with large housepits. The Lillooet sites were also unusually large communities, some of the largest in the Interior of Western Canada. This added another interesting dimension to the investigation.

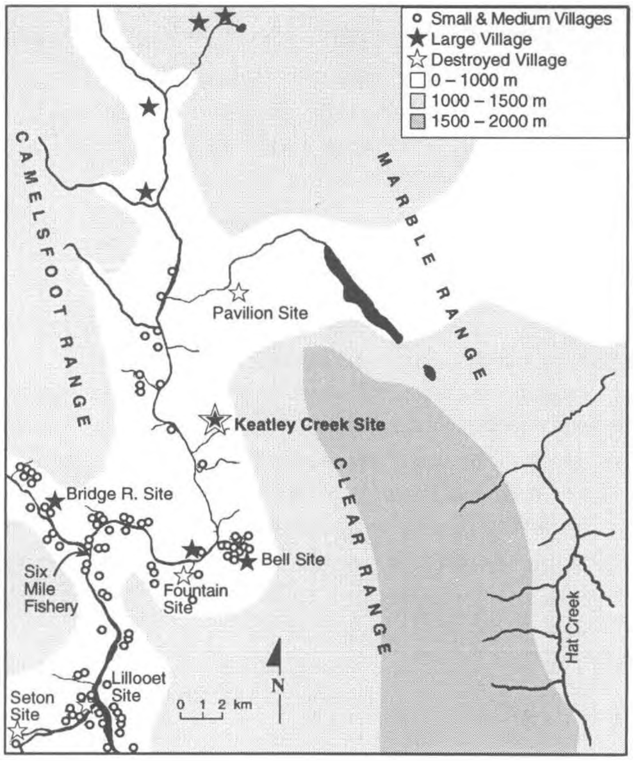

Figure 3. The Lillooet region, indicating the position of all recorded housepit villages (Stryd and Hills 1972, with data from the Archaeology Branch).

After narrowing the research field to the Lillooet region, Arnoud Stryd generously accompanied me on

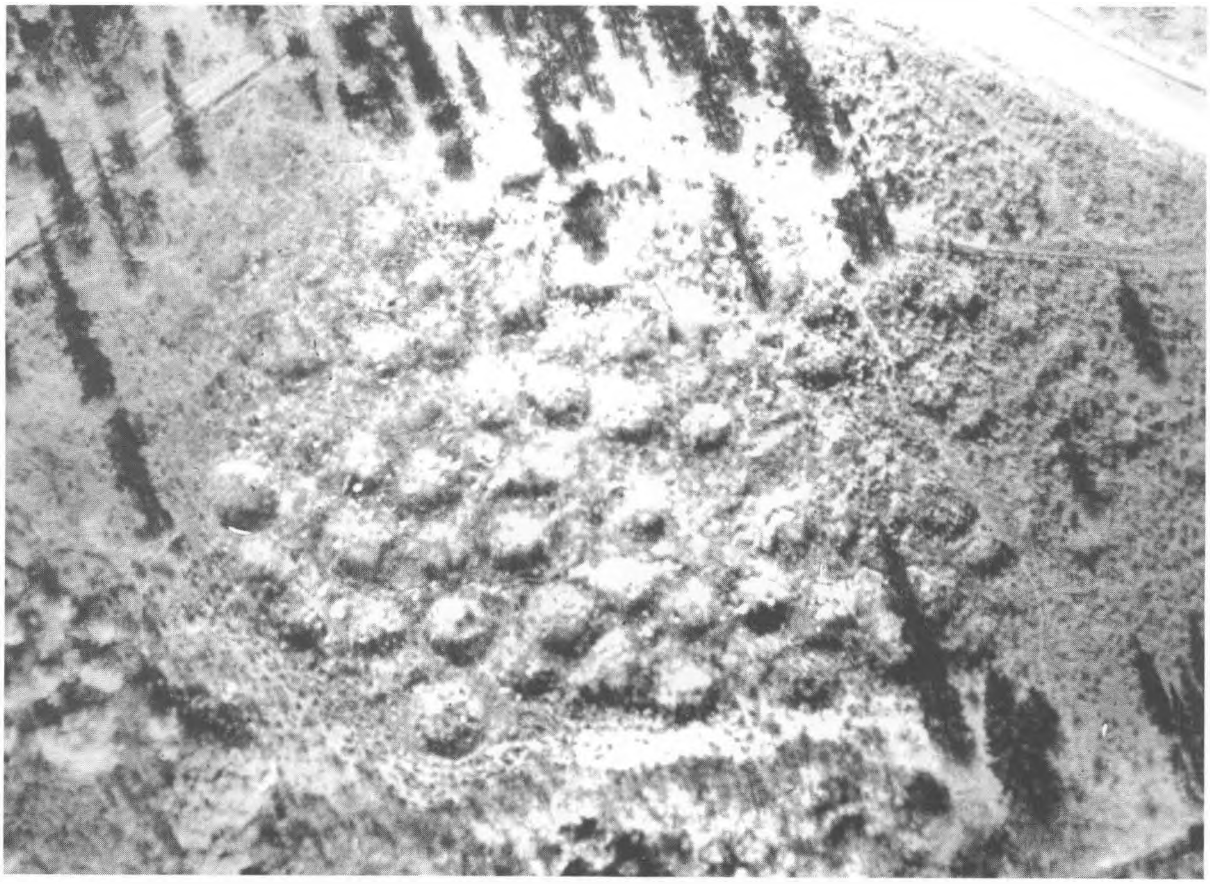

Figure 4. An aerial photograph of the Bridge River site. Note the high density and degree of clustering of the housepits, giving the impression of a bounded settlement. Imagery by Arthur Roberts.

a tour of all the potential sites where project goals might be investigated with the best chance of success. He had concentrated most of his excavation work at the Bell site (Fig. 3) where there were 23 housepits and 8 "flats" (different types of dwellings or possibly filled-in housepits). There were two other unusually large sites near Lillooet, both relatively unexcavated, and both containing large housepits: the Bridge River site with about 60 housepits (Fig. 4) and the Keatley Creek site with over 100 housepits (Fig. 5). Other relatively large housepit sites apparently existed at Texas Creek, at the east end of Seton Lake with over 75 housepits (Stryd and Hills 1972), at Fountain flats, and at Pavilion. However, if large numbers of structures did exist at these locations, they have been obliterated by roadbuilding, modern settlements, and agricultural activities. Only a few remnant housepits have been recorded at each of these locations.

Stryd and I also visited the large housepit site along Kelley Creek (EfRk 1) with about 100 housepits. However, no unusually large housepits occurred at this location and initial indications were that the site developed under contact conditions. Other reports of large villages and pithouses near Leon Creek (15 km upstream from Pavilion Creek) and at McKay Creek (4.5 km upstream from Pavilion Creek) could not be verified at the time. Leon Creek was inaccessible and examination of the McKay Creek area failed to disclose any large sites. The existence of large villages at both Leon Creek and McKay Creek has been subsequently confirmed. Still other reports of "large numbers" of housepits having been bulldozed up the Bridge River at the Moha, and smaller but substantial numbers being turned into gardens on the Bridge River Reserve, indicate still larger regional populations. Examination of private collections from these sites indicates that they were occupied during the same major periods (Shuswap, Plateau, and Kamloops) as the other classic Lillooet sites.

Of the three surviving large housepit sites near Lillooet that we were able to visit, the Keatley Creek site (EeRl 7) was not only the largest, but also had the largest sizes of structures, with one measuring 21 m in diameter. Keatley Creek therefore became the object of intensive excavation and analysis from 1986 to 1993. The chapters in these volumes constitute the result of this research.

Figure 5. An aerial photograph of the Keatley Creek site. The creek runs diagonally from the upper left to lower right. Imagery by Arthur Roberts.

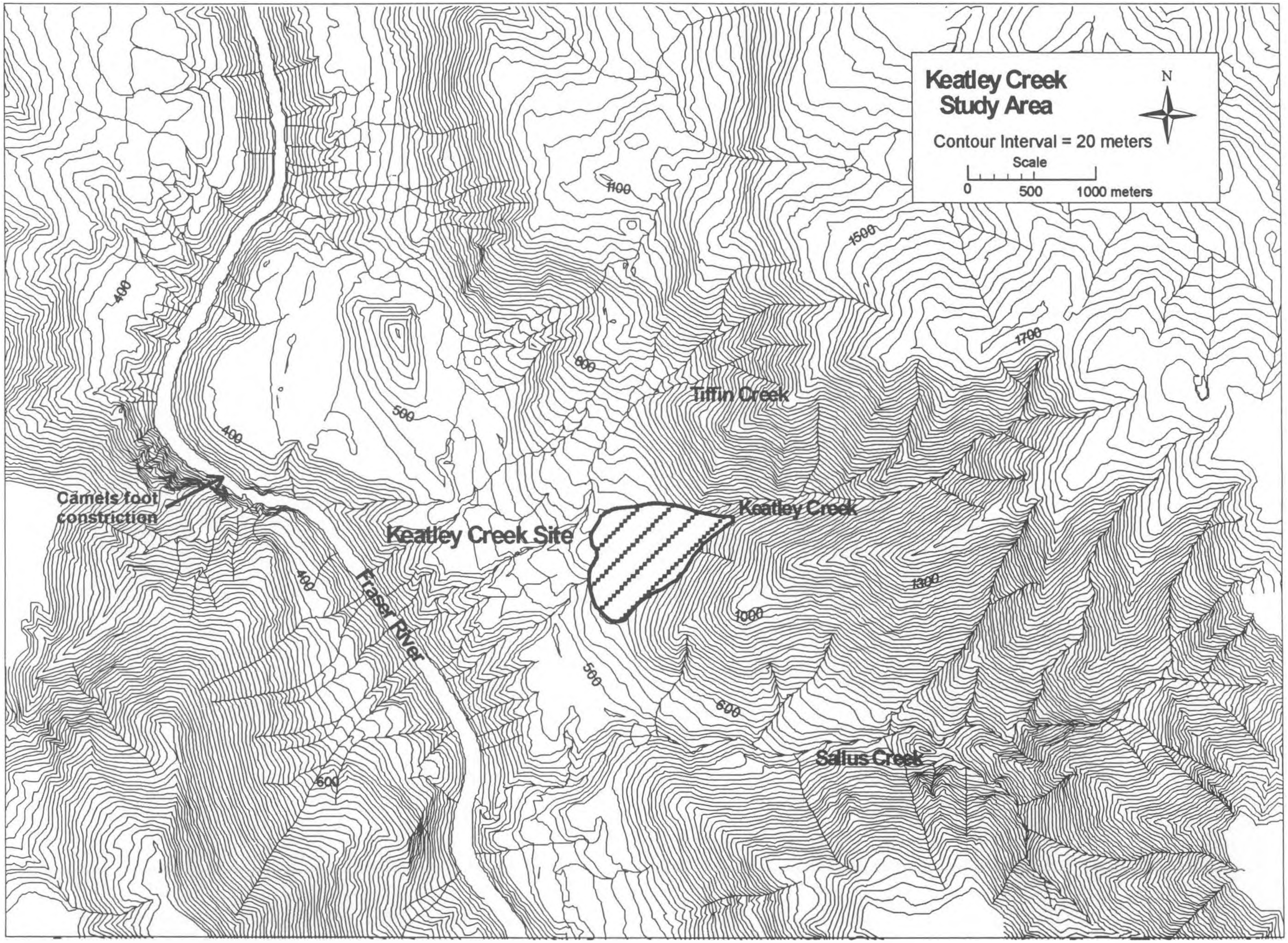

Figure 6. Topography of the Keatley Creek and Sallus Creek drainages showing the Keatley Creek site location.

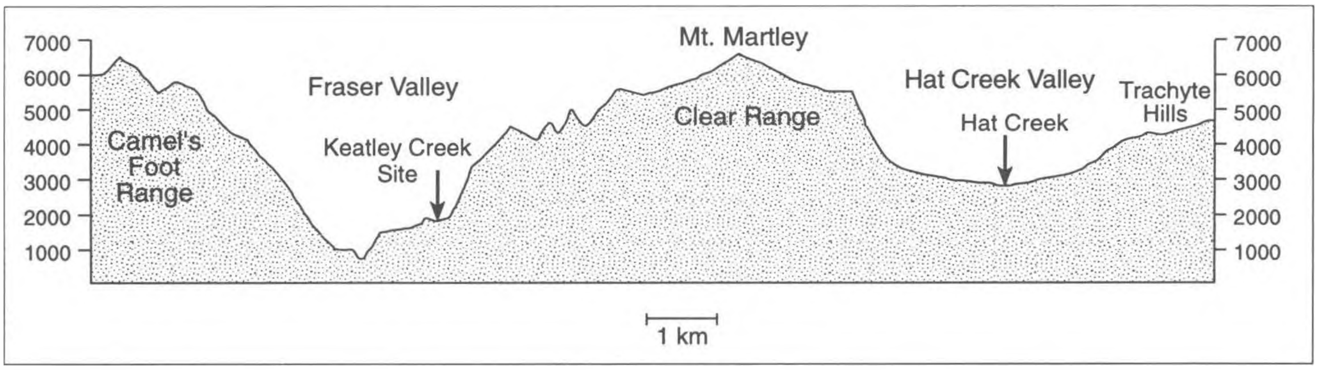

Figure 7. Transect from the Camelsfoot Range on the west side of the Fraser River, through the Keatley Creek site, over the Clear Range Mountains and through the Hat Creek Valley.

The Keatley Creek Site: Context and Ethnographic Background

The Keatley Creek site is spread over considerable vertical and horizontal space. At its maximum, the site extends from 550–640 m asl (1,800–2,100 feet asl) and stretches over 800 m along the back of a gravelly glacial terrace in the Middle Fraser River Valley. It is approximately 25 km upstream from the modern town of Lillooet (Fig. 3), and some 350 km upstream from the mouth of the Fraser River. At the eastern edge of the site, the Clear Range Mountains emerge abruptly and soar rapidly to alpine meadows reaching 1,980 m (6,500 feet asl) (Fig. 6). Below the glacial terrace, the valley flattens into a slightly lower riverine outwash terrace and then plunges precipitously down an erosional gorge to the river some 250 m (800 feet) below (Figs. 7 and 8A). The Fraser River at this point is about 210 m (700 feet).

Keatley Creek itself is also known as 15 Mile Creek (i.e., 15 miles upriver from the Cariboo trail head which is marked today by a road monument at the east end of the old bridge across the Fraser River to Lillooet). Given the ravines cut into bedrock and glacial tills, Keatley Creek must have had substantial waterflows during some periods of the Holocene; however, today the creek is largely subsurface and only emerges as a surface flow for a few hundred meters in the vicinity of the site. There is an interesting break both in the surface water run and in the vegetation of the creek bed where the creek bed passes the eastern core of the site. Mike Rousseau (personal communication) has suggested that part of the northern creek bed walls may have sloughed off as an earthflow and buried the stream channel; this seems a likely explanation. It is doubtful that the stream would have had significantly more water in the past 4,000 years since the drainage basin of Keatley Creek is considerably smaller than nearby Sallus Creek (14 Mile Creek), which does support a continuous year-round flow of water (Fig. 6).

The core of the Keatley Creek site is situated north of the creek bed in what may have been a large kettle depression containing a small kame-like hill at the north edge of the site. The densely occupied core in this depression covers about 4 ha (9.9 acres). This is a substantial size even by coastal standards; the largest Nuu-chah-nulth site is only 2.4 ha (Marshall 1992:102, 113). The permanent site datum was placed at the summit of the kame hill (Figs. 9 and 11). Several hundred meters north of the datum, there are shallow depressions and a few unusual charcoal rich ditch and ring structures which are probably associated with historical charcoal making and wood-cutting activities, either for the nearby railroad or for the substantial placer mining activities along the Fraser River only a few kilometers upstream. These features have not been investigated. A major train stop, called Glen Fraser, was situated only one kilometer due west of the site on the main river terrace. In 1986, Glen Fraser was still featured on road maps of British Columbia, and was still listed as a regular train stop even though there were no standing buildings and no inhabitants of the locality. The historical camp remains that we discovered near the surface in many housepits are undoubtedly related to this early European occupation of the locality.

The peripheries of the site extend up onto the rim of the kame terrace on the riverside, and up onto two small terrace remnants on the mountain side (Fig. 9). In addition, a few cultural depressions are found in the creek bed up to the point where the creek exits the mountains, and down near the road that enters the site along the creek bed, while lithic concentrations continue to occur sporadically along the creek bluffs out onto the river terrace. At its maximum, the site extends about 400 m from the mountain base towards the Fraser River. Scattered housepits and cache pits also occur on the terraces south of the creek. While the vast

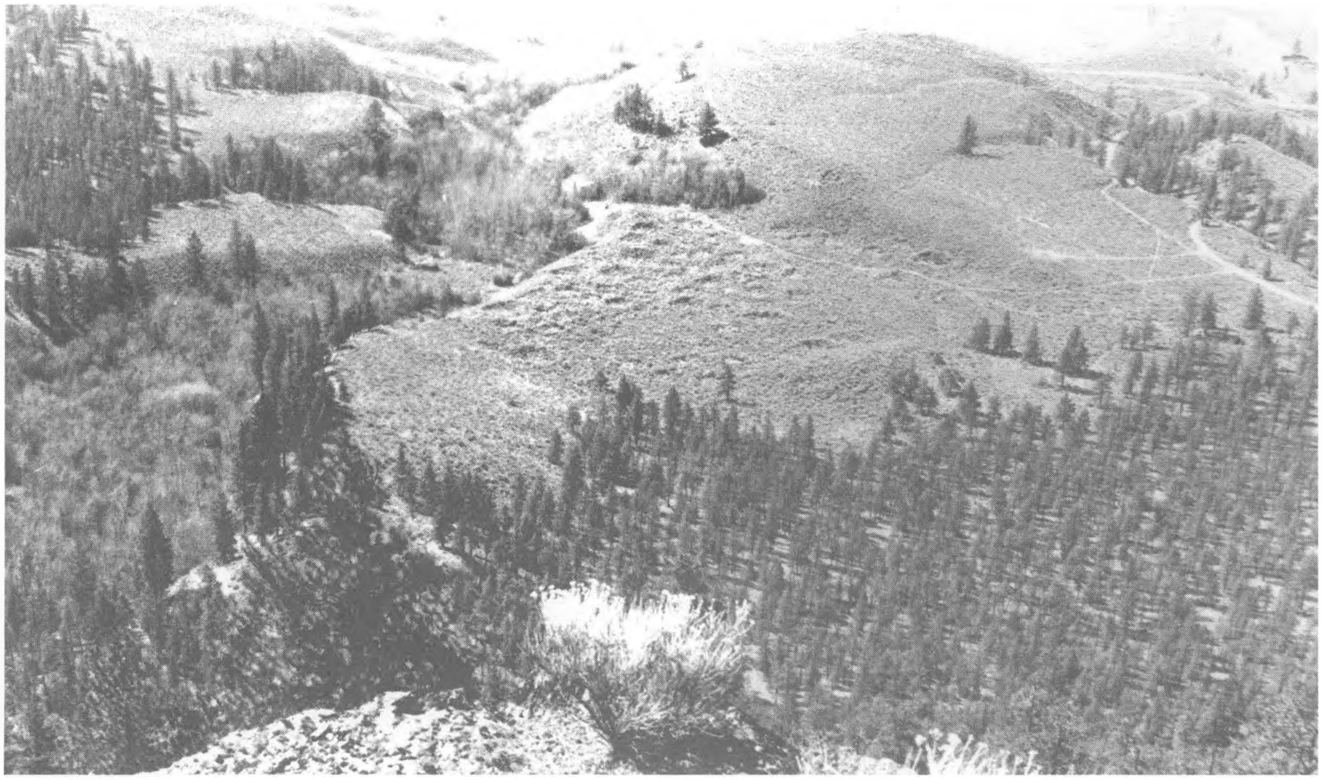

Figure 8A. A view of the core of the Keatley Creek site from the mountain slopes to its east.

Figure 8B. The core of the Keatley Creek site after the 1994 fire removed the sagebrush cover.

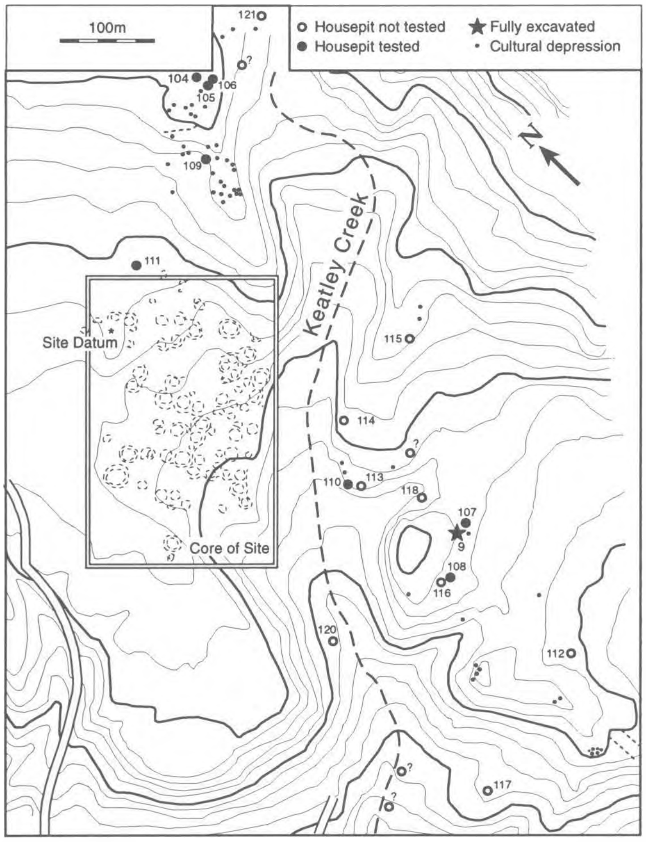

Figure 9. A contour map of the entire Keatley Creek site showing assigned numbers of housepits outside the core. The core area covers about 5 ha, while isolated housepits and small features in peripheral areas of the site cover another 8 ha. Several features and possible structures also occur along the creek about 60 m upstream from the top of the map. The map was generated by Triathalon Inc. from stereoscopic aerial photographs. Contour interval = 5 m. Imagery by Arthur Roberts.

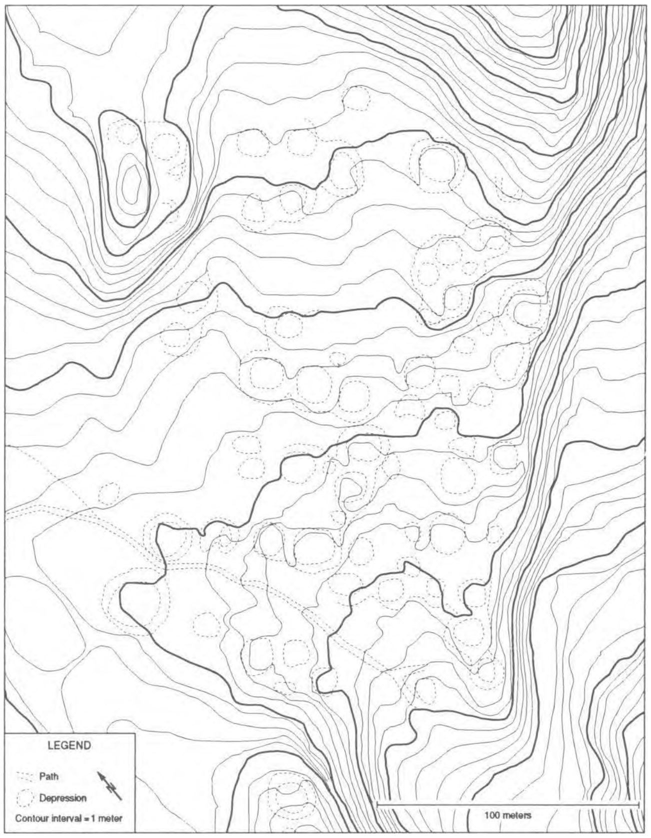

Figure 10. A contour map of the core area of Keatley Creek. Contour interval = 1 m.

majority of occupation occurs within the kettle-like depression in an area of about 4 ha, the outlying housepits and cache pits create a total site area on the order of 12 ha (Fig. 9).

Until 1994, the core of the site was covered in sagebrush, grasses, and small optunia cactus, with the upslope peripheries colonized by ponderosa pine and juniper, and the creek bed densely occupied by cottonwood, willow, aspen, some birch, and wild roses (see Lepofsky, Vol. I, Chap. 9). An early photograph of the site by James Teit (National Museums of Canada Photography No. 43555) indicates that sagebrush was well established at the end of the nineteenth century, even though local oral history as recounted by Tommy Conn and Chris Bob maintains that grassland used to be much more extensive at the site prior to 1950, and that there was more water in the creek bed but fewer trees. According to the present landowner, these changes may have been related to the past practice of overwintering cattle at Keatley Creek due to its sheltered position. On the other hand, in 1994, a forest fire completely removed all of the vegetation at the site (Fig. 8B), and given evidence of firescars on trees, this must have happened in the past as well. Thus, the site vegetation probably goes through cycles of grass and sagebrush colonization.

The site area has been of marginal value for feeding range animals, and this has undoubtedly helped to conserve the site as has its minimal water flow which has made the locality unattractive for agriculture. Approximately half of the site is on British Columbia Crown land. The other half has formed part of the Diamond S Ranch. Despite its limited grass feed and water, the overwintering of cattle at the site during the period after the goldrush (1858–1950) probably degraded surface deposits to some degree. While the waterflow was sufficient at one time to support a small orchard and homestead on the terrace immediately west of the site (to establish water rights), no such undertaking seems viable there today.

Around the time that Europeans arrived in the area, the entire eastern side of the Fraser River around Lillooet appears to have been inhabited by Shuswap

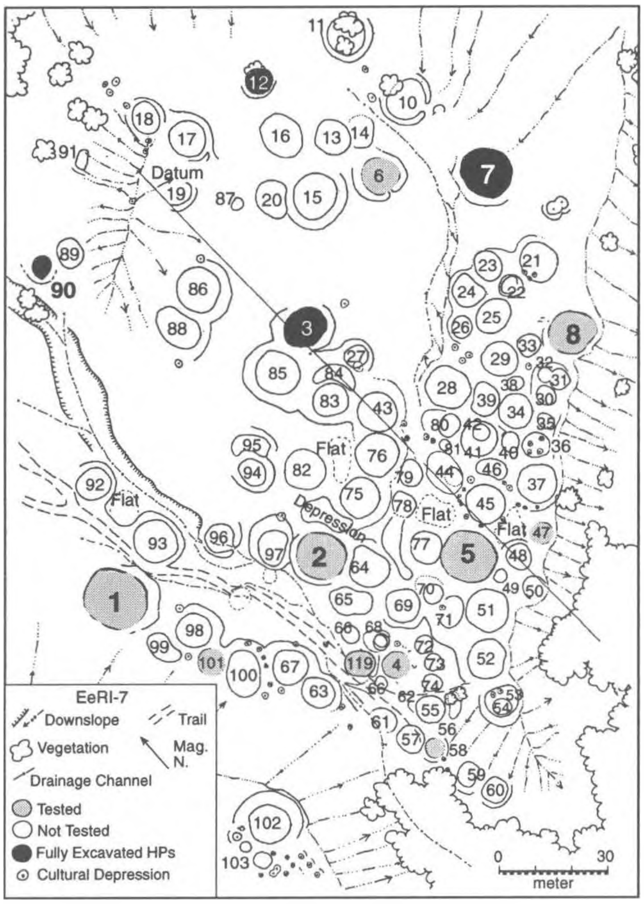

Figure 11. The Keatley Creek site core with assigned numbers of housepits. The five largest housepits are designated in bolder numbers.

speaking bands, although the Lillooet-speakers gradually became more numerous and ultimately dominated the communities of Fountain and Pavilion through intermarriage (Teit 1906:200). A detailed ethnographic and subsistence economy analysis of this region was undertaken as part of our initial research program. The results of this ethnographic study have been published as a separate volume (see Hayden 1992a). Thompson speaking communities used the Hat Creek Valley along the eastern slopes of the Clear Range (Fig. 3), while the Keatley Creek site is located at the bottom of the western slopes.

All three linguistic groups, Shuswap, Lillooet, and Thompson, are closely related linguistically and culturally, forming the main members of the Interior Salishan family. The current Lillooet term for all the Lillooet bands living along the Middle Fraser River and its lakes is, "Stl'atl'imx." This corresponds to Teit's term, "Upper Lillooet." Dorothy Kennedy and Randy Bouchard (1978:Table 1) recorded the native Lillooet term "tl'atl'lh" (derived from "sticky") for the name of the Keatley Creek locality, which is similar to the name "ta tlh" recorded for the site by Dawson (1892:42) in the last century. However, since most early ethnographers indicate that the locality was Shuswap speaking up until the nineteenth century (Teit 1906:200; 1909:463) there is no certain native name that might link the site with its earlier inhabitants.

Structural Remains at the Site and Domestic Groups

One of the most attractive reasons for conducting prehistoric research into social and economic organization on the Northwest Plateau is that individual residential structures are so easy to identify and differentiate. In contrast to the heavily vegetated coastal shell middens where post holes, not to mention living floors or structure limits, can be difficult to recognize except under special circumstances (e.g., Matson and Coupland 1995:208; Samuels 1991; Ames et al. 1992; Coupland 1985 and 1988; Marshell 1992; Chatters 1989), the sparse vegetation of the arid Interior and the excavation of residences into the ground creates ideal circumstances for the surface recognition of individual structures as well as external cache pits (Figs. 8, 9, 10, and 11). Moreover, the practice of covering roofs with dirt helped protect organic materials associated with living floors from decay once the roofs had collapsed. Using both aerial photographs and on-ground inspection, it was therefore possible to fully map all of the last used semi-subterranean housepits and cache pits at the Keatley Creek site (Fig. 11). Remains of a few earlier housepits were also encountered buried underneath the structures that were last used at the site. In conformity with established British Columbian academic usage, the term, "housepit," will be used to refer to archaeological house depressions, whereas the term, "pithouse," will be used to refer to semi-subterranean structures that were still functioning, i.e., with standing roofs.

In all, there are 119 housepit size depressions at Keatley Creek and approximately an equal number of smaller identifiable external features, most of which are probably cache pits. In this tabulation, we have assumed that structures less than 5 m in diameter (all measurements are taken from rim-crest to rim–crest) are unlikely to be residential structures, although excavations of some of these depressions has revealed that a few may have been residences for single families or individuals, or even temporary residences for menstruating women (e.g., Extra Housepit Excavations [EHPE's] 4 and 26). Other small cultural depressions were roasting pits, and still others seem too small to have been used for significant food storage (see Vol.

III, Chap. 11). While the total number of small depressions is not great for a site of this size, their functions are varied and it is difficult to use them for site-wide interpretations without excavating them.

Nor is it possible to assume that all larger cultural depressions were habitations used contemporaneously, e.g., in the calculation of population levels. While it is certainly true that the vast majority of the depressions over 5 m in diameter were probably residential structures, there appear to be several important exceptions, largely located in peripheral areas. At least one depression located in the creek bed (EHPE 20) resembled a moderate size housepit, but was clearly a very large roasting pit similar to those excavated by Pokotylo and Froese (1983) in the Hat Creek Valley. The three tested structures that occupy terrace remnants above the core of the site (HP's 104, 105, and 109) also appear to be ritual in nature. Even though these are clearly not normal residential structures, the convention of designating them by HP (housepit) numbers will be retained for referring to them in the following analyses with the implicit understanding that what is actually meant is, "housepit-sized cultural depression."

The details of pithouse construction are presented by Alexander (Vol. II, Chap. 2), and MacDonald (Vol. II, Chap. 15), and I will mention discernible changes over time in my review of culture history at the site. It is sufficient to note at this point that pithouses were generally constructed at Keatley Creek by excavating a circular area down into the ground to a depth of 0.4–1.0 m so that the bottom formed a flat floor and the material taken out formed a rim around the excavation. For larger houses, internal support posts were erected, although these were not generally used for smaller houses (e.g., HP's 9, 12, and 90). A framework of logs was then set up around the edge forming a cone with an open central space as a smokehole and entrance. The framework was filled in with poles forming a solid base on which bark slabs or mats were laid, after which pine or fir needles were added and then dirt from the rim was heaped over the surface for additional insulation.

People entered and left by ladders placed through the smokehole or by side entrances which appear to be common in small structures and may also have been regularly used in large houses but are simply more difficult to identify archaeologically. We discovered a great deal of variability not only in construction, but also in the manner in which the inside space of different sized housepits was organized. In some houses, activities seem to determine how space was used, in other houses, domestic units appear to be the dominant concern in how space was used. These are topics to be covered in Volume II. Throughout the analyses, we avoid using the terms, "household," or "family," because these are ambiguous ethnographic terms and because even when precisely defined they would be impossible to operationalize archaeologically. We prefer to use the more archaeologically-friendly term, "domestic group," and "domestic area," to refer to recognizable areas where a group either slept and/or cooked and/or carried out other manufacturing or storage activities as a unit distinct from other similar groups either within the same structure or between structures. "Domestic group" carries no implication as to whether the group consisted of a single nuclear family, an extended family, unrelated individuals, families with slaves, or several unrelated nuclear families. The term is simply an indication of the minimally identifiable socioeconomic group of people that carried out normal domestic activities together in a bounded identifiable area; it is similar to Hill-Tout's (1978b:109) term, "fire group."

Regional and Community Settlement Patterns

Considerable survey work was undertaken by Arnoud Stryd during his research around the Bell site, only 5.5 km (3.4 miles) downstream from Keatley Creek. We can therefore be relatively certain that the great majority of housepit sites in the Middle Fraser Valley around Lillooet have been recorded (Fig. 3). Unfortunately, few of these recorded sites have been dated in even a relative sense. On the other hand, the large Classic Lillooet housepit sites such as Keatley Creek and the Bell site appear to have been used from the beginning of the Plateau housepit tradition (during the Shuswap horizon ca. 3,500–2,400 BP—Stryd and Rousseau, 1995) until about 1,100 BP when a major depopulation of the Lillooet region appears to have taken place and lasted for a number of centuries (Hayden and Ryder 1991). Relatively dense populations (0.3–1.0 people per square km—Hayden 1992b:530) had been re-established by the time Europeans arrived in the nineteenth century, but the large Classic sites were never intensively reoccupied and historical winter pithouse villages rarely consisted of more than a few structures, with the communities at Fountain, Lillooet, and Bridge River being notable because of their 8–9 pithouses (Teit 1906:199; see also Teit 1900:192).

Six of the nine small sites tested by Stryd (1980) turned out to be contemporaneous with the occupations of the large Classic Lillooet sites. This, plus the fact that the large sites were occupied for about 75% of the entire period that pithouses were used in the region, makes it seem likely that a very large number of the undated smaller sites that have been recorded in the Lillooet

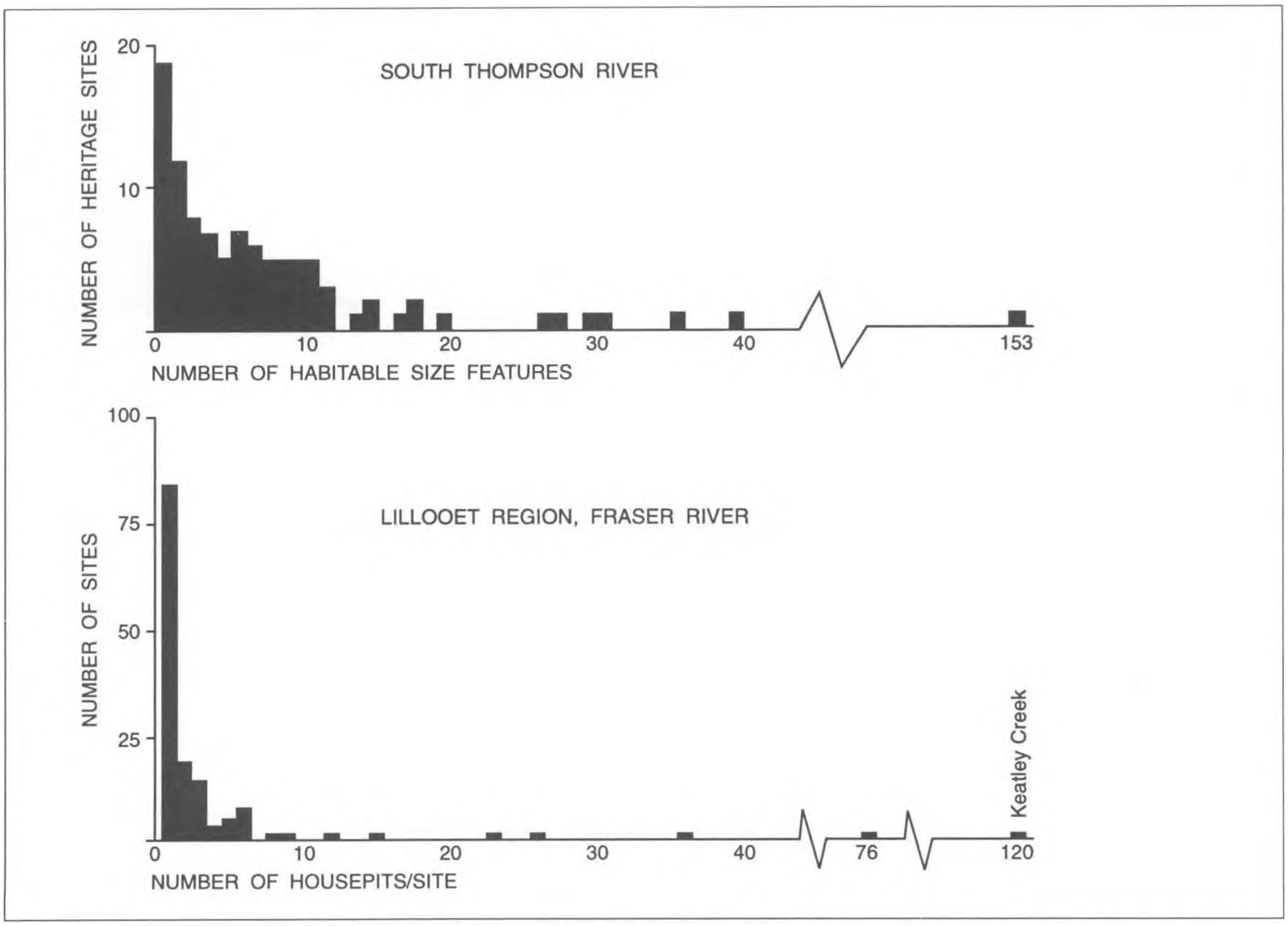

Figure 12. Settlement size distribution (based on number of housepits) for sites along the South Thompson River (above), and the Fraser River from Lytton to Lillooet (below), (Mohs 1981:56).

region were occupied contemporaneously with the large sites such as Keatley Creek. This makes it reasonable to conduct an exploratory examination of the size distribution of sites for potential indications of hierarchies in the regional settlement pattern. The results (Fig. 12) show a two or three tier grouping of settlements with sites: those with less than 20 housepits forming one tier, sites with 20–60 housepits forming another tier, and sites with more than 100 housepits (such as Keatley Creek) forming a possible third tier. Rick Schulting calculated the Gini coefficient for the Lorenz curves in both the Lillooet and South Thompson regions (Fig. 13). The Gini values and Lorenze curves measure the degree of inequality in distributions. Values were strikingly similar: 0.64 for the Lillooet region and 0.57 for the South Thompson region although it is interesting that the Lillooet region is the more extreme value. Even considering only sites that have confirmed contemporaneity with the large Classic Lillooet villages, these are strong indicators of complexity, perhaps greater complexity than was observed by Europeans.

Another striking pattern in the Classic Lillooet regional settlement pattern involves the location of three of the remaining major sites: Keatley Creek, the Bell site, and the Bridge River site. All three occur in unusual locations that were never reused once abandoned about 1,100 BP. The Keatley Creek community was located in a secluded hollow, as if hidden. Its position may have been good for defense, but also might be accounted for simply by considerations of shelter from the wind and nearness to wood and water. Two large sites near McKay Creek also seem situated for shelter from winter winds. Dawson (1892:8) notes that winter village sites are often chosen for their shelter from the wind as well as proximity to water and dry sandy soil. On the other hand, the positions of the Bell site and the Bridge River site seem to lend themselves to easy defense. The Bell site is at the top of a steep mountain incline and is also hidden among the trees, while the Bridge River site occupies an extremely compact core area at the edge of a terrace so that one wonders if there may not have been a palisade around the community that might account for its extreme

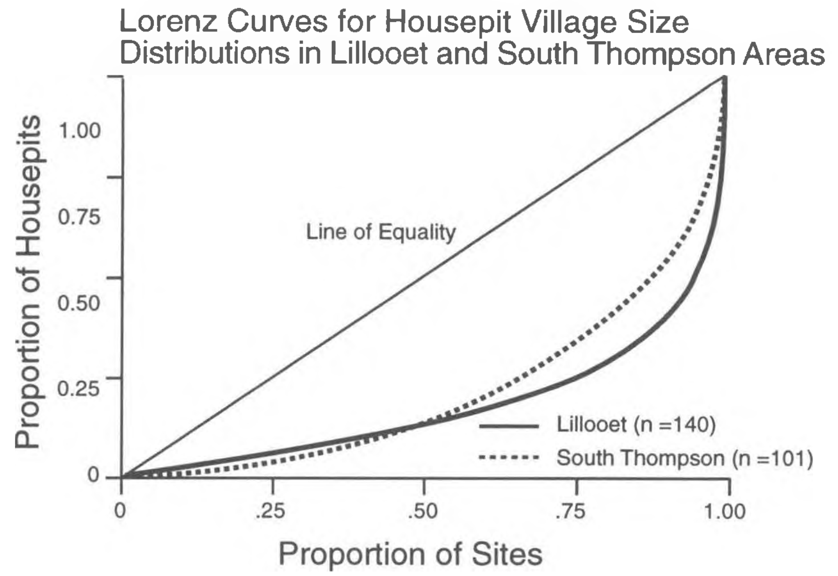

Figure 13. Settlement size distribution Lorenz curves for sites along the Fraser River in the Lillooet Region and for the South Thompson River (courtesy of Rick Schulting).

compactness. Although protohistoric and historic communities used the same major fishing sites and other resource locations as their Classic Lillooet predecessors, they chose to situate their settlements in different locations. There are many possible reasons for the abandonment of the large Classic Lillooet winter villages around 1,100 years ago. June Ryder and I (Hayden and Ryder 1991) have suggested that massive landslides in the Fraser Canyon around that time probably blocked salmon runs for decades, causing the collapse of spawning cycles and upstream prehistoric communities such as Keatley Creek that depended heavily on salmon for food and trade.

Simon Fraser (Lamb 1960:120) observed about 1,000 people camped "in shades" (probably mat shelters) at a single location near Lillooet on 17 July in 1808; however, this appears to have been for the summer salmon runs and probably included people from many winter villages as well as visitors. Simon Fraser also noted palisaded communities near Lillooet, the largest being 100 × 24 feet (Lamb 1960:82). These palisaded villages were clearly summer sites with the palisade forming one side of the shade shelters. There is no mention of pithouses in these settlements. Teit (1906:236) also recorded that fortresses were common, although no evidence of them has been found archaeologically. Moreover, it is not clear to what extent the conditions observed by Simon Fraser had already been affected by trade in European goods which he observed in some abundance even in 1808 at Lillooet. In comparable situations on the Skeena River (MacDonald 1989:18; MacDonald and Cove 1987:ix) and in the neighboring Carrier territories (Goldman 1940:334–9; Bishop 1987), the introduction of European trade led to palisaded and larger settlements as well as to increased socioeconomic inequality and concentration of power. Campbell (1990:20) documents similar trends on the Columbia River. Thus, it is difficult to argue from ethnographic evidence that palisaded settlements should be or should not be expected prehistorically.

Within the large prehistoric settlements, there is also some evident patterning. While Stryd (1973:81) remarked that the larger housepits at the Bell site seemed to cluster close to the watercourse, thereby exhibiting some access priviledges, this is clearly not the case at Keatley Creek where the five largest structures (HP's 1, 2, 5, 7, and 8) are spaced so as to maximize the distance between them (Fig. 11). It is almost as though each dominated its own local neighborhood of less important, but economically and politically allied supporters and kin. This would certainly be consistent with observations from the Northwest Coast by Garfield and McNeary (Coupland 1988:229; see also Maschner and Hoffman 1994) to the effect that there were 3–5 smaller commoners' dwellings for every chief's house. Moreover, because we know from our test excavations that the large housepits were occupied from the beginning of the housepit occupational sequence (during the Shuswap horizon) to the end of the Keatley Creek occupation, it is apparent that the spacing considerations between large housepits probably prevailed from very early

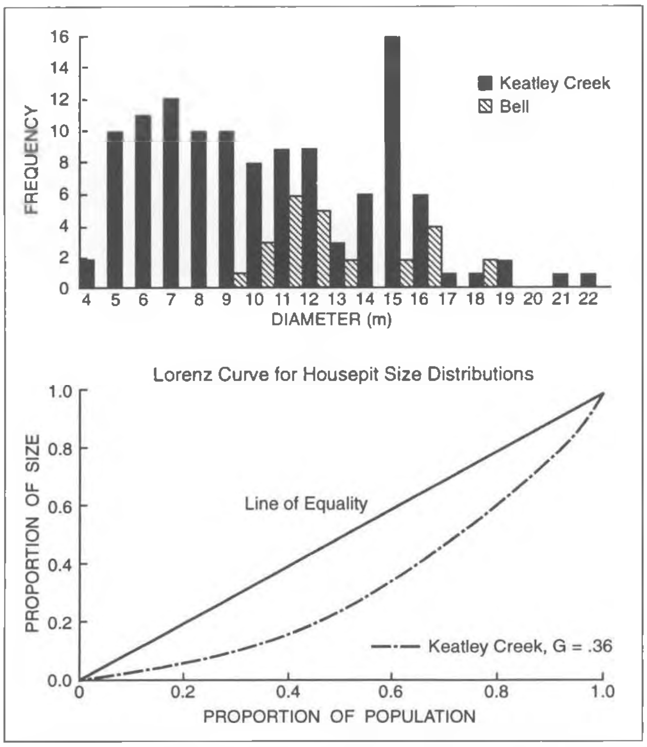

Figure 14. Housepit size distribution (rim to rim diameters) at Keatley Creek and the Bell site (from Stryd 1973) and the corresponding Lorenz curve for Keatley Creek (courtesy of Rick Schulting).

times in the site's history. Stryd (1973:81) also observed that large housepits do not occur in small sites or by themselves. This indicates that there was some economic, social, and political support from smaller houses required for the existence of large houses, resulting in a structural hierarchy.

A size distribution graph of the diameters of housepits at both the Bell site and the Keatley Creek site (Fig. 14) reveals a basic hierarchical pattern such as one might expect in communities with significant socioeconomic differences between households. from the projectile point styles associated with the housepits, we can be fairly certain that the smaller housepits were occupied at the same time as the larger housepits. There is a striking bimodal distribution of housepit sizes at the 5–12 and 14–16 m range in both sites, with very large structures (over 17 m) being so few in number that it is difficult to tell whether they might constitute a third mode at Keatley Creek. The overall distributions depart from an ideal "egalitarian" Gini coefficient of 0.0 (the coefficient is 0.36) while the maximum possible value of inequality is 1.0. We will return to these observations in the final chapter of Volume II.

As noted previously, special purpose structures such as large special meat roasting pits and probable ritual structures appear to occur on the periphery of the site, especially in upslope areas. Other special structures such as sweatbaths and other types of large roasting pits may occur in the creek bed possibly buried by earthflows or creek deposits.

On a more curious note, the specific location of some housepits is often interesting to observe. While we often attribute much greater wisdom to our predecessors than to ourselves in such matters as avoiding flood plains for building permanent structures, Keatley Creek provides a number of examples of poor judgement in the placement of housepits. Several housepits were constructed at the bottom of what are even today obvious, although very small, intermittent stream beds. One of these structures (HP 119) filled up extremely rapidly and completely to the top of its rim with sands and silts to a depth of two meters, while another (HP 118) seems to have undergone a similar fate. At first we wondered if these were not artificially created dance plazas or other special features. Still other structures, such as HP's 7 and 90, show clear evidence of water seepage and problems due to poor positioning. Other structures have been partially filled with alluvium after abandonment. It is possible that the "flats" described by Stryd (1973:77) at the Bell site were housepits that had been filled in by these, or similar, processes.

Interestingly, in the Interior Salish myths that Teit (1909, 1917) recorded, the theme of water filling up houses by magic or other means occurs frequently. Most water damage to pithouses still in use probably occurred during the warmer months when torrential storms can deposit large amounts of water in short periods of time. Precipitation in the winter is lighter and generally occurs as snow. While the pithouses may not have been occupied fully in the warmer seasons, considerable damage must still have been done to the architecture and any stored items within the houses.

Population Estimates

In 1847 Alexander Anderson, a Hudson's Bay Company trader, estimated that there were 4–5,000 natives that lived in the "Fountain" area—presumably referring to the Lower Fountain (6 Mile Fishery) and the Upper Fountain (10 Mile Fishery) on his map (Drake-Terry 1989:30–2). In comparison to Simon Fraser's earlier observations and to Teit's later estimates, Anderson's figures seem quite inflated, and may represent unusual congregations at optimal times of the year at these especially lucrative fishing and trading locations. On the other hand, Anderson's estimates are within the range that might be expected prehistorically at maximum exploitation levels during Classic Lillooet times.

Teit (1906:199) estimated that there were 1,200 people living in the entire Upper Lillooet, or Stl'atl'imx, region before European impacts or epidemics. He recorded the number of pithouses for each of the major settlements during this period, and refered to a "lesser number" or "a few scattered" structures between the major villages. If we assign about ten structures to this lesser residual category, the total number of pithouses for the region would be on the order of 60. This translates to an average of 20 people per housepit. The estimate of 20 people living in an average house accords very well with our independent estimates for the number of people living in small to medium sized housepits for the late prehistoric period. Our independent estimates are based on calculations of ethnographically documented floorspace per person from a North American cross-cultural sample. This estimate is about 2.5 m² per person (see Spafford 1991:24; Hayden et al., 1996). There is certainly some variation around the central tendency in these cross-cultural data, and this variation is reflected in the range of probable population densities for given floor areas highlighted in Table 1. We have used the values most closely corresponding to the central tendencies. A reasonable case can also be made for slightly higher densities (about one person per 2.0 m²) in smaller ethnographic housepits than in larger housepits where most densities are on the order of one person per 2.5–3.0 m² (see Hayden et al. 1996). This is the reason for the slightly different density estimates used for small and large housepits in Table 2. The use of lower density figures for estimating resident populations of medium and large housepits results in a relatively conservative total population estimated. Diana Alexander's assessment using only data from the Plateau arrived at estimates about twice as dense as those that I am using and almost twice the number of inhabitants for the largest pithouses (Vol. II, Chap. 2). However, I have decided to use the far more conservative estimates based on the larger cross-cultural sample, preferring to err on the side of caution. However, the following population estimates might easily be increased by 50% and still be considered justifiable. On the other hand, Samuels (1991:204–7) reports that Coastal "family areas" with 2–12 people in each were 4–5 m in diameter. This is remarkably similar in size to the size of "domestic area" sectors that were identified on strictly archaeological criteria in HP's 3 and 7 at Keatley Creek (Vol. II, Chap. 11). The population estimates based on the number of resident families implied by these "domestic areas" accords well with our conservative housepit population estimates based on floor areas. Thus, floor area estimates are used in determining the population levels at Keatley Creek.

In order to approximate the population of Keatley Creek at its height, it is necessary to make a number of assumptions. First, it is reasonable to assume on the basis of our test pits and with the evidence for continuous occupation in Bakewell's analysis (Vol. I, Chap. 16), that all of the five largest housepits were occupied contemporaneously and for the vast majority of the site's history. This is probably also true of the medium sized housepits such as HP 3 that occur in the 13–17 m diameter range (a total of 32 housepits in all). It is really only the smaller housepits that seem to have been occupied for relatively short periods of time and which may include some non-residential structures as well. Given the rarity of housepit overlap, i.e., cross-cutting surface relationship of housepits (indicating non-contemporaneity), it would seem that a high proportion of the housepits present in the core of the site were probably occupied more or less simultaneously. The equidistant spacing of the largest housepits also suggests that the areas between these major structures were occupied by other smaller structures when the original locations for the large housepits were chosen,

Table 1. Pithouse Population Estimates

House Radius (m)	Floor Area (m²)	Pithouse Population									
2.50	19.6	19	13	9	7	6	5	4	4	3	
3.00	28.3	28	18	14	11	9	8	7	6	5	
3.50	38.5	38	25	19	15	12	10	9	8	7	HP 12
4.00	50.3	50	33	25	20	16	14	12	11	10	
4.50	63.6	63	42	31	25	21	18	15	14	12	
5.00	78.5	78	52	39	31	26	22	19	17	15	HP 3
5.50	95.0	95	63	47	38	31	27	23	21	19	
6.00	113.1	113	75	56	45	37	32	28	25	22	HP 7
6.50	132.7	132	88	66	53	44	37	33	29	26	
7.00	153.9	153	102	76	61	51	43	38	34	30	
m²/person		1	1.5	2	2.5	3	3.5	4	4.5	5	

Table 2. Estimating the Maximum Site Population at Keatley Creek (see text for detailed discussion)

1. Assuming there is a linear relationship between rim and floor diameter and based on the data from HP’s 12, 3, & 7 generated the following regression formula:

   floor diameter = 2.7 + 0.47 (rim diameter)

2. Population density is assumed to be higher in smaller housepits. Figures used for density estimates were:

   large HP’s = 2.5 m^2/person

   small HP’s = 2 m^2/person

3. Excavated housepits with diameters > 14 m (n=6) consistently have evidence of occupations extending across at least 2 Plateau Pithouse horizons. Evidence of occupation during 3 or even 4 horizons is present in 4 out of the 6. So, large housepits were probably occupied throughout much of the site’s history.

   Smaller housepits tend to have shorter occupations. Probably only a portion of small housepits were occupied at any given time. Thus the estimated population of large and medium HP’s = 1,100; with $^1/_4$ of small HP’s = 1,500 total site population, or with $^1/_2$ of small HP’s = 1,900 total site population.

and presumably for some time thereafter. Most of our testing of the small housepits has indicated that a high proportion were last occupied during the Plateau horizon (2,400–1,200 BP). If we assume that a conservative 25% of the small structures (N=80) were simultaneously in use, this means about 20 small structures were in use at the peak occupation of the site together with the 32 medium sized and the five large structures. Using the floor area per person estimates that were generated by our cross-cultural analysis, Spafford (1991:24) estimated about 45 residents for the large housepits, 25 for the medium sized housepits, and 16 for the smaller housepits. This would result in 1,100 residents for the combined medium and large housepits, plus 400 residents for the estimated 20 contemporaneous small structures, for a total peak site population of 1,500 (Tables 1 and 2).

This accords reasonably well, and very conservatively, with the estimate provided by Teit of 1,200 people in approximately 60 small or medium sized pithouses (at an average of 20 people per house). Even if we reduce the resident density of large and medium sized housepits to one person for every 3.0 m^2 of floor area, this still results in a site population of 1,187, without attempting to account for families that overwintered in mat lodges rather than in pithouses, a practice Teit documented numerous times (Teit 1900:195; 1906:213; 1917:22; 1930:226; also Dawson 1892:8). Among other pithouse using groups such as the South Okanagan and Pomo, only the richer families had pithouses (Post and Commons 1938:40; Barrett 1975:42), and this may have also been a factor of importance in the Lillooet region. It is also possible that large houses held many more residents, at much higher densities of people per floor area, than we have allowed. Several ethnographers report large houses with 60 to 70 to 80 or even 100 residents (Hill-Tout 1978a:58; Post and Commons 1938:40; Nastich 1954:37). This is considerably more than the 45 residents that we have assumed occupied the largest housepit we excavated which approaches the maximum recorded housepit size anywhere on the Plateau. Thus, we have a fair degree of confidence that the total site population at Keatley Creek at its greatest would have *minimally* been on the order of 1,200–1,500 people with some allowance for a few structures not being in constant use. The maximum site population may have been substantially more. I will discuss variations by chronological period below.

If the other Classic Lillooet communities together with the Bell site and the Bridge River site, as well as sites on Seton Lake, at Pavilion, at Texas Creek, McKay Creek, Leon Creek, and smaller communities such as those recorded and tested by Stryd, are all considered contemporaneous at some time in the past, then the regional population of the Stl’átl’imx area must have been considerably greater than even the early levels reported by Teit. In fact, Stryd (1973, 1980) reports an occupation history at the Bell site similar to Keatley Creek, that is, all the large housepits were occupied during the three major Late Prehistoric periods, the Shuswap, Plateau, and Kamloops horizons. This in turn, would imply much more abundant salmon runs during Classic Lillooet times since it is difficult to imagine any of the other resources having been substantially more abundant during this period, whereas we are quite confident that dramatic changes took place in the salmon runs (see Vol. II, Chap. 8). There is strong evidence that the large and medium sized housepits at Keatley Creek were continuously occupied (see Vol. I, Chap. 16), and there is no reason to assume that this would not have also been true at the other large Classic Lillooet villages. If we minimally assume that populations at all the other locations *combined* were on the same order of magnitude as the population at Keatley Creek, then the regional population density would be on the order of two to three people per square km (see Hayden 1992b:530). With such an increase in population density (and the increased density in resources that this implies), compared to historic records, it might well be expected that the

Classic Lillooet communities would exhibit more complexity than those historically observed. Unfortunately, the uncertain and usually powerful influence of trade for European goods may have had a disproportionate effect on socioeconomic complexity even among relatively low density populations as demonstrated among the Alkstcho (Goldman 1940). Thus, the question of the relative complexity of historic, protohistoric, and prehistoric communities in the Lillooet region must be deferred to a later discussion (Vol. II, Chap. 17).

Sampling, Testing, and Excavating at Keatley Creek

Sampling and Testing

Having decided to focus our archaeological research at Keatley Creek, it remained to decide which housepits to excavate. As already noted, the very nature of the research problem suggested that we should excavate one of the largest housepits in order to maximize chances of detecting and understanding the strongest material, social, and economic patterns associated with residential corporate groups. We therefore tested the five largest structures at the site to determine which had the clearest indications of intact and recognizable living floor deposits. In order to understand how these larger housepits differed in terms of economy and social organization from other housepits, a sample of small and medium sized housepits was also tested with an emphasis on smaller housepits in order to provide as much contrast as possible to the large residential corporate groups, and therefore, hopefully reveal basic factors related to the emergence of residential corporate groups in the area.

In selecting housepits in the small size range for testing, emphasis was placed on peripheral structures rather than those in the core since it was reasoned that the structures closest to the center of the site would have the highest chances of being built into earlier structures, would have the most complex stratigraphy, and therefore be the most difficult to interpret. The few small structures that we did test in the site core, did, in fact, tend to exhibit unusually complex stratigraphy that was difficult to interpret (e.g., HP's 48, 57, and 101). A high proportion of the smaller housepits on the periphery of the site were tested, and a selection from these was made for more extensive excavation based upon the clarity of their stratigraphy, particularly as related to living floor deposits, as well as upon their perceived contemporaneity with the living floors in the large housepits. Only two medium sized housepits were tested or excavated, chosen partly on the basis of the lower density of other housepits in the immediate vicinity (thereby reducing chances of complex or disturbed stratigraphy), and partly on a simple judgemental basis. We also avoided housepits that had been heavily disturbed by unauthorized excavators. Probably 80% of the structures exhibited limited disturbance of a few square meters. Only three or four structures had been intensively plundered.

In all, 23 housepit size structures (Fig. 11) were tested; this constitutes 20% of all the housepit size structures at Keatley Creek. The floors of five structures were completely excavated, including three small housepits (HP's 9, 12, and 90), one medium sized housepit (HP 3), and one large housepit (HP 7). While small housepits can be excavated by small crews in one or two field seasons, the careful excavation of medium and large sized housepits requires much larger crews, resources, and analytical capabilities. The funding available for the project therefore restricted our sampling of medium and large sized housepits to one each. It would have clearly been desirable to have excavated other examples from the medium and large housepit size categories; however, from our experience in testing other large structures, our results seem representative of the group as a whole. The strong results that have emerged from our research also inspires confidence that the major patterns that we have detected will be confirmed by future work along similar lines. In terms of a pioneering and exploratory research project, I feel that the results have more than justified the procedures and efforts involved. We have succeeded in establishing some of the soundest foundations available for understanding past social and economic organization in prehistoric Canada.

Testing of housepits was standardized by the excavation of trenches 50 cm wide laid out from the top of the southernmost point of the rim and extending due north to a point approximately in the center of the housepit. Trenches were divided into 2 m linear sections, and sediments were excavated in natural layers where these were apparent, and in arbitrary 10 cm levels contoured to the surface where no stratigraphy was apparent. The southern sector of housepits was chosen because I suspected that higher ranking individuals might set up their domestic affairs in the southern sectors inside pithouses due to possible warming effects of the roof by the winter sun (e.g., Thomas 1988:576). If there were any striking differences to be immediately detected between housepits during our sampling program, I thought testing them in the southern sector would be the most likely to reveal such differences. This manner of testing structures was efficient (given the small width of the test trench involved), minimally disturbed housepit desposits, provided important stratigraphic information about the suitability of each structure for further excavation, and also provided key information from rims on the intensity of occupation, length of occupation, and period of occupation of the structure. These test trenches also enabled us to determine which depressions were not structures or were specialized structures, how frequent burning of roofs occurred at the site, and provided important glimpses of internal features such as large storage pits that occurred in most test trenches of large housepits but were never encountered in test trenches of small housepits. In all, a great deal of information was derived from this testing program that enabled us to reconstruct the site structure and history in considerable detail (see Vol. II, Chap. 17; Vol. III, Chap. 10).

In order to determine further details about site structure and activities, as well as to determine whether selective removal of bone material and dumping of bone occurred (thus biasing our view of housepit subsistence), we undertook a program of testing 13 of the approximately 125 clearly non-housepit depressions (termed, Extra Housepit Excavations, or EHPE's). In many cases, a 50 cm test trench across these features involved excavating half of the entire feature. These features proved to be unexpectedly varied, including roasting pits, large storage pits, small storage pits, and small structures (see Vol. III, Chap. 11). No unusually dense concentrations of bone materials were recovered from any of these features.

We also initiated a series of shovel test pits across the northern part of the site, in open areas between housepits (Fig. 11). These served not only to monitor the intensity of activities in spaces between housepits, but also provided soil samples for pedological and chemical analyses (see Vol. I, Chaps. 6 and 7; Vol. II, Chap. 6). The results show that there was very little activity that occurred away from the immediate vicinity of most housepits.

Excavation

Each housepit or extra-housepit excavation was considered an independent excavation unit. Local datum points were established for each formal excavation, including test pits (generally in the southest corner of the original test trench), and all measurements for the excavation unit were taken from the local datum (referred to as depth below datum—BD). Depths below surface (BS) were also sometimes recorded to provide some sense of the actual depth of the features being excavated. All local datums and excavation units were integrated into an overall site map and given absolute depths below the site datum. These site-wide coordinates were rarely if ever used due to the large, complex and cumbersome notation system required to cover a site with the extent and topographical relief of Keatley Creek.

Housepits selected for extensive excavation were first cleared of sagebrush and cactus, and then gridded out into 2 × 2 m squares with arbitrary letter designations assigned to each square and recorded on the excavation unit map. Each 2 × 2 m square was then divided into a standardized sequence of 16 subsquares, designated by numerals 1–16 (Fig. 15). Each subsquare was 50 × 50 cm, a size which I found from previous experience to provide maximum control over stratigraphically complex deposits, as well as providing relatively fine level resolution for the plotting of artifacts on surfaces. This procedure obviated the need to plot three coordinates for every tool of interest (as well as eliminating the need to identify every tool of interest at the time of excavation) in order to graph the distribution of artifacts on living floors. Excavating in 50 cm subsquares proved to be very efficient. This procedure also avoided the problems inherent in opening up entire square meters (or even 4 m^2) at a time when stratigraphy could be ambiguous and when analysts wanted to know with more precision where specific artifacts came from within such large areas. The positions of time diagnostic or unusual artifacts found *in situ* were also extrapolated to the nearest profiling wall of a square, and the precise relative stratigraphic position recorded on the profile. Although this approach described above requires the filling out of many more provenience cards than the use of larger excavation units, I feel the results have amply demonstrated its advantages and utility.

In order to minimize time spent in filling out provenience forms, a "quick-check" card was developed so that excavators had only to enter key provenience data (housepit number, square, subsquare, stratum, and level) and circle the type of deposit, as well as check off the contents (lithic, faunal, or botanical), initial the card, and record the number of fire-cracked rocks excavated in a stratum or level. Other specialized information fields were used for soil, flotation, and radiocarbon samples. There was also a small centimeter scale along one edge with the Wentworth breakpoints for granules, pebbles, and cobbles marked out.

Four of the 16 subsquares in each square of an excavation unit were designated as "sampling subsquares." Slightly more than one liter samples were taken from all floor deposits (and occasionally roof deposits) in the sampling subsquares, forming a systematic sample pattern across the floors. A small amount of these samples was reserved for chemical tests (see Vol. II, Chap. 6), and the remainder was floated for botanical remains by water screening with a 1 mm mesh (see Vol. I, Chap. 9; Vol. II, Chaps. 4 and 5). Heavy fractions were

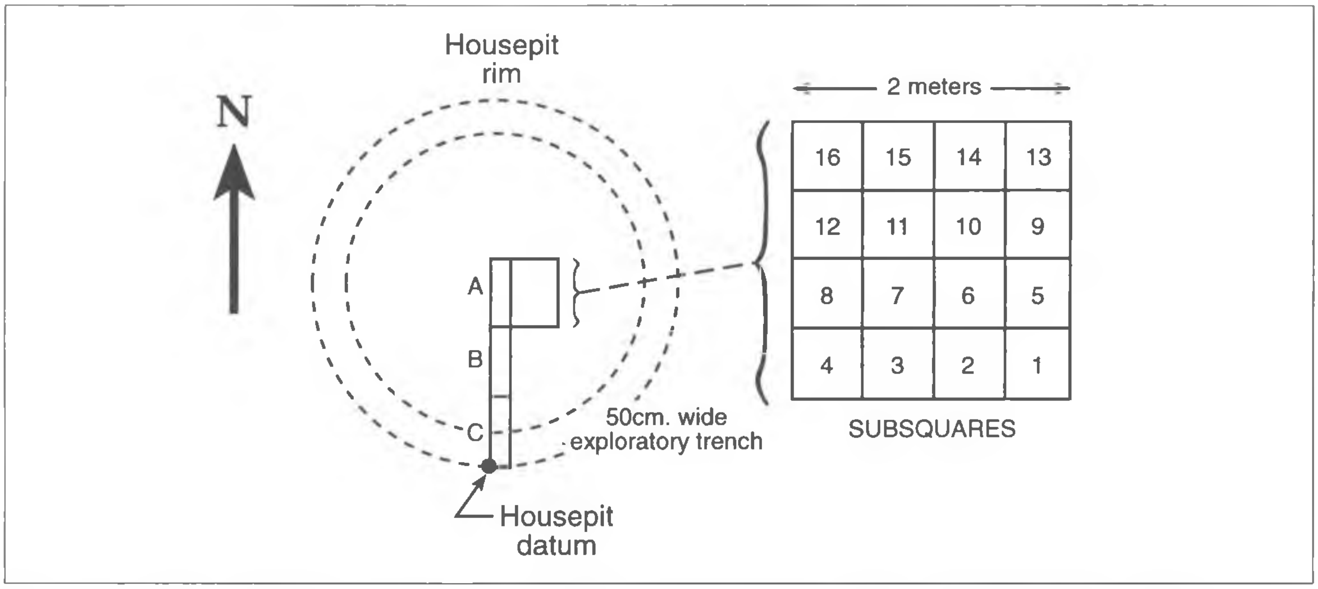

Figure 15. A schematic diagram of the provenience system used in the excavations at the Keatley Creek site.

then analyzed for small debitage and bone (Vol. II, Chap. 9), while the light fractions were analyzed for botanical remains. Otherwise, all deposits were screened with a 1/4 inch mesh screen.

Extensive excavations always proceeded from a known stratigraphic profile, initially from the test trench walls, in order to maximize good stratigraphic control. The nature of these deposits is described in detail in other chapters of this volume. A great deal of variability was encountered in virtually all deposit types (floors, roofs, and rims). In order to attempt to record some sense of this variability and the characteristics of each deposit type, stratigraphic records were filled out detailing the general pattern of cobble, pebble, gravel, sand, silt, and clay content, as well as frequencies of charcoal, artifacts, bone, and degrees of compactness, staining, color, bioturbation, or other modifications. During the first field season, excavators recorded the dip of all bone and chipped stone materials in order to determine whether there were differences in the angle of repose of these items in floor versus roof deposits. After 1987, excavators were asked to place cobbles and pebbles in their buckets after screening in order to monitor the relative proportion of these elements in various strata. This provided a good empirical, and relatively accurate, check on variability between and within strata. With percentage lines marked on the inside of buckets, most people had little difficulty in estimating the various clast percentages to within 10%.

Archaeological deposits were divided up into strata (deposits covering a large portion of the local excavation unit), levels (arbitrary subdivisions of usually 5 or 10 cm within thick strata), and fill units (highly localized deposits such as those in storage pits or those forming identifiable dumping events on certain parts of the floor).

In hindsight, it is possible to identify some of the features of this excavation program that worked well and others that might be improved. Among the aspects that worked well were the use of 50 cm subsquares; the use of cards that could be easily and quickly filled out (including fields for all important types of information, such as floor characteristics); the insistence that excavators attempt to interpret the nature and origin of strata in the field; the use of localized datum points for each housepit or extra-housepit excavation and the tying of these localized points into an overall site grid and datum point; the use of nails in the field to mark important boundaries between strata and to mark positions of important artifacts in wall profiles; recording of important artifacts in field notes by means of outline drawings; the systematic taking of flotation samples across floors and some other strata; the recording of the depth of fire reddening in hearth features; and the systematic estimation of pebble and cobble fractions of deposits.

Aspects of the project that would be improved in an ideal world would include the incorporation of recording specialists whose sole job would be to record profiles, photograph important aspects of the site, as well as specialists in screening and recognizing/recording fire cracked rock, quartzite and other unusual types of artifact materials. However, realistically, this creates a great deal of monotony on the job and it might be difficult to find individuals willing to take on such tasks full time.

Research History of the Lillooet Region

Little archaeological research was conducted in the Lillooet region until the 1960's. However, in the neighboring downstream stretch of the Fraser River between Lillooet and Lytton, George Dawson (1892) and Harlan I. Smith (1899) conducted some of the earliest archaeological work in the province, concentrating on the recovery of burials without establishing any refined cultural sequences. Dawson (cited in Smith 1899:159) also reported finding beads or pendants of galena and bone at Lillooet. Prehistoric burials were also recovered by Charles Borden at Cache Creek between 1954 and 1956 (Pokotylo et al. 1987) and by Borden and Sanger at a location disturbed by earth moving equipment near Texas Creek (Sanger 1968). Further afield, Smith (1900) excavated burials near Kamloops and Sanger (1969a) recovered another set of disturbed burials in the same region.

In the 1960's about 25 sites were recorded by geologist Len Hills (Hills 1961; Stryd and Hills 1972), and David Sanger (1963,1966) began excavations at the Lochnore-Nesikep Creek Locality about 26 km downstream from Lillooet along the Fraser River. This locality includes a now destroyed site which once included 24 housepits according to the landowner (Bert Lehman, personal communication) with artifacts indicating that the site was contemporaneous with the Keatley Creek site. Sanger (1967, 1969b, 1970) established the first major chronological sequence for Interior British Columbia.

Sanger's chronological sequence was subsequently refined by a number of researchers beginning with Arnoud Stryd and others involved in his Lillooet Archaeological Project (Stryd 1972, 1973, 1980, 1981; Stryd and Baker 1968; Stryd and Lawhead 1978; Blake 1974; Rittenberg 1976). Stryd's work included the comprehensive survey and mapping of all housepit sites in the Lillooet region with the exception of a few subareas including the area between Keatley Creek and Pavilion. He also tested a number of housepit sites and conducted extensive excavations at the Bell site.

In 1976, David Pokotylo began the intensive survey of sample quadrats in the Upper Hat Creek valley and the Clear Range uplands, located along the opposite slopes of Mount Martley from Keatley Creek (Fig. 6). Pokotylo also undertook test excavations at a number of the sites located in Hat Creek valley (Pokotylo 1978, 1981; Pokotylo, Greaves, and Burnard 1983). Some of the most surprising results included the identification of roasting pits up to 7 m in diameter (Pokotylo and Froese 1983).

More recently, Michael Rousseau (Rousseau 1986, 1989; Rousseau and Gargett 1987; Rousseau and Richards 1988) has undertaken survey and excavation work in the Cornwall Hills area on the opposite side of Hat Creek, and extended his work down to the Thompson River. Farther upstream from Keatley Creek, R.G. Matson and Martin Magne (Magne 1985; Magne and Matson 1987) have undertaken survey and excavation work in the Chilko River drainage, a tributary of the Fraser River.

As a result of these research projects, plus a number of consulting investigations and other research done in the Kamloops region or elsewhere on the Plateau, a reasonably detailed synthesis of culture history has emerged for the Plateau. The major syntheses have been the work of Richards and Rousseau (1987), Stryd and Lawhead (1978), Pokotylo and Mitchell (1993), and Stryd and Rousseau (1995). One of the major achievements of these syntheses, particularly those of Rousseau, Richards, and Stryd, has been the secure identification of time-sensitive projectile point styles for each of the periods and each of the major horizons on the Plateau. The following summary of the occupation at Keatley Creek is based upon these syntheses.

Culture History at Keatley Creek

Early Prehistoric (11,000–7,000 BP)

There is only one possible indication of the presence of Early Prehistoric period man at the site. This is the basally edge-ground fragment of a point that may be related to Windust point types (see Vol. I, Chap. 3, and also Stryd and Rousseau 1995). Given the fragmentary nature of this point, it is also possible that it could be from the Middle Prehistoric period. This point base was recovered from loessic deposits underneath the rim of HP 5 which contained microblades in the upper levels. Unfortunately, little organic material was preserved in this stratum and the very limited area exposed by the test trench did not provide any opportunity to investigate these deposits further.

Middle Prehistoric Period (7,000–3,500 BP)

There is localized but very strong evidence for the use of Keatley Creek as a probable base camp during the Middle Prehistoric period. Interestingly, both of the major deposits that we encountered from this period occurred underneath the thick rim deposits of large housepits with indications that the rims began to accumulate in the following Shuswap horizon. Very high densities of microblades (over 100 per square meter in some 10 cm levels) occurred in the upper loess deposits under the rim of HP 5 in association with the Early Prehistoricperiod point base, a Lehman point fragment, and other less diagnostic tool types (see Vol. I, Chap. 3; Vol. III, Chap. 10.7). Lochnore point fragments in redeposited contexts were also recovered from HP 5. Because of the elevated location of this structure on the top edge of the creek bed wall, this dense concentration of artifats probably either represents a warm weather activity locus, or is in close proximity to a substantial winter shelter. Little organic material or staining are preserved in these deposits.

The other deposit from this time period occurs under the south and southwest portion of the rim of HP 7. Microblades are associated with a Lehman and several Lochnore point fragments plus other less diagnostic tool types (Vol. I, Chap. 3; Vol. III, Chap. 5). These early deposits also extend under a small part of the southwest living floor of HP 7. Limited testing of the eastern "till" wall of HP 7 indicated that much of this material was redeposited and contained occasional flaked artifacts which may also be derived from upslope Middle Prehistoric occupations.

Under the southwest rim of HP 7, microblades and points occurred in loess deposits similar to those under the HP 5 rim. There was little organic material or staining. While most of these loess deposits appeared to be in undisturbed contexts, some of the upper deposits directly under the southwestern rim were softer with more random dips and orientations of flaked stone artifacts. It was from these apparently disturbed deposits that Lochnore point fragments were found. Groups making Lochnore style points are generally considered to be intrusive in the area and to have replaced earlier groups that manufactured Lehman style points (Sanger's Nesikep tradition, or Stryd and Rousseau's Lehman phase) around 5,500–4,500 BP (Fig. 16). The Lochnore groups (Sanger's Lochnore complex, or Stryd and Rousseau's Sqlelten tradition—see Stryd and Rousseau 1995) probably spoke Interior Salish languages. However, Wilson (1992:187) has recently questioned whether Lehman and Lochnore are really two distinct cultural entities. According to the traditional model, the bearers of the intrusive Sqlelten cultural tradition continued to occupy the region until, and after, European contact. Assuming that the Lehman and Lochnore point styles belong to different, and apparently competing, cultural traditions, it is unusual to find them in the same site.

We do not know if the Lochnore bands constructed any pithouses at Keatley Creek, although the concentrations of lithic materials at two widely separated spots where very large housepits were later built might seem to favor such an interpretation, as does the presence of a deeply buried housepit floor under the northwest rim of HP 7 which we did not have the resources to explore. The recent recovery of Lochnore housepits dating to 4,400–4,000 BP at the Baker site near Kamloops (Wilson 1992) constitutes the first definite occurrence of housepits in British Columbia from the Middle Prehistoric period. The documentation of housepits in Lochnore times in the neighbouring Thompson River drainage makes the presence of housepits at Keatley Creek seem more probable for this same time period, even though most or all of them may have been obliterated by subsequent constructions.

Although Rousseau (Rousseau et al. 1991) views Lochnore and other Middle Prehistoric communities as foragers (in Binford's 1980 classification), I suspect that the Lochnore phase represents the appearance of the frst moderately successful mass harvesting and storage technology associated with the exploitation of salmon, a technology which was refined and became the basis for the entire Plateau Pithouse Tradition (defined by Richards and Rousseau in 1987) which constitutes the latter part of the Sqlelten Tradition. Before the spread of Lochnore communities throughout the Plateau with their seasonally permanent winter pithouses, storage facilities, dogs, and other Pithouse Tradition traits (Wilson 1992), Lehman groups must have relied to a much greater extent on the year-round

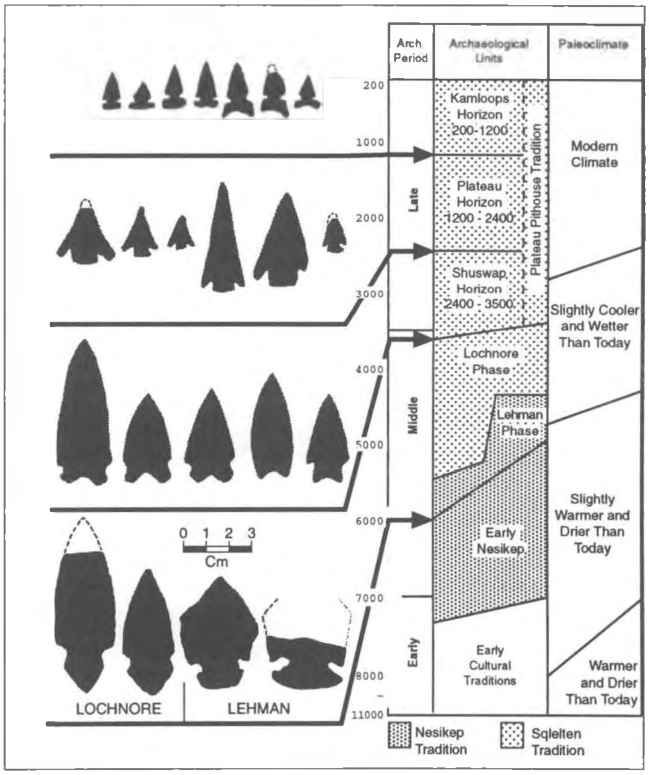

Figure 16. The culture-historical sequence of the British Columbia Plateau (Stryd and Rousseau 1995).

hunting of large and small game. It is these Lehman groups that would have been much more like Binford's foragers.

Schalk and Cleveland (1983:32) and Matson and Coupland (1995:304–5) view the establishment of semi-sedentary settlements based on salmon storage (such as is implied for some Lochnore communities) as a development of equal magnitude to the shift to agriculture in other regions. This clearly was the case in the Lillooet region and ultimately led to one of the most pronounced developments of collector (Binford 1980) and complex hunter/gatherers in Canada. Carbon isotope analysis indicates that Early Prehistoric groups in the region were only using salmon to a very modest extent: nine percent as measured from the Gore Creek burial, east of Kamloops, dated at 8,250 BP (Chisholm and Nelson 1983). By 4,950 BP, groups were well on their way to transforming their subsistence base, as indicated by two burials from the Clinton region upstream from Keatley Creek. Both individuals had obtained about 40% of their protein diet from salmon (Chisholm 1986:124) which increased to 50–67% by the Plateau horizon of the Pithouse Tradition (Chisholm 1986:124; Lovell et al. 1986). I suspect that the two individuals buried at Clinton belonged to Lochnore communities that had already begun to harvest and store salmon in bulk for at least part of the winter; however, it is not possible at this point to state with certainty that they belonged to Lochnore rather that Lehman communities.

Whether it was Lochnore groups that scooped out their own and earlier deposits and dumped them to the southwest of the future HP 7, or whether it was the Shuswap horizon descendants of the Lochnore community at Keatley Creek that scraped out these Middle Prehistoric deposits, is impossible to determine at this point.

The Late Prehistoric Period (3,500–200 BP)

The Late Prehistoric period is divided into three horizons: the Shuswap horizon, the Plateau horizon, and the Kamloops horizon. What I have termed "the Classic Lillooet culture" begins with the establishment of large houses and pithouse villages late in the Shuswap horizon and ends with the abandonment of these large villages and large structures around 1,100 BP.

The Shuswap Horizon (3,500–2,400 BP)

While the climate around Lillooet was slightly cooler and wetter during Lochnore times than it is today, an essentially modern climate was established during the Shuswap horizon (Vol. I, Chap. 4; as well as, Stryd and Rousseau 1995; Mathewes and King 1989). It is during the Shuswap horizon that the first widespread occurrence of permanent, seasonally used housepits is apparent together with other attributes typical of the Plateau Pithouse Tradition (see Richards and Rousseau 1987). Presumably, it was the successful exploitation and storage of salmon which made this development possible. It is interesting to note that while climate change may have affected the availability of salmon, deer, and elk, the Keatley Creek site continued to be used throughout the Middle and Late Prehistoric periods as a favored location, probably primarily for winter residence during all of these periods.

At Keatley Creek, almost all of the large housepits that were tested or excavated contained exclusively Shuswap style points in the basal levels of their rim middens. Many medium sized housepits also appear to contain basal rim levels formed during the Shuswap horizon. Only one indication of a Shuswap occupation was detected in a smaller housepit (Fig. 17; and Vol. I, Chap. 3), but no exclusively Shuswap occupation floors were encountered with the exception of one buried floor edge under the northwest rim of HP 7. Since the stratigraphic layers in the rims of the large and medium sized housepits did not exhibit any indications of disturbance or redeposition (see Vol. I, Chaps. 3 and 17), it seems relatively certain that Shuswap residents had constructed substantial winter structures at Keatley Creek and that they returned to these structures on a regular yearly basis. Because of the overall undisturbed nature of these deposits, it also seems likely that the Shuswap structures were about the same size as the structures represented in the last occupation of the site. That is, it does not appear that the large (and perhaps medium sized) structures changed in size to any significant degree from their Shuswap horizon occupations until their final abandonment. Moreover, in several cases, the distinctive lithic procurement profiles of the large housepits begin in the Shuswap levels and continue essentially unchanged until abandonment (Vol. I, Chap. 16). It is difficult to account for different procurement patterns between housepits that persist through time unless one also assumes some sort of continuity of corporate rights and land use patterns persisting over the same period of time. If this is the case, the Shuswap levels in the rims of the large housepits indicate the initial founding of large corporate groups which we argue later owned the most lucrative fishing locations. These corporate groups, then, would have persisted for 1,300 (minimally) to 2,400 (maximally) years.

Richards and Rousseau (1987:30) note the presence of occasional prestige items in Shuswap horizon deposits, such as nephrite tools, although decorated or

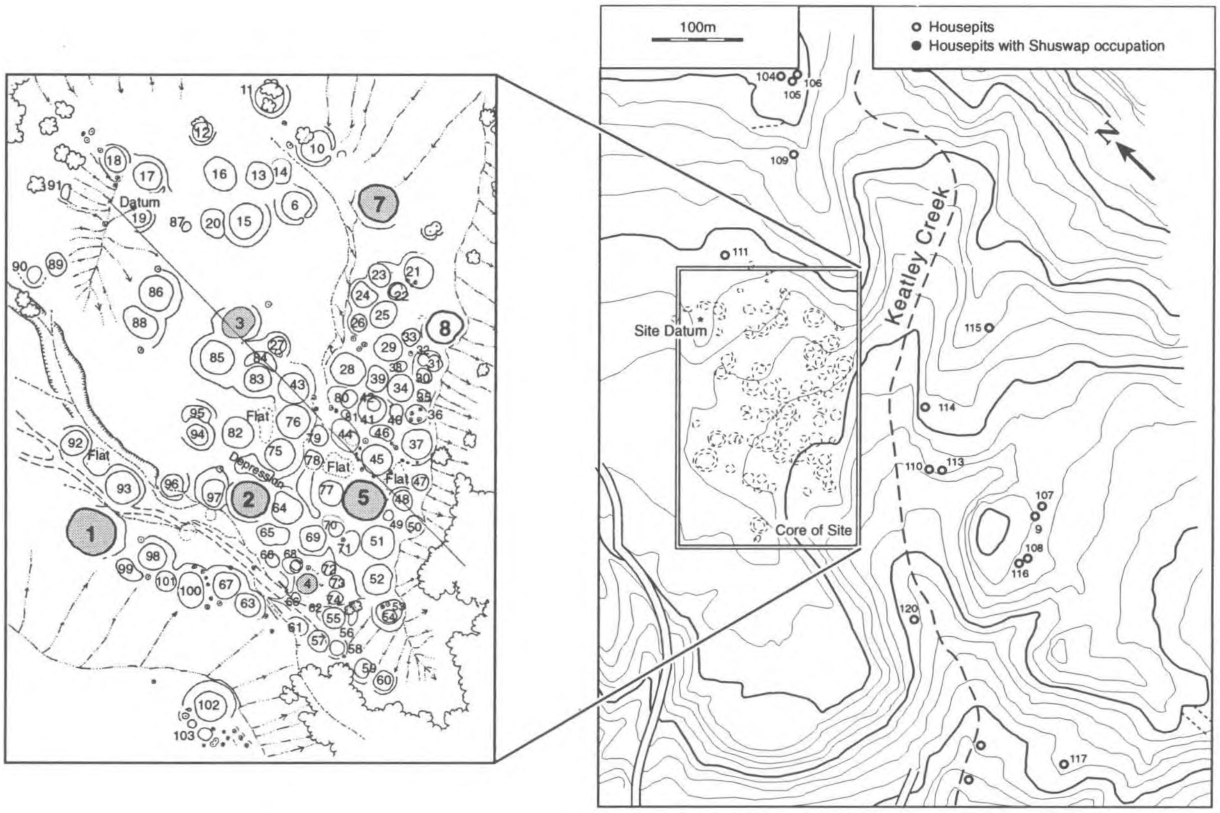

Figure 17. Housepit locations where Shuswap deposits were encountered at the base of the rims.

sculptured items are quite rare. Burials, in general, are rare from this time period, which may largely explain the relative paucity of prestige items. However, in the bottom Shuswap levels of the rim of HP 7 at Keatley Creek, we also recovered one half of a moose antler segment that had been sawn, split in half, and hollowed out, as if to create part of a protective container (see Vol. III, Chap. 2). Since there is no prehistoric indication of any moose closer than Prince George, a distance of 650 km., this appears to represent considerable long distance trade or contact. Given its unusual nature, its apparent non-functional role, and its long-distance origin, this artifact constitutes a prestige item used by some of the earliest pithouse occupants of HP 7.

Richards and Rousseau (1987:25) and Stryd (personal communication) also suggest that some of the pithouses of this horizon may not have had earth covered roofs given the shallowness and lack of roof-like material on the rims at many sites. This is entirely consistent with the stratigraphic evidence that we recovered in Shuswap and the succeeding Plateau levels of rim deposits in the large and medium sized housepits (Vol. I, Chap. 17).

Thus, during the Shuswap horizon at Keatley Creek, it appears that the full extent of the site's core area was occupied, and that residential corporate groups with rights over productive fishing locations and specific tracts of land in the mountains had become established and began building the large and medium size housepits at the site. It does not appear that many smaller housepits were constructed at this time, although more sampling of housepits in the core area of the site is required to verify this. Members of the large residential corporate groups began producing and acquiring prestige artifacts either locally or through long-distance contacts.

The Plateau Horizon (2,400–1,200 BP)

Although Richards and Rousseau (1987:32) characterize the Plateau horizon as a time when housepits diminish in size, this is clearly an inappropriate characterization of the situation at Keatley Creek. Virtually all of the large housepits continue to be used and may have even expanded slightly. All of the post holes used for major roof supports cluster in a few narrowly delimited floor areas in both HP 3 and 7, indicating continuity of the same basic structure design and size over time. Moreover, there is no indication in rim deposits of major breaks and the placement of fire-reddening and large storage pits conforms entirely to the maximum size of the housepits as represented by the last occupation during the Kamloops horizon. Some of these large bell-shaped pits appear to have been used during the Plateau horizon on the basis of the point styles found in their fill (although this is not definitive), again indicating little change in structure size during these periods. Thus, a number of lines of evidence indicate that the large housepits remained close to their maximum size before, during, and after the Plateau horizon.

On the other hand, our test excavations in smaller housepits suggest that a relatively large proportion of the more peripheral small housepits were built and used during the Plateau horizon (Fig. 18), usually for comparatively brief time periods probably spanning only one or a few generations (see Table 1 in Vol. I, Chap. 17; Vol. III, Chap. 10). Thus, it appears that the maximum site size and population at Keatley Creek was probably reached during the Plateau horizon with the perimeter of the site being expanded by the addition of small housepits. Residents of some of these smaller housepits appear to exhibit substantial variability in their relative social and economic standing. Some are relatively poor, some are relatively rich, and some are relatively specialized. At least one example of a specialized, probably ritual structure, was used during the Plateau horizon at Keatley Creek (HP 105) and there may well be others (e.g., HP 9). The florescence of these small, independent residences may be related to the occurrence of cooler, wetter climates around 2,000–2,400 BP coincident with the Neoglacial (Mathewes and King 1989). Such conditions could have enhanced salmon runs and broadened the surplus base for many families.

Richards and Rousseau (1987:32) indicate that there are no side-entrances during this horizon, although there is at least one, and probably two, good late Plateau examples at Keatley Creek (HP's 9 and 90). They also suggest that earth covered roofs became common, although there is no evidence for this among the large and medium sized housepits at Keatley Creek. The narrow earth benches that they see as common in this horizon are not common at Keatley Creek except for one occurrence along the east wall of HP 7.

Prestige items probably become more common than during the Shuswap horizon, especially in the Lillooet-Lytton region (Richards and Rousseau 1987:36–8). The grave goods associated with the infant burial at the Bell site (Stryd 1981, 1973) probably date from this horizon according to Richards and Rousseau (1987:39). At Keatley Creek, however, not enough intact Plateau horizon living floors or rim deposits have been excavated from large housepits to argue this point with any statistical conviction. The remains of copper recovered at Keatley Creek could be from Plateau horizon deposits, while it seems more certain that at least some of the nephrite (e.g., HP's 9 and 90) is from this period. Other prestige objects are more difficult to date because they are from pits or roof contexts (Vol. II, Chap. 13), although Richards and Rousseau (1987:36–9) argue that copper jewelry, incised decorations, bone beads and tools, and extensive trade with coastal groups (for shells) and with the Rocky Mountains began in this horizon. Richards and Rousseau also

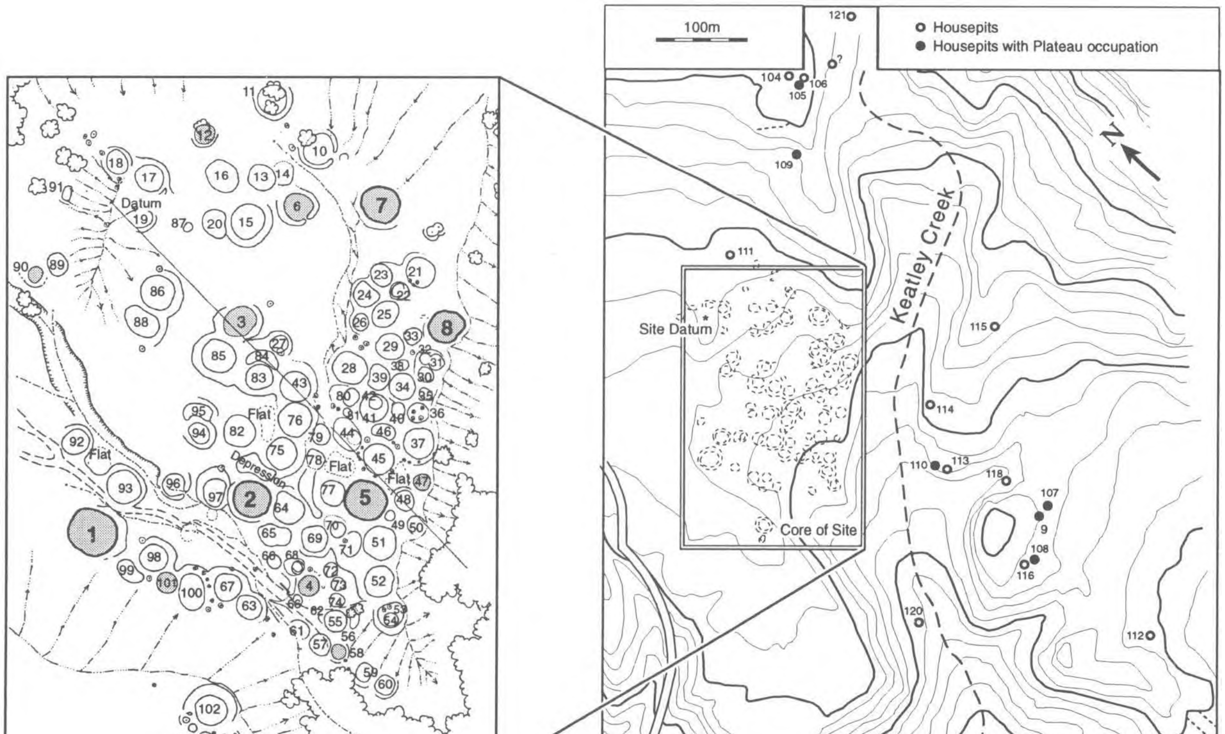

Figure 18. Housepit locations with Plateau occupation deposits.

imply that antler digging stick handles first occur in the Plateau horizon. This is consistent with the context of the antler handle that we recovered at Keatley Creek, which may also have been used as a status item. The occurrence of 60 bone buttons in a pit in HP 105 almost certainly also represents a ritual and prestige occurrence during the same time period, possibly the remains of the earliest button blanket in British Columbia.

The only other change in artifacts that is evident is a reduction in the size of some projectile points during the last centuries of the Plateau horizon probably representing the introduction of the bow and arrow (Richards and Rousseau 1987:34). This also appears to occur at Keatley Creek, although precise temporal control on the appearance of these smaller points is difficult to establish (see Vol. I, Chap. 3). While Rousseau (1992) argues that the key-shaped scraper is a diagnostic type for the Plateau and Shuswap horizons, it also seems to occur as a regular type in the early Kamloops horizon floor assemblages at the site.

Other notable archaeological occurrences during this horizon are the large root roasting pits in the Hat Creek Valley which date primarily to the Plateau horizon, and become significantly smaller after AD 800 (Pokotylo and Froese 1983). As the nearest large population to these root gathering areas, it seems highly likely that the roots, game animals, and lithic sources of the Upper Hat Creek Valley were being systematically exploited during warmer months by the residents of the Keatley Creek site. Isotopic analysis of burials near Lillooet by Chisholm (1986:124) indicates that individuals were obtaining about 60% of their protein from salmon during the Plateau horizon. This is essentially the same as much more recent values, showing that heavy reliance on salmon was well established by 2,400 BP, and, as previously noted, was quite substantial as early as 4,000 BP (contra Thomison 1987 and Johnston 1987).

In sum, in comparison to the Shuswap horizon, there are indications for greater populations, more socioeconomically diverse households, greater socioeconomic inequality, greater production of prestige and exchange items, greater exploitation of salmon, and greater use of mountain root gathering areas during the Plateau horizon at Keatley Creek and its vicinity. The large residential corporate groups at the site appear to have continued to dominate community life and were undoubtedly the most powerful forces within the community.

The Kamloops Horizon (1,200–200 BP)

If the beginning date for the Kamloops horizon provided by Richards and Rousseau (1987) is accurate, and the abandonment dates estimated for the Bell and Keatley sites (ca. 1,100 BP) are also accurate, the Kamloops occupation of the Keatley Creek site is limited to the first one hundred years of the beginning of this horizon. A number of living floors that were excavated appear to occur very close to the transition between the Plateau and Kamloops horizon, such as HP's 9, 12, and perhaps 90. The major technological change used to characterize occupations of the Kamloops horizon is the occurrence of small, side-notched projectile points, generally accepted as indicating the use of bow and arrow technology. The presence of larger corner notched points (typical of the Plateau horizon) in the early Kamloops living floors may well represent the persistence of the earlier atlatl or thrusting spear technology, or even an atlatl point and knife technology, along side the more complex, costly, and risky bow and arrow technology, especially in its early manifestations (Vol. I, Chap. 3). Thus, atlatl technology may have continued to be used during the beginning of the Kamloops horizon as a backup hunting system, as a system which provided convenient butchering knives with detachable foreshafts (a function which arrowheads could not serve), or as a system used primarily by poorer individuals or less skilled individuals.

In addition, steatite pipes and other steatite carvings appear about the same time as arrowpoints (at Keatley Creek and elsewhere on the Plateau—Stryd 1973:34–5; Richards and Rousseau 1987:45). While Richards and Rousseau (1987:45–7) also suggest that many bone and sculptural types or styles are also unique to, or especially common in, the Kamloops horizon (e.g., incised bone and antler), these rarely occur at Keatley Creek in contexts that would enable us to assign them to a specific period. Mica flakes, which Stryd (1973:34–5) thought might characterize Kamloops horizon deposits, seem to occur in Kamloops and slightly earlier contexts at Keatley Creek. We found no zoomorphic pestles, which Stryd, and Richards and Rousseau associate with the Kamloops horizon, although a zoomorphic pestle in a private collection was reported to have come from HP 92. In general, Schulting (1995) finds an increasing degree of socioeconomic inequality represented in burial assemblages of the late Prehistoric and Protohistoric period on the Plateau.

The Kamloops rim deposits (or perhaps beginning in the later Plateau horizon deposits) are the first to provide unequivocal evidence for the large scale use of dirt for covering the roofs of large and medium sized housepits (Vol. I, Chap. 17)—an observation originally made by Stryd (personal communication). The largest structures continue to be maintained at about the same size, and presumably with the same powerful political and economic roles in the community as in previous periods. There is no evidence for either a substantial increase or decrease in the size of the large housepits.

While some small housepits may have been constructed during this short period, it proved unexpectedly difficult to find any clear, undisturbed examples (Fig. 19). On the basis of this observation, I would suggest that the total site population may have decreased at the beginning of the Kamloops horizon, and that formerly independent small households may have been incorporated into the larger residential corporate groups. This may have been the result of increasing socioeconomic competition, possibly drier conditions with reduced salmon runs, increasing control over resources by the more powerful corporate groups, and/or the increasing marginalization of the poorer members of the community. On the other hand, the apparent low frequency of small Kamloops horizon houses may simply be a product of the much shorter duration of the Kamloops occupation at the site (100 years) compared to the Plateau horizon occupation (1,200 years).

Only a few multi-notch points were recovered from the Keatley Creek site indicative of use in the late Kamloops horizon (ca. 400–200 BP). One multinotch point was found at the edge of the site on the surface near a game trail leading into the mountains. It may have therefore resulted from a hunter's visit to the site. Several other points were from a cache pit on the far southern site periphery (Vol. III, Chap. 11.22). No convincing evidence of winter re-occupation of the site core during late Kamloops times has been encountered, although it is clear that some peripheral structures were used around the time of European contact, especially those on the upper terraces.

The Historic Period (200–50 BP)

There was a notable resurgence of occupation at the site during the early Historic period as evidenced by the remains of small transient campsites in the bottom of many housepit depressions. These generally contain large pieces of butchered bone, remains of a hearth, occasional segments of bark or buckskin, and early historic glass or metal artifacts. They also frequently include chipped stone assemblages. It seems likely that these groups were attracted to the Euro-Canadian gold rush presence at Glen Fraser and the surrounding areas, and simply used the Keatley Creek location as a convenient, somewhat removed camping area. A single bifacially pointed piece of glass was recovered on the surface of the site which may be from the Historic period, but might equally well be from earlier knapping by archaeologists or others, given the extensive disturbance by amateur archaeologists at the site.

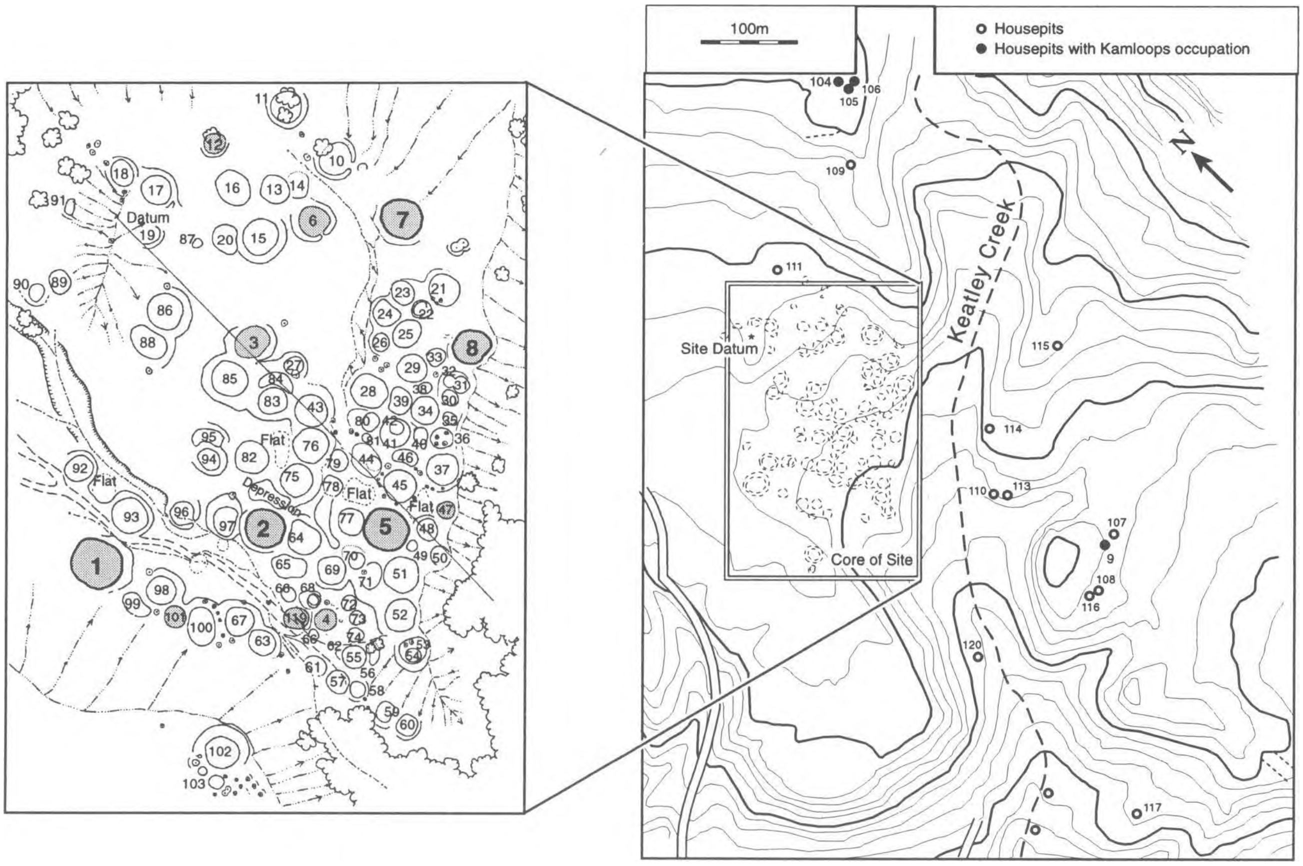

Figure 19. Housepit locations with Kamloops occupations.

The Salish and the Origins of Complex Cultures

There are two basic opinions concerning the geographical origin of complex societies in the Northwest. The development of complex societies may also be related to the spread of Salishan speakers, a topic on which opinions are equally divided. On initial examination of the Coastal versus the Interior environments, it might seem a more natural development for salmon mass harvesting and storage technology to develop first in the arid Interior. In regions such as Lillooet, salmon are densely concentrated in back eddies below rapids. Moreover, the arid climate facilitates drying and the development of long-term storage. In Coastal estuaries, there are no such eddies and the climate is generally damp and unpredictable making long-term storage much more difficult. Thus, it seems to make more logical sense to view the salmon mass harvesting and storage technology as an Interior development. If the development of cultural complexity is dependent on stored salmon surpluses, as Carlson (1991:121; 1993), Hunn (1990:214), Donald and Mitchell (1975), Mitchell and Donald (1988:321), Matson (1985; 1992:420), Matson and Coupland (1995:148, 243–5), and many others have argued, then it would seem to make more sense to view complexity as emerging first in the Interior and then spreading to the coast (e.g., Burley 1980).

Unfortunately, the empirical data at hand seem to indicate a much more elaborate, and perhaps earlier development of prestige technology on the Coast rather than in the Interior. By 5,000–4,000 BP, burials with lip plugs and ornaments of shell or soapstone occur on the Coast. By 4,000–3,500 BP there is good evidence for burial potlatching, status differentiation, surplus wealth, art, sculpture, and masked ceremonialism (Carlson 1989, 1991). This is the approximate date of the beginning of the Shuswap horizon in the Interior where there is only limited evidence for the development of prestige technology. Matson (1992:421) also remarks that evidence for settled village life is no earlier in the Interior than on the Coast, and that these may be coeval developments.

The discrepancy between theory and observation may be explained in several ways. First, the most compelling evidence for prestige technology, status differentiation, surplus wealth, and art in these early periods comes from the burials at the Pender Island cemetery site (Carlson 1991, 1993). No comparable burials have been excavated in the Interior from this time period, and it is possible that when sufficient Interior burials are excavated from this time period a similar level of prestige technology will be evident. Certainly, the recent excavations at the Baker site near Kamloops indicate that significant wealth differences existed in the Interior by 4,400 BP involving trade for coastal shells, differential access to salmon, domesticated dogs, jewelry, and ground stone (Wilson 1992:171, 176). Similar developments were occurring on the Columbia Plateau where Chatters (1986) reports a marine shell adze blade dating to 4,000 BP and Ames et al. (1981:92, 107) report a pipe and bone jewelry from the 4,300 BP.

The second possible way of reconciling the theoretical priority of Interior harvesting/storage technology with the observed priority of Coastal prestige technology is to view the basic mass harvesting and salmon storage technology as being developed in the Middle Prehistoric period, by Lochnore populations. This technology could have then spread both to the Coast and the Interior with differing results due to differences between the Coast and the Interior in salmon (and other resource) abundance and/or in terms of the labor requirements for undertaking mass harvesting and successful long-term storage. It is clear that the resource abundance is much greater and more evenly spread over seasons on the Coast compared to the Interior and that much more labor is required for the harvesting, processing, and effective storage of salmon on the Coast. Both conditions can be construed as leading to a greater degree of complexity on the Coast than in the Interior, even with the same harvesting and storage technologies.

At this point, we do not know where the origins of the Lochnore populations lie, whether in the Interior or on the Coast. If people in Lochnore communities originally perfected the mass harvesting and long-term storage of salmon, I would expect them to have done this somewhere in the Interior, resulting in expanding populations both in the Interior and onto the Coast as a result of the ability to assemble larger war parties and take over desirable resources. Keeley (1996) observes that the single best predictor of success in warfare is the size (and logistical support) of the opposing forces. There are abundant accounts of attempted and successful takeovers of desirable fishing locations in the Interior (Teit 1906:237; 1909:524; 1930:258; Bouchard and Kennedy 1985:37, 58–61). Thus, groups that successfully developed resource strategies enabling them to increase the size of their communities and the logistical subsistence support of warriors (dried salmon), would have a major advantage over other groups and could be expected to expand over time. As previously noted, there is general agreement that Lochnore communities were some of the earliest Salishan speakers in the Interior. Basing their arguments on social structure characteristics, Rosman and Rubel (1986) argue that the Coastal Salish migrated from the Interior, and that most of the Coastal cognatic societies (Kwakiutl, Nootka, and Bella Coola) were heavily influenced by the Interior Salish. Ives (1987), too, argues that many of the Coastal social organization characteristics originated in the Interior. However, this is not generally agreed upon, and Suttles (1976:68), Stryd and Rousseau (1995), as well as Kincade (1991) argue for a Coastal origin of Proto-Salish on historical linguistic grounds. I think it makes more sense to view Salishan speakers as expanding with the advantages of a new technological and storage technology that would have been easiest to develop in the dry Interior. There is, as yet, no convincing spread of a tradition identifiable with Salishan speakers on the Coast around 5,500 BP similar to the emergence and spread of the Lochnore communities in the Interior.

Achieving Project Goals

With the preceding background information in mind, how is it possible to deal with the question of central concern to the research program, namely, why unusually large residential structures developed in the Lillooet region and what their socioeconomic organization was like? The associated problems of understanding why these large structures occurred in unusually large villages and whether they were associated with unusually complex hunting and gathering cultures also seemed pertinent questions to address in understanding these structures.

In order to deal with these issues, the following strategy was adopted. First, given the considerable amount of effort involved in constructing large houses, the lower thermal efficiency of large houses (Vol. II, Chap. 16), and the inherent problems involved in maintaining harmony and cooperation among the 40–50 people that lived in large structures, it seemed reasonable that the residents of large pithouses must have benefited in some very tangible way from their choice to build and reside in large structures (see Hayden and Cannon 1982).

Moreover, since these large structures only appear in the Late Prehistoric period on the Plateau in conjunction with substantial changes in subsistence and technology, it seemed likely that resource conditions were probably related to the emergence of these residential corporate groups. The fact that the Lillooet region historically contained the most lucrative fisheries in the entire Interior Fraser drainage also seemed to indicate that resources somehow probably played a key role in the answer to our questions. Cultural ecology and cultural materialism deal with both the influence of resources on behavior and with the practical benefits of behavior involving substantial outlays of energy, time, and organization. No other paradigms (cognitive anthropology, structuralist anthropology, post-processualism) seemed to have as much potential for explaining why large residential corporate groups emerged at the specific time and place that they did. Thus, it seemed most efficient to explore cultural ecological and cultural materialist explanations first in order to see if they could adequately account for the large residences, large villages, and complex cultures of the Lillooet region. When research funds are relatively limited, testing or exploring the most likely theories or paradigms first is the only approach that is reasonable, unless alternatives can be tested easily and quickly which is rarely the case. Thus, at Keatley Creek, if no sense could be made of large housepits and villages following the cultural ecological paradigm, then clearly other theoretical models would have to be explored.

As I mentioned at the outset, we examined the resource base of the Keatley Creek prehistoric community in many ways. However, obtaining a clear, accurate picture of the subsistence economy from archaeological remains alone is a difficult undertaking. Many food remains are not preserved. Many of the remains that might be preserved are left at procurement sites like fishing sites rather than at consumption sites like the Keatley Creek winter village (Fig. 20). Much of the meat that was hunted was deboned before being brought to the winter village. Bones that were brought back were generally smashed into small pieces. Other parts of animals or fish (especially fins) might be given to dogs. Boiling of fish bones could also diminish their preservation. Waste bone within the Keatley Creek village might also be dumped away from the pithouse of residence, in unused storage pits or abandoned pithouses. Thus, it is clear, that at best, we only have a rather biased sample of the total subsistence regime of the Keatley Creek community or of households within the community. In order to understand the subsistence remains in any coherent terms it would be necessary to understand, at least in general terms, the entire subsistence round together with the taphonomic and formation processes that created the subsistence assemblages both at Keatley Creek and elsewhere. This is one of the main reasons why a detailed ethnoarchaeological project was initiated concerning the traditional subsistence of the Stl'ätl'imx Indians in the vicinity of Keatley Creek (Hayden 1992a).

Given all of the problems involved in making direct quantified inferences about resource exploitation from the subsistence remains alone, it became clear that it would be necessary to use proxy measures for many of the estimates of resource characteristics. Thus, the relative amount of food storage capacity in pits, the relative bone densities between housepits, the degree of sedentism, the regional population density, and evidence of surplus in the form of trade or prestige artifacts, could all be used as indicators of exploitable resource abundance in the region, and to some extent at the site itself. We have therefore paid special attention to all of these features during excavation and analysis.

Because of the strong basic cultural continuity through prehistoric and historic times in the region and the Plateau in general, it was also meaningful to employ ethnographic analogies at the level of synthetic cultural descriptions, together with ethnohistory and ethnoarchaeology as guides to the subsistence and other behavior represented in the archaeological deposits at Keatley Creek. While these data sources provided numerous invaluable insights into the interpretation of otherwise enigmatic artifacts, features, and patterning, we were constantly aware of minor and major discrepancies in almost every domain between ethnographic descriptions and archaeological occurrences, e.g., different hide working tools, the presence of abundant fish fins in some housepits, the preponderance of a totally different species of salmon from those used historically, different architectural details, and differences in the basic organization of house interiors and social units. At best, the descriptions of traditional cultures that were available were relicts that had been variously transformed by the influences of Euro-Canadian (or Russian) traders, missionaries, ranchers, gold miners, and government officials. Moreover, even the best ethnographies were frequently silent on important details such as differences between elites and nonelites in subsistence and other areas. Thus, while the existing historical and ethnographic information has been an invaluable resource, it has not been used uncritically. We have employed it primarily as a guide to directing our questions, inquiries, and observations.

Another way of assessing the exploitable food resources of Keatley Creek and neighboring catchment areas was to simply inventory the principal food resources traditionally used in the area. This was accomplished by various researchers in conjunction with the ethnoarchaeological research related to the work at Keatley Creek (see chapters in Hayden 1992a). Approximations of wildlife, plant, and fish resources were generated in this publication, and together with ethnoarchaeological observations helped considerably in modeling the approximate overall yearly subsistence budget that must have characterized the community at Keatley Creek. Observations of archaeological deposits at many of the recently and historically used procurement sites helped to impart confidence that

Figure 20. A salmon bone and waste refuse dump in a ravine at the Six Mile fishery (east bank).

basic exploitation patterns had not changed in the last centuries or millenia.

While our excavations at winter villages may have only revealed a partial and biased sample of subsistence remains, our excavations were much more successful in revealing the basic social and economic organization inside housepits. It is in this domain that most of the artifactual analysis has concentrated, including all botanical remains, faunal remains, and lithic artifacts. The patterning evident on housepit floors revealed critical information about the hierarchical socioeconomic differences between subgroups of residents of a single house. This, in turn, has been invaluable for understanding how the large residential corporate groups functioned, and, I believe, how and why they emerged in the first place.

Dealing directly with resources, is only one facet of understanding the puzzle of complexity. Other kinds of archaeological and ethno-archaeological analyses can be explored in trying to describe and understand complexity. In order to measure complexity on a regional and site level, I have used a number of indicators which will be presented more fully in Volume II Chapter 17. At the regional level, the existence of site hierarchies, the association of large sites with the most productive fishing locations, the occurrence of prestige or long distance exotics, and the differences in grave goods between burials can all be used as indicators of complexity. At the site level, hierarchies in house sizes, differential storage capacity, the occurrence of prestige or long distance exotics in some houses, differences in hearth sizes, differences in utilization of preferred animal or fish species, community size, and the excavation of cemeteries (which we have not undertaken), are all potentially productive ways of measuring complexity. This is an issue of some considerable interest given the very different existing points of view on the fundamental nature of Plateau communities.

Following Boas, Ray (1939) was pivotal in establishing the more traditional view that Plateau cultures were essentially egalitarian and peaceful (see also Jorgensen 1980:143). This pattern was portrayed as having only been disturbed by relatively recent cultural diffusion of status distinctions and raiding from the Coast. In contrast to the egalitarian views of Plateau culture, Sanger (1971:255), Stryd (1973:90), Cannon (1992), Schulting (1995), and others have advanced strong arguments for much more variability on the Plateau with strongly hierarchical communities extending back many thousands of years in some regions of the Plateau. The excavations at Keatley Creek have certainly contributed significantly to this debate.

Finally, in order to obtain a much better idea of just how complex the society at Keatley Creek was, and to increase my own understanding of how residential corporate groups functioned within the Lillooet communities and how the communities functioned as a whole, I conducted a comparative review of ethnographic communities that spanned the range of initial inegalitarian to incipient chiefdom types of organization. Because of operational and theoretical problems with the terms, "tribal," and "ranked" societies, I have opted not to use those terms. I use the term "trans-egalitarian" to refer to the range of societies from initial inegalitarian communities to proto-chiefdoms. The most traditional and the best documented cases that I found were from the New Guinea Highlands; however, I also incorporated Northwest Coast and Interior groups. This exercise (Hayden 1995), has provided a useful framework both for understanding the likely structure of the prehistoric society at Keatley Creek, and for situating it along a continuum of complexity and other social dimensions. Because of the historical connexions with the Coast and the existence of residential corporate groups on the Coast, I have also relied on coastal ethnographies in places to help understand how the corporate groups of Keatley Creek were probably organized and structured.

Given the many uncertainties that existed at the outset of this project, it seems that we have been unusually fortunate in having gambled and discovered an untapped wealth of insights into the social and economic organization of a remarkable hunting and gathering culture. Our results are pertinent to the understanding of corporate groups, private ownership, social and economic inequalities, and many other fundamental kinds of cultural issues that are still important in contemporary communities. I hope readers will enjoy the unraveling of the tale of the Classic Lillooet culture as much as I have over the many years.

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Chapter 2

Dating Deposits at Keatley Creek

Brian Hayden

This chapter presents and discusses the radiocarbon dates from Keatley Creek. Assessing the relative contemporaneity of floor deposits in different housepits was critical for understanding the overall social and economic structure of the site. Therefore considerable emphasis was given to dating floor deposits and assessing the degree to which they had been disturbed or mixed. During the initial field season at Keatley Creek, in order to determine the relative dates of deposits, it was necessary to rely on the time-diagnostic artifact types that Richards and Rousseau (1987) had identified in their comprehensive synthesis of Canadian Plateau archaeology. These included a number of different types of projectile point styles (Vol. I, Chap. 3), maul styles, the introduction of pipes during the Kamloops horizon (ca. 1,200 BP), and the preponderance of key shaped scrapers in the Plateau horizon (2,400–1,200 BP). In general, except for obviously mixed deposits such as roofs, these artifact styles occurred in stratagraphic relationships consistent with the sequence proposed by Richards and Rousseau (see Vol. I, Chap. 3). We used the relative dates provided by this method of dating to assess the suitability of various housepits for more extended excavations and to determine the general length of time each housepit had been in use as indicated by the horizons represented in house rim middens.

Since the goal of the project was to compare contemporaneous floor assemblages from housepits of varying sizes, we tried to determine which housepit floors were occupied in Kamloops horizon times and which were earlier. No housepit deposits that we excavated yielded multinotch points which only appear during the middle of the Kamloops horizon. Therefore, it seemed that all deposits with Kamloops (side-notched) points must have come from the early part of the Kamloops horizon. Since most of the large housepits that we tested (including those with the most easily defined floors) contained side-notched Kamloops points in their floor deposits (Vol. I, Chap. 3), it was most logical to look for medium and small sized housepits that also dated from the early Kamloops horizon. As it turned out, finding small housepits from this time period was more difficult than anticipated, although a number of tested small houses yielded very few artifacts, none of which was diagnostic. These houses may well have been from the early Kamloops period.

Several series of radiocarbon samples were subsequently analyzed in the hope of providing more precise parameters for the occupation of the Keatley Creek structures. Most of these analyses were carried out at the Simon Fraser University radiocarbon lab and all dates are presented in Table 1. All samples were on wood charcoal and all dates are uncalibrated. The first dates to be run basically conformed to all of our expectations, in some cases, even to remarkable degrees. I would like to discuss these individually.

The most remarkable dates were the first ones derived from the burned roof beams lying on the floors of HP 3 and 7. On the basis of the side-notched Kamloops points associated with these floors, I

Table 1. Radiocarbon Dates from Keatley Creek

Lab. sample No.	Provenience and Material	Uncorrected Age BP
1987 Series		
SFU 1001	HP 3, SQ AA, SS 13, Stratum III (floor) Wood charcoal on floor containing Kamloops points	1,080 ± 70
SFU 1002	HP 7, SQ W, SS 2, Stratum V (roof) Charred roof beam in contact with floor containing Kamloops points	1,080 ± 70
SFU —	HP 7, SQ N, Stratum XIIId (rim) Wood charcoal below Kamloops levels	1,590 ± 70
SFU —	HP 7, SQ N, Stratum XIIIe (rim) Wood charcoal below Kamloops levels	2,080 ± 50
SFU —	HP 7, SQ O, Stratum XIIIf (rim) Wood charcoal	980 ± 60
SFU —	HP 7, SQ N, Stratum XIII (rim base) Wood charcoal	2,620 ± 50
SFU —	HP 5, SQ F, Stratum X (pre-rim paleosol) Wood charcoal associated with microblades and Middle Prehistoric points	2,160 ± 70
SFU 1009	HP 7, SQ M, Stratum XIIIb (rim) Wood charcoal associated with Kamloops points	6,470 ± 90
Beta 25181	HP 7, SQ N, Stratum XIII (rim-base) Same sample as HP 7, SQ N, Stratum XIII (rim base)	2,140 ± 110
1988 Series		
SFU 633	HP 1, SQ D, test trench level 4 (floor) Charcoal on floor containing Kamloops points	1,970 ± 60
SFU 641	HP 105, SQ B, test trench level 6 (floor) Unburned wood	270 ± 55
SFU 642	HP 105, SQ C, Feature 1, Stratum IX (pit) Wood charcoal	2,170 ± 60
1989 Series		
SFU 720	HP 7, SQ QQ, SS 3, Stratum V (roof) Charred roof beam in contact with last floor containing Kamloops points	900 ± 65
SFU 721	HP 12, SQ B, SS 11, Stratum III (floor) Charred roof beam in contact with floor	1,550 ± 60
SFU 722	HP 3, SQ II, SS 14, Stratum IIc (roof) Charred plank fragments in contact with floor containing Kamloops points	1,330 ± 60
SFU 723	HP 90, SQ C, SS 9, Stratum IV (roof) Charred wood (roof beam) in contact with floor	1,410 ± 60
SFU 724	HP 7, SQ PP, SS 6, Stratum II level 2 Wood charcoal in occupation deposits under last floor	740 ± 70
SFU 796	HP 7, SQ QQ, SS 3, Stratum V (roof) 14 year-old Populus branch in contact with last floor containing Kamloops points	1,000 ± 85
1995–1998 Series		
CAMS 32253	HP 104, SqA, ssq 7, Stratum VII (floor) level 1, charred basket fragment on floor	250 ± 60
CAMS 35105	HP 7, Feature P-31 Dog bone (full skeleton) in the bottom of a storage pit	2,160 ± 60
Beta 106611	HP 106 Test trench floor/roof contact Pinebark used in roofing	220 ± 70
Beta 125907	HP 109 SqB ssq3, Stratum III (upper floor), charred 200 ± 50 roof beams lying directly on the floor	220 ± 50

expected the floors to be relatively contemporaneous. It was therefore very gratifying to obtain exactly the same date from both housepit floors: 1,080 BP (SFU#1001, 1002).

The first series of dates also included five samples from HP 7 rim deposits (Stratum XIII—Fig. 1). Three of these dates conform to what we generally expected; two did not. The uppermost sample (from Stratum XIIIb—SFU#1009) was the most anomalous with a date of 6,470 BP—clearly far too old for the deposit as a whole or for the Kamloops points with which it was associated. The most reasonable explanation is that old charcoal was somehow incorporated into the rim deposits (e.g., by the re-excavation of storage pits from the Middle Prehistoric deposits that exist under parts of the HP 7 floor, and the subsequent discard of Middle Prehistoric deposits including charcoal onto the rim). Other sources of contamination may also be possible. The other anamolous date came from Stratum XIIIf which is a rim zone with poorly defined stratigraphy that is adjacent to the interior wall of the house. In Volume I Chapter 17, the unstable nature of this wall is emphasized, and in the field, the unconsolidated nature of the deposits forming the wall led to the interpretation that slumping and sloughing off had probably occurred in many places. Large blocks of stone placed against the wall also seemed to be measures aimed at limiting the sloughing off of wall deposits. Thus, parts of Stratum XIIIf appear to have been actively reworked during the occupation of the housepit and it is perhaps not surprising that later materials could have been incorporated in what otherwise seemed to be early rim deposits. In fact, a complete Kamloops horizon-style maul (Vol. II, Chap. 13; Vol. III, Chap. 5) was found in the XIIIf deposits at the base of the wall, apparently either buried by rim material sloughing off or perhaps cached by digging a small lateral hole into the wall deposits. Given all these observations, it is perhaps not surprising that our sample from Stratum XIIIf near the wall yielded a date of 980 BP with a standard deviation that overlaps the time range represented by the date of 1,080 BP from the floor.

The three remaining dates from the HP 7 rim are all consistent with each other and generally correspond to the range of dates that were expected from the rims. From the uppermost levels to the bottom of the rim, these were: 1,590 BP (Stratum XIIId); 2,080 BP (Stratum XIIIe); and 2,620 BP (from the bottom of XIII). These samples were all derived from levels below the zone where Kamloops points were recovered (Vol. I, Chap. 3). I therefore had every reason to expect them to be of Plateau or even earlier age. Because I wished to obtain an external check on some of the more important samples that we were analyzing, I submitted a portion of the same sample from the bottom of Stratum XIII to Beta Analytic for dating. The result was considerably younger than the SFU results (2,140 BP; Beta 25,181) and is clearly inconsistent with the Shuswap points that occur in the bottom levels of the rim midden. Thus, I have chosen the SFU date from this sample as more realistic. This series of dates indicate that HP 7 was established in its present approximate size and form about 2,600 years ago towards the end of the Shuswap horizon. This series of dates conforms quite well with the occurrence of Shuswap horizon style projectile points (2,400–3,500 BP) in the lower parts of the rim accumulations, and the much more extensive series of Plateau horizon projectile points (2,400–1,200 BP) throughout the bulk of the rim deposits that we excavated. A subsequent date of 2,160 (CAMS 35105) from a dog buried in a large storage pit (P-31) near the house wall (Vol. II, Chap. 10), also indicates that HP 7 had expanded in size to its full extent within a few hundred years of initial construction.

The remaining sample that was submitted in the first series of analyses was a charcoal sample from deposits containing a rich collection of Middle Prehistoric microblades and points which should date to before 3,500 BP. These deposits occurred under the lowest rim midden accumulations in HP 5. Aside from a few flecks of charcoal and very small fragments of calcined bone, there was no organic matter in these deposits, except for the sample of charcoal that we submitted. This situation indicated that it was unlikely for the charcoal that we recovered to be contemporaneous with the artifacts in these deposits; however, since this was the only sample from the Middle Prehistoric Period deposits that we had, I thought it might be worth dating. Not surprisingly, the date that was obtained was much younger than expected (2,160 BP). It is clear that the charcoal in these deposits probably represents a root burn or similar contamination since there was absolutely no other evidence of post-depositional disturbance of these deposits. In fact, I visited the Keatley Creek site four months after the Tiffin Creek fire had burned off all vegetation at the site in 1994. I recorded many examples of tree roots that had burned many meters underground, and in fact, there were still some smouldering roots underground even four months after the fire had been officially extinguished! Similar underground burning of roots must have also typified prehistoric brush fires and the burning of housepit roofs prior to reroofing events. Natural brushfires in the area occur in about seven year cycles.

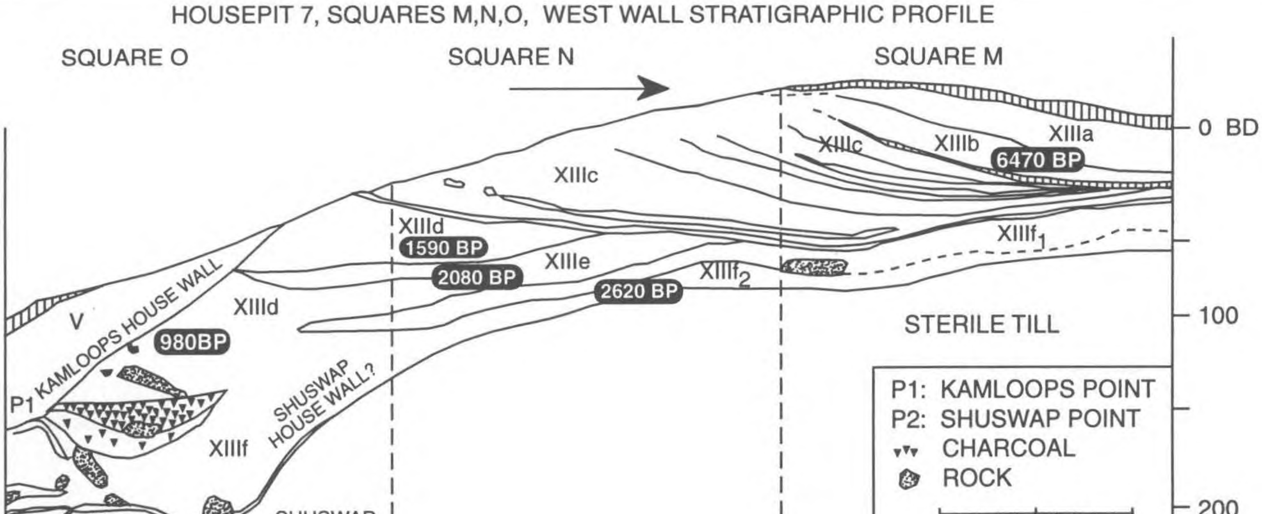

Figure 1. Cross section of rim deposits in Squares M, N, and O in HP 7 showing dates obtained from various substrata.

A second series of samples were analyzed for dating after the second season of excavations, primarily from other housepits being tested. Two of these samples came from HP 105, a structure on the highest terrace above the site which I suspect may have been used for ritual purposes. The structure had been heavily disturbed by clandestine excavators many years previously. Our test excavations encountered only a small portion of a floor that was relatively close to the surface and which was unusual in terms of the amount of fish spines and ribs associated with it. A charcoal sample from this floor yielded an unexpectedly recent date of 270 BP (SFU#641). Subsequent dating of bark used in the roof of the immediately adjacent housepit (HP 106) yielded a similar result of 220 ± 70 BP, while a date on a charred piece of basket on the floor of another nearby housepit (HP 104) fell in the same range (250 ± 60 BP). The only housepit (HP 109) on the next terrace down also provided a protohistoric date from its upper floor level (200 ± 50), although its lower floor level was clearly much older (see Vol. III, Chap. 10.18). These dates are the best evidence that currently exists for an occupation of the site after its major abandonment around 1,100 BP, and this occurrence is a very minor one that was probably short-lived and was probably confined to this peripheral location. The recovery of a single Kamloops side-notched point along one of the trails leading into the mountains from this upper terrace is also consistent with a small, short re-occupation of the site around this time.

A second date from HP 105 came from the fill of a large storage pit near the center of the structure, undoubtedly associated with an earlier floor. An unusually broad bone point and 72 bone buttons were found in this pit. Mike Rousseau (personal communication) suggested that the bone buttons were most characteristic of Plateau horizon assemblages. The dating of this pit at 2,170 BP supports his assessment.

A third sample in this series was submitted from the floor deposits of HP 1 (SFU#633). Given the presence of Kamloops points in the floor deposits, I expected a date of around 1,100 BP. The actual date was 1,970 BP which is clearly too early. Given the test trench nature of these excavations, either the sample was not chosen carefully enough in terms of context, or the inhabitants of this housepit were recycling roof beams, similar to practices in prehistoric Southwestern U.S. structures. I will return to this topic shortly.

A fourth sample in this series was obtained from a small fishing site (EdRl 195) along the Fraser River near Keatley Creek. The excavations were carried out by Diana Alexander and focused on the cache pits at the site. A single sample yielded a date of 2,840 BP (SFU#643), which is generally consistent with material found at the site.

A third series of samples was submitted for radiocarbon analysis after more extensive excavations in HP's 3, 7, 12, and 90. I wished to determine whether the initial dates from HP's 3 and 7 were representative, and I also wished to find out to what extent the smaller housepits (12 and 90) were contemporaneous with the larger ones since the diagnostic point styles associated with these structures seemed somewhat earlier than the typical Kamloops style points in the floors of larger houses. Almost all of the results from this series of analyses seem aberrant. With one exception, all materials submitted were taken from burned beams laying immediately on top of the floor deposits. Thus, we have good reason to view these beams as having formed part of the roof of the last occupation of each housepit. Since the earlier date from HP 3 (1,080 ± 70 BP) was taken from an identical context, the substantially earlier date of 1,330 ± 60 BP (SFU#722) seems inconsistent. If the Richards and Rousseau (1987) synthesis is to be viewed as the best approximation for the appearance of Kamloops points which they place at 1,200 BP, the date of 1,330 BP for the floor deposits of HP 3 is clearly too early since these deposits contain typical Kamloops points in abundance. Since this date was on a wood plank, it may represent an item that was curated over more than a century.

Similarly, the date of 1,550 BP (SFU#721) for the roof of HP 12 seems far too early for the transitional (Plateau to Kamloops style) or very late Plateau style of points associated with its floor. I had expected a dating much closer to 1,300 BP. The date derived from the HP 90 sample (1,410 BP; SFU#723) is closer to the late Plateau age indicated by the point styles associated with that structure.

The two most problematical dates in this series were from HP 7 samples. The date of 1,080 ± 70 BP from our first season of work in HP 7 was from a roof beam lying directly on the floor. The date that we obtained from the last series of samples analyzed was also from a roof beam lying directly on the floor, but gave an age of 900 ± 65 BP which fails to overlap the original date at one standard deviation. To complicate matters even more, I submitted another sample of charcoal from a buried wedge of floor that clearly preceeded the floor associated with both of the above dates. The date from this buried, prior floor (740 ± 70 BP; SFU#724) came out to be significantly younger than either of the later floor dates. This was clearly the reverse of any normal sequence. Moreover, the date is totally aberrant in terms of all other dates associated with roofs or floors throughout the site. It is too young by at least 2–300 years.

How can the anomalies present in this last series of dates be accounted for? There is no clear or obvious solution. It is clear, however, that some of them such as this last date and the date for HP 3 conflict with the vast bulk other evidence from the site and other Plateau sites. There are three relatively plausible explanations for these anomalies. The first is that the younger dates are all accurate and that the older dates for the same deposits are derived from "old wood" that has been recycled over the centuries for rebuilding sequential roofs. Such re-use of wood beams in roof construction (sometimes more than once) has been well documented for pueblos in the Southwestern United States (Ahlstrom et al. 1991). It seems reasonable to assume that similar processes occurred at Keatley Creek especially given the effort involved in procuring roof timbers and the probable need to bring them from some distance. Some skewing might also be expected from medium sized timbers due to the growing time represented from the first to the last growth rings. However, most of the burned secondary timbers were under 15 cm in diameter and probably did not represent growth period of more than 20–30 years. While the recycling explanation undoubtedly accounts for some of the spread in dates associated with a given roof, it seems unlikely to explain spreads on the order of 1–300 years. In the first place, the beams that lay on the floors were not the large support posts or joists, but smaller secondary beams that would be unlikely to last over very long periods. In the second place, if most of these secondary beams were burned prior to each re-roofing event, it seems unlikely that many beams would be used for more than a few re-roofings. Given an average life span of a roof of about twenty years (Vol. I, Chap. 17), it seems unlikely that many if any secondary roof beams would be used more than 60 years maximum, although it is conceivable that labor intensive items such as planks could have been curated for a number of generations or even centuries, such as the plank fragments in HP 3 that yielded unexpectedly old dates (SFU#722). In the case of small housepits (e.g., HP's 12 and 90) with evidence of only single, short term occupations (less than a century), this explanation probably does not account for unexpectedly old dates.

A second explanation for some of the dates that seem too young, such as the 740 BP date from the early floor of HP 7, is that these charcoal samples may represent root burns instead of wood that was used culturally at the time of occupation. Given the strong pattern of substantial beams lying on floors, this, too, seems implausible except in the case of the date from HP 5.

A third explanation involves variability in preparation and processing techniques between laboratories and individuals. Such variability has been documented and discussed by Shott (1992), and even more remarkable anecdotal examples of split samples sent to different laboratories resulting in widely divergent dates are legion at conferences throughout North America. During the period when the last series of dates was run at the Simon Fraser University laboratory, a number of personnel changes may explain some of the unexpected results. In fact, when I expressed my concern about the anomalous dates from HP 7 to the director of the SFU laboratory, he offered to run another very carefully chosen sample as a check on the earlier results. I chose a branch segment from a 14-year-old *Populus* pole that had formed part of the roof and collapsed down onto the final occupation floor together with other roof collapse debris. I reasoned that such a small, softwood pole would minimize skewing effects from long growth periods and would be the least likely roof element to be recycled from previous roof structures both because of its size and greater susceptibility to decay. The resulting date of 1,000 ± 85 BP clearly indicates that the aberrantly young date from the floor of HP 7 is inaccurate for whichever of the above possible reasons.

Given the preceeding problems using radiocarbon dating at Keatley Creek, it seemed that there was little more to be gained in submitting further samples for absolute dates except in very well controlled situations or in cases where time-diagnostic artifacts were missing from specific assemblages of interest. In order to counterbalance the various factors creating inconsistencies among samples from the same deposits, a much larger, probabilistic sampling program would be required (per Shott 1992). Such an expanded program of testing was too ambitious for our available resources. Therefore, few further samples have been submitted for absolute dating. In most cases, we have found the use of time-sensative diagnostic tool types to be of almost equal value as the absolute radiocarbon dates for the purposes of determining the relative age of assemblages at Keatley Creek and determining relative contemporaneity.

Informally, a number of archaeologists have remarked that the floor assemblages that we have excavated must be temporally mixed since some of them contain more than one style of projectile points, such as the co-occurrence of Plateau and Kamloops points in the floor deposits of HP's 3 and 7. This is an issue I address in more detail in the next chapter. However, to summarize the arguments over this issue, it can be stated that there is overwhelming evidence of the relative integrity of the floor deposits. That some minor mixing undoubtedly has taken place due to insect burrows or inability to clearly distinguish floor from roof deposits in the field is certainly true. However, the extent of such mixing appears to have had a negligible impact on the overall distribution of stone debitage and artifacts, bone debris and artifacts, botanical remains, anthropogenic enrichment of chemicals on the floors, and pedological fabric characteristics. If older Plateau points occur in deposits predominantly characterized by Kamloops points, such occurrences can more economically be explained either in terms of the well-documented reuse of older point types by later individuals in Kamloops times, or by the persistence of older hunting technologies alongside newer technologies for several hundred years, a feature well documented on the Columbia Plateau, the Great Basin, the Northwest Coast, and elsewhere in North America. In fact, excavations of two longhouses on the Northwest Coast clearly show newer technologies existing side-by-side with older technologies, with use of the older and newer technologies being determined by relative status within the houses (Chatters 1989; Ames, personal communication, September 1995). A similar situation appears to occur in HP 7 at Keatley Creek where twice as many points of the older atlatl technology were recovered from domestic areas in the lower ranking half of the house as from the higher ranked half of the house (Vol. I, Chap. 3; Spafford 1991).

Thus, in sum, the radiocarbon analysis program at Keatley Creek has provided some important temporal reference points for the interpretation of the various deposits and structures that have been excavated. However, this analysis program has not been without problems and contradictions that probably stem from a number of sources including: root burns, the sloughing off of rim midden materials against inside walls, redeposition of old carbon in later midden contexts, the recycling of construction beams from one roofing events to succeeding ones, the length of growth represented by large structural beams, inaccurate identification of provenience for samples, and variability between laboratories and preparation or processing procedures. My assessment of all the available evidence from the radiocarbon dating program, the comparative dates from the Richards and Rousseau synthesis, the time-diagnostic artifact occurrences, and the stratigraphic relationships yields the following temporal interpretations for some of the most important structures in our analysis.

HP 1 floor: early Kamloops horizon, contemporaneous with HP 7 floor; rim also largely contemporaneous with HP 7 rim.

HP 3 floor and rim: the same as HP 7.

HP 5 floor and rim: the same as HP 7.

HP 7 floor: early Kamloops horizon, ca. 1,000–1,100 BP; rim: initial construction ca. 2,600 BP, expansion to full size by 2,160 BP, and continuous use until final abandonment of the last floor.

HP 9 initial floor: probably middle or late Plateau horizon time period, last occupation, early Kamloops horizon, probably 1,100–1,200 BP. Each occupation may have been short-lived and discontinuous.

HP 12 floor and rim: a single, late Plateau occupation probably ca. 1,200–1,300 BP.

HP 90 floor and rim: a single late Plateau occupation, probably ca. 1,300 BP.

HP's 104, 105, 106, 109 all single, relatively short occupations ca. 250 BP.

On the basis of the terminal dates in all major housepits that cluster around 1,000–1,100 BP, I view this period as the most likely time of abandonment of the Classic Lillooet occupation at Keatley Creek. This is completely consistent with the radiocarbon dating results obtained at other major Classic Lillooet sites such as the neighboring Bell site and the Bridge River site (see Stryd 1978; Hayden and Ryder 1991). This interpretation reinforces the notion that the abandonment of the large Classic Lillooet settlements took place over a relatively short period of time and that a catastrophic damming of the Fraser River may well have been the precipitating factor behind this abandonment.

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Chapter 3

Mixing of Projectile Point Types within Housepit Rim and Floor Strata at Keatley Creek

Andrew Henry & Brian Hayden

Introduction

This issue of whether artifacts in floor deposits in housepits result only from activities carried out on those floors, or whether floor assemblages are contaminated by artifacts from earlier periods that became mixed in with floor deposits is crucial for interpreting artifact patterning on those floors, and hence the socioeconomic organization in housepits. Some archaeologists in the region have expressed skepticism that anything useful can be learned from the study of housepit floor deposits due to the supposedly mixed nature of these deposits (based on observations of different styles of projectile points occurring in the same floor deposits). If this is true it certainly needs to be taken into consideration when interpreting house floor assemblages. If it is not true, other explanations for the co-occurrence of different point styles need to be examined. This is the goal of this chapter. Projectile points are also one of the most useful lithic types for identifying regional cultures, changes over time, and interactions between groups. Therefore projectile points have been given extended attention in the following analysis. We focus, however, on the morphological variability and spatial distribution of projectile points recovered from the housepit assemblages at Keatley Creek.

Description of Projectile Point Types

Projectile points from the Keatley Creek site have been classified as: Windust, Lochnore, Lehman, Shuswap, Plateau, Late Plateau (or Transitional), and Kamloops points. These projectile point types have been defined using criteria such as dimensions, base shape, barbs, notchs, shoulders, and angle characteristics combined to form the comparative types used on the Canadian Plateau. Representative samples of these types are illustrated in Volume I, Chapter 1, Figure 16 (see also Richards and Rousseau 1987).

The Kamloops point type is differentiated from other point types by the presence of side-notches and the generally smaller dimensions of this point type. The Kamloops point, originally defined by Stryd (1972:20), is associated with bow and arrow technology as opposed to atlatl or spear technology. Kamloops multi-notched points have similar diagnostic attributes to the Kamloops side-notched points. The multi-notched variety, however, have multiple notches along one lateral blade margin. Dates associated with this point type are between ca. 400 and 100 BP (Richards and

Rousseau 1987:43–45). There have been only a few of these projectile point types recovered associated with the Keatley Creek site. One was a surface find along a trail from the site into the mountain, several others were from a peripheral storage pit (EHPE 21) with horse remains (Vol. III, Chap. 11.22), and several are from the HP 7 surface, with one recorded from the floor that was probably associated with an intrusive, post-abandonment hunter's encampment.

Being larger, Plateau points are appropriate for tipping spears or atlatl darts. Late Plateau points have the same general shape as other Plateau points, but are significantly smaller, being intermediate in size between Plateau and Kamloops points. Late Plateau points may represent projectile points used with the initial introduction of the bow and arrow (Rousseau 1992:102; Richards and Rousseau 1987:34). They appear to date from 1,500–1,200 BP. Shuswap points are also considered associated with atlatl darts rather than arrowheads (Richards and Rousseau 1987:25). Some have concave lateral sides of bases or are shouldered.

Lochnore points are "leaf-shaped to lanceolate, unbarbed projectile points with side notches, heavy basal grinding, and pointed or convex bases" (Stryd and Rousseau 1996:193). Lehman points, according to Stryd and Rousseau (1996:189), are characterized as "thin, pentagonal projectile points with obliquely-oriented, V-shaped corner or side notches." A single possible example of a Windust point was recovered from the pre-housepit deposits under the rim of HP 5 (Fig. 1). Given its fragmentary state, positive identification is problematical, but edge grinding of the stem does indicate the possible presence of Windust-like Paleo-Indian groups at the site before 9,000 BP.

One other example of a non-standard regional point type also occurs in the excavated assemblage. A unique, small bipointed piece from the protohistorical occupation of HP 104 (Fig. 1) resembles the shape of early Historic metal arrowheads. We will not deal with the unique occurrences further, but will concentrate our analysis on the recurring regional point types.

Projectile Point Occurrences at Keatley Creek

Housepits 3 and 7 are the central focus of this analysis due to their completely excavated floor strata, and the high concentration and variety of projectile points found throughout their roof, rim, and floor strata. Housepits 3 and 7 have yielded 19.4% and 53%, respectively, of all projectile points as yet recovered from this site. Outline forms and quantification of the various projectile point types from each housepit are provided in Figures 2–6, and Table 1. Not all housepits yielded enough projectile points to render quantitative analyses meaningful as Figure 2 indicates. However, to provide an overall synthesis of projectile points at this site, all occurrences have been tabulated (see Table 1).

Housepit 3

Housepit 3 is a multi-component housepit initially occupied during the Shuswap horizon. It was periodically cleared down to sterile till by its occupants with the debris of each preceding occupation being deposited upon the rim or roof of the housepit (Vol. III, Chap. 4). Floor deposits of HP 3, as Table 1 illustrates, contain 13 Kamloops points (76.5%), 3 Plateau points (17.7%), and 1 possible Lehman point (5.9%). These numbers represent 26.6% of the total number of points

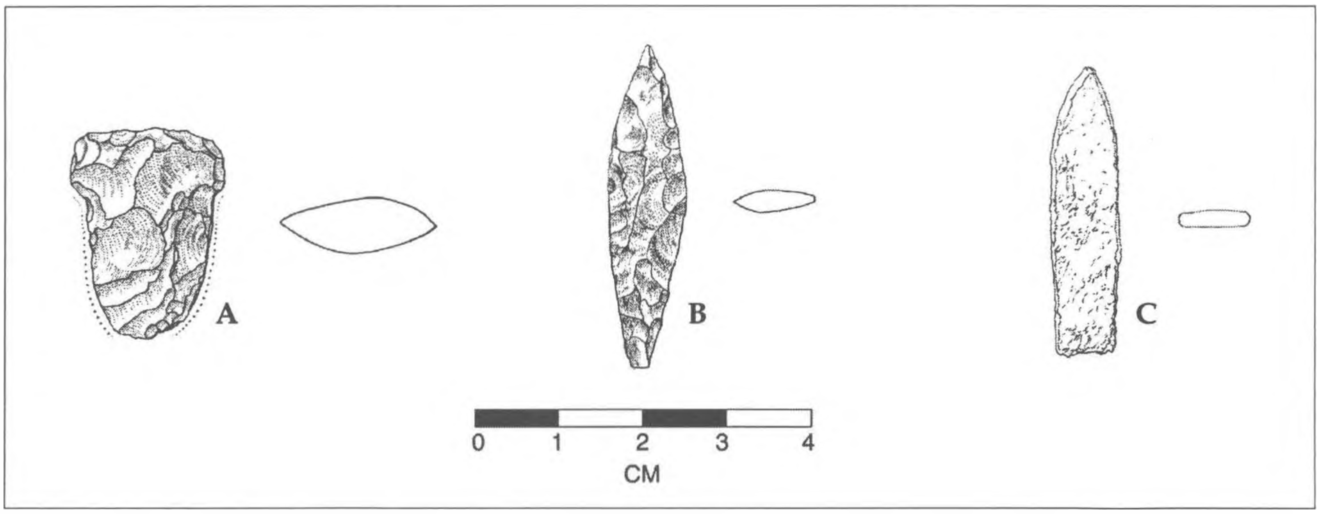

Figure 1. The possible Windust point base (A: with basal grinding indicated by dots) found below the rim deposits of HP 5; and the unusual Protohistoric bipointed arrowhead (B) from HP 104, compared to an historic metal arrowhead (C) found in Keatley Creek surface deposits in HP 5.

recovered from this housepit. Roof and roof surface strata contain 19 (50%) Kamloops points, 12 (31.6%) Late Plateau points, 5 (13.2%) Plateau points, and 2 (5.3%) Shuswap point. This is 58.8% of the total number of points from this housepit. Rim stratum levels in this housepit lack any direct evidence of projectile points other than one Shuswap point located at the bottom of the rim on the southern extreme of the housepit. The final occupation of this floor has been dated to 1,080 BP (Vol. I, Chap. 2) as is consistent with the predominance of Kamloops points in the floor deposits and the lack of any multinotch Kamloops points in the house.

Housepit 7

Housepit 7 is also a multi-component residence. The initial occupation of this housepit probably dates to the late Shuswap horizon based on a date of 2,600 BP from the base of its rim (Vol. I, Chap. 2). Housepit 7 appears to have been excavated into an earlier Lochnore phase surface occupation (See Vol. III, Chap. 5). A terminal date of 1,080 BP during the Kamloops horizon is given to this housepit based on radiocarbon dating of the floor.

As Table 1 indicates, the floor stratum in HP 7 contained 21 (78%) Kamloops points, 3 (11%) Plateau points, 1 (3.7%) Shuswap points, and 2 (7.4%) Lochnore points. The number of projectile points located within this stratum, represents 15.2% of the total number of points recovered from this housepit. Of the three Plateau points that were recovered from the floor stratum, two are located near the edge of the floor and one at the very center of the floor. These are areas not occupied by Kamloops points. Shuswap points occur almost exclusively near the eastern wall.

Roof and Roof Surface strata in this housepit contain 49 (53.3%) Kamloops points, 19 (20.7%) Late Plateau points, 12 (13%) Plateau points, 8 (8.7%) Shuswap points, and 4 (4.4%) Lochnore points. The roof stratum contains 51.7% of the total number of points from this housepit. The Lochnore points and all but one Shuswap point associated with the roof stratum of this housepit are located near the edge of the roof. This might be expected in a roof matrix if there was mixing with rim deposits that contained artifacts from previous horizon occupations. There would undoubtedly be some such mixing of the rim deposits with the roof strata during the digging of post or roof beam emplacement holes in the rims for roofs.

Rim deposits in this housepit contain 4 (21%) Kamloops, 4 (21%) Plateau, 3 (15.8%) Late Plateau, 4 (21%) Shuswap, 3 (15.8%) Lochnore points, and 1 Lehman point (5.3%). These various projectile point types represent only 10.7% of the total number of points found in this housepit. This low proportion is largely due to the very limited testing of rim deposits that took place compared to the complete excavation of roof and floor deposits. The same holds true for HP 3.

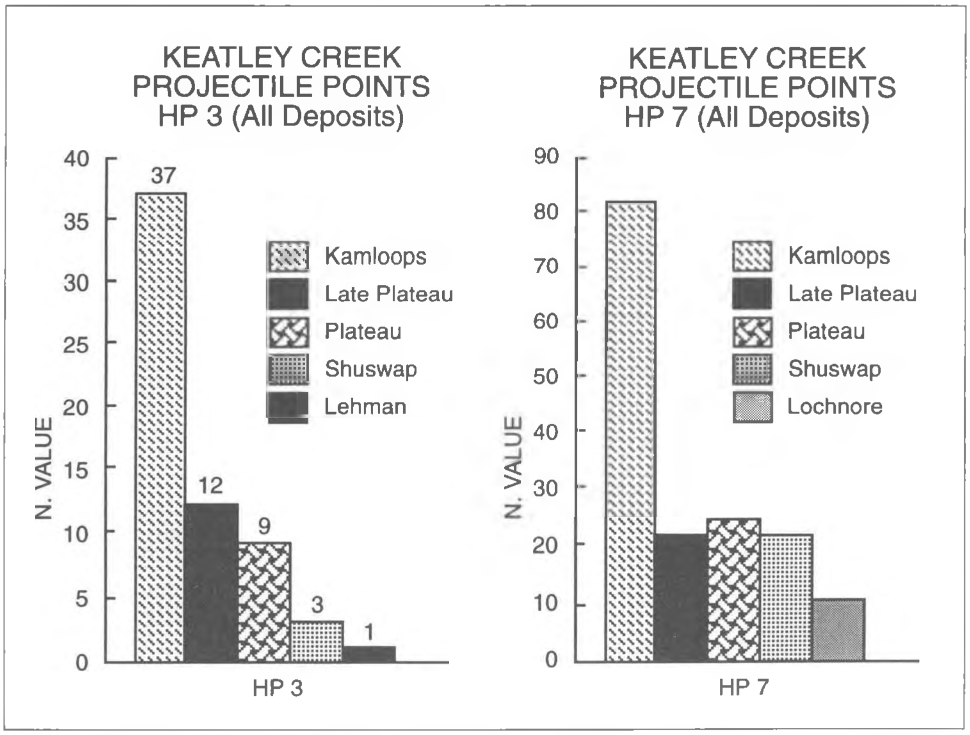

Figure 2. Histograms showing the distribution of types of projectile points in excavated floor deposits as well as the total type distribution of projectile points in HP's 3 and 7.

The predominance of Kamloops points in the floor deposits and the lack of Kamloops multinotch points (other than the probable intrusive post abandonment specimens noted earlier) is consistent with an early Kamloops final occupation as indicated by radiocarbon dates.

From the foregoing description of projectile point proveniences, it is abundantly clear that there are few stylistically "pure" deposits in any of the major types of strata, whether floors, roofs, or rims. While mixed styles may not be surprising in some contexts, such as roofs, mixed styles in other contexts such as floors present more interpretive problems.

Table 1. Keatley Creek Projectile Point Frequencies and Proveniences

HP 1

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Feature	1						1
Rim Spoil	1		1				2
Unknown	3			1			4
Subtotals	5		1	1			Total points: 7

HP 2

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof Surface	1						1
Floor	2						2
Rim: Level 5				1			1
Level 8			1				1
Subtotals	3		1	1			Total points: 5

HP 3

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Surface	3						3
Roof Surface	6	4	2	1			13
Roof	13	8	3	1			25
Floor	13		3			1	17
Rim: Level 10B				1			1
Collapse	3		1	1			5
Unknown	1						1
Subtotals	39	12	9	4		1	Total points: 65

HP 4

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof	1		2	1			4
Floor			1				1
Rim: Level 6				1			1
Subtotals	1		3	2			Total points: 6

Table 1. Keatley Creek Projectile Point Frequencies and Proveniences *(continued)*

HP 5

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof				1			1
Floor					2		2
Rim: Level 1	1		3	1		1	6
Level 2	1						1
Level 3			2				2
Level 6				1			1
Level 7							
Subtotals	2		5	3	2	1	Total points: 14

1 windust and 1 misc. point not included here.

HP 6

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof	1		1				2
Floor	1						1
Subtotals	2		1				Total points: 3

HP 7*

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Surface	2						2
Roof Surface	4	2	1	1			8
Roof	45	17	11	7	4		84
Floor	21		3	9	2		35
Feature	5	3	2	1	1		12
Rim: Level 1	4			2	1		7
Level 2		2		1	2	1	6
Level 3		1		1			2
Level 6			1				1
Level 8			1				1
Level 9			1				1
Rim Spoil			1				1
Collapse	1		2				3
Pit Fill					1		1
Potted				2			2
Unknown	9	1	6	2	2		20
Subtotals	91	26	29	26	13	1	Total points: 186

* Some entries differ from detailed analyses in Vol. I, Chap. 15; however, no resolution of discrepancies could be achieved and we assume the detailed analysis is more accurate.

Table 1. Keatley Creek Projectile Point Frequencies and Proveniences *(continued)*

HP 8

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof	1	1	1				3
Floor	1	1					2
Subtotals	2	2	1				Total points: 5

HP 9

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Surface	3						3
Roof Surface	1						1
Roof	1						1
Floor			5	1			6
Feature	2						2
Unknown			1				1
Subtotals	7		6	2			Total points: 15

HP 12

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof Surface	1						1
Roof	1	1	2				4
Floor			2				2
Subtotals	2	1	4				Total points: 7

HP 47

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Dump			1				1
Subtotals			1				Total points: 1

HP 58

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Rim: Level 1			1				1
Subtotals			1				Total points: 1

Table 1. Keatley Creek Projectile Point Frequencies and Proveniences *(continued)*

HP 90

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof Surface			2				2
Roof				1			1
Feature			1				1
Unknown				1			1
Subtotals			3	2			Total points: 5

HP 101

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Floor	2		1				3
Subtotals	2		1				Total points: 3

HP 104

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Floor	1						1
Subtotals	1						Total points: 1

1 misc. point not included here.

HP 105

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Surface	1						1
Dump	1						1
Unknown	1						1
Subtotals	3						Total points: 3

HP 106

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof Surface	1						1
Subtotals	1						Total points: 1

Table 1. Keatley Creek Projectile Point Frequencies and Proveniences *(continued)*

HP 107

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Dump			1				1
Subtotals			1				Total points: 1

HP 109

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Fill				1			1
Subtotals							Total points: 1

HP 110

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Roof				1			1
Floor	1			4			5
Feature	1			1			2
Subtotals	2			6			Total points: 8

EHPE 11

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Unknown	2						2
Subtotals	2						Total points: 2

EHPE 12

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Unknown			2				2
Subtotals			2				Total points: 2

EHPE 21

	Strata Type						
Point Type	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	*Strata Type Subtotals*
Unknown	2						2
Subtotals	2						Total points: 2

Table 1. Keatley Creek Projectile Point Frequencies and Proveniences *(continued)*

Grand Totals

	Strata Type						
	Kamloops	Late Plateau	Plateau	Shuswap	Lochnore	Lehman	
Point Type Totals:	167	41	75	42	16	3	Point Grand Total: 343

Analysis

Mixing of projectile point types may be due to several causes. These include: (1) Simultaneous use of the different point styles or technologies. (2) Collection and possible reuse, recycling, and/or rejuvenation of point types from previous inhabitants of the locality, site, or housepit. (3) Incomplete removal of floor debris from occupations when creating or renovating the structure and its floor surface. (4) Filtration of artifacts from roof or wall deposits onto the most recently occupied floor surface before abandonment. (5) Possible failure of excavators to adequately distinguish floor, roof, and later intrusive pit deposits during excavations thus resulting in the inclusion of some artifacts contained in the roof or later pits with sediments identified as floor deposits. (6) Deep trampling by livestock or other post-occupational turbation of the soil matrix. (7) Mixing of deposits from different time periods due to the excavation of soil for roofing, filling of large storage pits, or other purposes. We will begin by discussing the clearest case of projectile point style mixing: roof deposits.

Roof and Roof Surfaces

From ethnographic accounts (Vol. I, Chap. 2) and archaeological observation (Vol. I, Chap. 17), it is clear that soil used to cover pithouse roofs was frequently recycled and mixed with both floor and rim deposits, perhaps even every time a new roof was constructed to replace rotting ones. This process more than adequately accounts for the degree of stylistic mixing of projectile points observed in the roof deposits of HP's 3 and 7. However, there is some unexpected and interesting patterning in these roof deposits.

In both HP 3 and 7 there is a larger quantity of projectile points of each type located within the roof stratum than in the floor stratum. Among other things, and assuming floors were incorporated in roofs every 20–30 years when roofs were replaced, this indicates that placing dirt on the roofs of large houses was a practice that had only begun within the last 200 years or so of the site's history, otherwise even more points would be found in the roof deposits. The estimate of 200 years is derived by dividing the number of Kamloops and Late Plateau points in the roof by the number of Kamloops points in the floor deposit. This results in an estimate of 3.6 reroofing events for HP 3 and 3.5 reroofing events for HP 7. If the number of Plateau points in the roofs and floors are similarly divided, this results in an additional 1.7 and 3.3 reroofing events for HP's 3 and 7, or a total of 5.3 reroofing events for HP 3 and 6.8 reroofings for HP 7. Assuming roofs lasted 25 years, this would mean that earth covered roofs had been used for about 150–200 years (including the last floor) at Keatley Creek.

The predominant location of Kamloops points in the roof stratum of both housepits is in the northern sectors. The locations of most points in the northern sector of the housepit roofs may be due to cultural agencies, noncultural agencies, or a combination of both factors. Some of the likely factors responsible for point location within the roof strata are: (1) the preferred area for discarding general hard (lithic) materials including projectile points was probably the north roof and rim, and (2) the preferred location for projectile point knapping, maintenance and/or storage of points may have been the north roof (less likely). This pattern will be important later for interpreting causes of mixing in floor deposits.

Since the bulk of *Late* Plateau points in HP 3 and 7 (N=39) are located in the roof surface (N=6) and roof (N=25) strata but not in the floor stratum, this may provide some indication of the degree to which filtration from roof to floor occurred during the pre- and post-abandonment periods of the Keatley Creek pithouses and may also provide clues to the dynamics of change in point styles, a topic discussed below. Most Plateau points are located in roof strata as would be expected if the last floor occupation was of Kamloops date and if previous, Plateau, floor deposits had been incorporated into roof sediment during re-roofing events.

Floors

Of all the strata types that seemed as though they should be relatively "pure" in terms of temporally bounded artifact types, housepit living floor deposits seemed to have the greatest potential, especially since they seem to have been used for short periods of time (20–30 years) and to have been sealed by the intentional burning and collapse of the roof structures at the time of abandonment (Vol. I, Chap. 17). Moreover, much of the interpretation of social and economic organization within structures depends upon the floor deposits being relatively uncontaminated from mixing with artifacts from other time periods, whether during the occupation or after abandonment. The presence of both Plateau (and earlier) styles of projectile points together with Kamloops style projectile points on the floors of HP's 3 and 7 (as well as other housepits) therefore presents interpretive problems of some significance (Figs. 2, 4, and 5). We had assumed at the outset that the floors would only contain projectile points that were supposed to characterize the latest prehistoric period i.e., Kamloops points. While the vast majority of points in some floors were certainly Kamloops style points, there were a surprising percentage of other point styles as well. What factors were responsible for this occurrence of non-Kamloops style points in the floor deposits?

While we cannot come to any definitive conclusions at this point, we believe that a number of sources of mixing can be excluded on the basis of the patterning in the data and on the basis of similar developments elsewhere that parallel the changes that occurred at Keatley Creek.

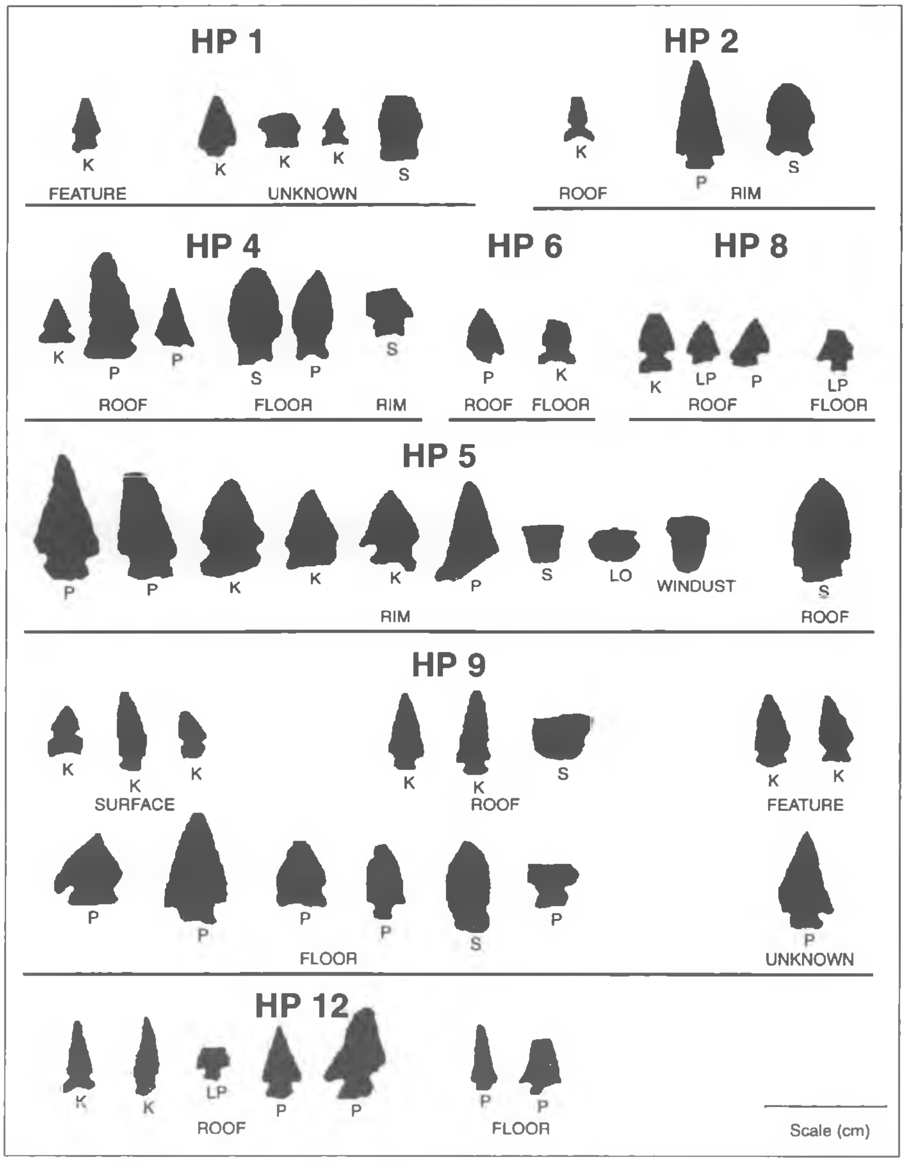

Figure 3. Outline shapes of projectile points from HP's 1, 2, 4, 5, 6, 8, 9, and 12. K = Kamloops point; LO = Lochmore point; LP = Late Plateau point; P = Plateau point; S = Shuswap point.

First, as already noted, most of the earlier Plateau and Shuswap points in the floors of HP's 3 and 7 are located close to the walls, especially the eastern wall of HP 7. Because these areas are the most deeply buried by roof collapse, they are the least likely to have been affected by any kind of post-depositional turbation after the burning and collapse of the pithouse roof. Post-depositional mixing can therefore probably be eliminated. Other early points may occur in floor deposits due to recycling.

Second, the degree of filtration from the roof postulated for the translocation of points from the roof sediments to the floor while the pithouse was functioning seems inconceivable. We would expect that the inhabitants would have reroofed the structure long before artifact-sized debris began raining down on the floor from the roofs.

On the other hand, many of the walls inside the house were cut into earlier rim midden deposits to the extent that the walls would have been relatively unstable given the soft, unconsolidated, organic nature of the rim deposits in larger houses. During excavation, we noted on many occasions that floor deposits near the walls seemed to become indistinct and graded into wall deposits as though there had been sloughing off of the wall or deposits that had trickled down onto the floors (perhaps under sleeping platforms) and become mixed with floor deposits. The sloughing off of steep wall or rim midden deposits along the walls could have certainly contributed some earlier artifactual materials to the floor deposits near the walls. This might well explain the dominant distribution of Plateau points in HP's 3 and 7 near the walls.

Also in HP 7, excavators noted several occasions where there appeared to be earlier deposits under the Kamloops living floors, especially near the walls, and especially in the south and west sectors where Middle Prehistoric deposits underlie the Kamloops floors. These earlier deposits were often simply cataloged as "level 2" of the floor deposits and treated as floor artifacts, whereas, with hindsight, it is clear that they should have been dealt with separately. Similarly, several laminated floor remnants were present against the east wall of HP 7. Thus, failure of excavators or analysts to adequately distinguish between the deposits of the last floor and deposits underlying the last floor, as well as material sloughed off of the walls, must account for some of the non-Kamloops style points cataloged in with the artifacts of the last floor deposits. However, since the flotation samples that were analyzed generally came from the uppermost level of the floor deposits, and since the stone tools and bone elements that were examined for distributional patterning were only taken from the uppermost levels of the floors, we have considerable confidence that these sources of error have not affected the overall patterning of artifacts, especially away from the immediate wall zones.

Another source of mixing may have been derived from the periodic filling with earth and subsequent emptying of the large storage pits in the medium and large sized houses. These storage pits were sometimes over a meter deep and wide. We do not know when they were first dug, but the presence of Plateau points in some of them and a radiocarbon date of 2,060 BP from one pit in HP 7 indicate that many storage pits probably originated during the Plateau horizon. If dirt from these pits was banked inside the houses when the pits were full of food, it is likely that some artifacts contained in the pit fill could have become mixed with the floor deposits. However, we do not know precisely where such dirt was stored (whether inside or outside the house) nor when these pits were last used. While emptying dirt fill from pits may have contributed to the random "background" occurrences of artifacts across the floor (including occasional occurrences of earlier style points), this source of mixing does not seem to have affected the overall, more robust patterning of artifacts across the floor as indicated by the close association of debitage, FCR, and artifacts with hearth locations and sleeping areas. Thus, prehistoric excavations of soil containing earlier materials may have contributed some items to the floor assemblages, but does not appear to have created any major biases.

Similarly, the prehistoric retrieval and recycling of early point styles from surface finds undoubtedly contributed to some extent to the mixing of point styles in the floor deposits at Keatley Creek. This kind of retrieval and recycling is specifically documented in the region ethnographically by James Teit (1900:241,338; 1909:519,539,645) and Harlan Smith (1899:126–7,137). It is also documented for other regions of North America (e.g., Trigger 1989:28). While this source of mixing might certainly account for the introduction of an occasional earlier point style into an otherwise pure

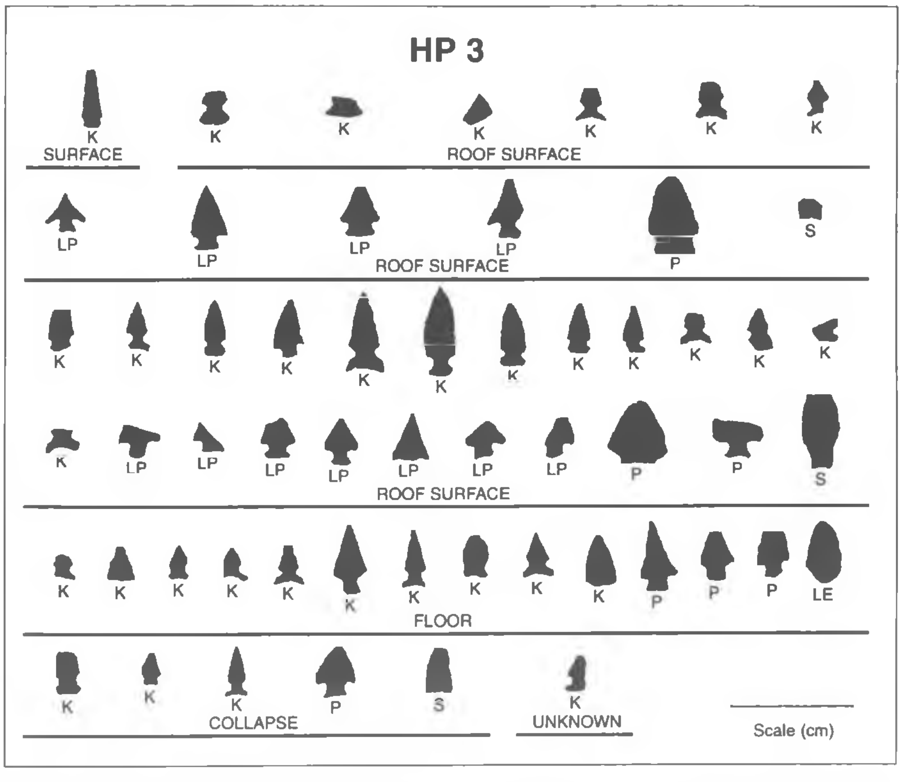

Figure 4. Outline shapes of projectile points from HP 3. Small point fragments are not included and some points are missing from the collection. K = Kamloops point; LE = Lehman point; LP = Late Plateau point; P = Plateau point; S = Shuswap point.

assemblage, it seems unrealistic to assume that it could have accounted for the large percentages of non-Kamloops points documented in HP's 3 and 7. Thus, other factors likely contributed to the formation of these "mixed" point styles in floor deposits.

The final source of mixing that we would like to consider is the possibility that there were actually two projectile technologies being used simultaneously by the occupants of HP's 3 and 7: a bow and arrow technology, and a spearthrower and dart technology. There are several reasons why it might make sense for both of these technologies to coexist at least for some extended period of time. First, the bow and arrow technology is much more time consuming and difficult to manufacture. In fact, specialists were probably required to produce good functional bows (Prusinski 1993–4). It is also a much higher risk technology since bows and bow strings can break under too much stress. On the other hand, bow and arrows have the advantage of being able to be fired more rapidly, and hunters or warriors are able to carry more missiles with less weight. Neither accuracy nor ranges seem to differ significantly between bows and arrows, and spearthrowers and darts. Second, given the higher costs and the initial problems of first adoptions, it could well be expected that only certain individuals in any community would be able to adopt and use the bow and arrow initially. These individuals would have typically been the more affluent and powerful members of the community.

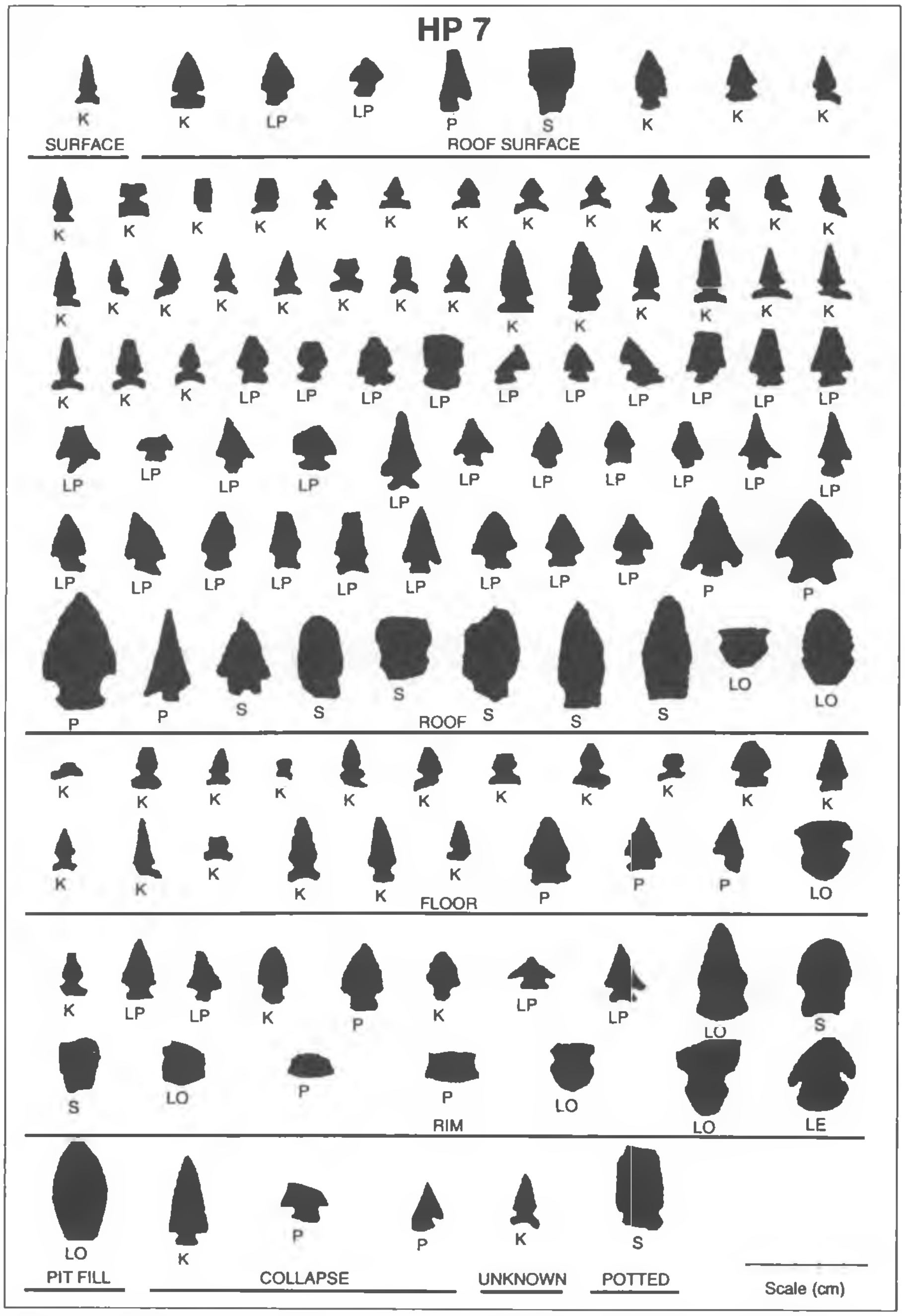

Figure 5. Outline shapes of projectile points from HP 7. Small point fragments are not included and some points are missing from the collection. K = Kamloops point; LO = Lochmore point; LP = Late Plateau point; P = Plateau point; S = Shuswap point.

A variety of observations support this scenario. It is widely recognized that the bow and arrow did not abruptly replace the spearthrower and dart in the Northwest, or in adjoining areas, or indeed elsewhere in North America. In the Plateau area, Rousseau (1992:102) considers that the bow and arrow was introduced about 1,500 BP (as reflected in the appearance of small "Late Plateau" style points, and that it was used concurrently with the spearthrower for about 500 years, until 1,000 BP when the bow and arrow functionally replaced the spearthrower everywhere and for everyone (see also Fladmark 1986:131–2). Farther south on the American Plateau and in the Great Basin, a similar situation prevailed (Cressman 1977:106; Aikens 1986:20,47), as it did on the Northwest Coast (Pettigrew 1990:523). Blitz

(1988) and Shott (1993) document similar replacement scenarios elsewhere in North America.

In addition, the two styles of projectile points are distributed in a roughly complementary fashion on the floor of HP 7, the most hierarchically organized housepit that we have fully excavated (Figs. 7 & 8). Plateau spearthrower projectile points occur exclusively in the poor half of the house and do not coincide with occurrences of Kamloops style bow and arrow projectile points (Spafford 1991:134). Moreover, the distribution of key-shaped scrapers on the HP 7 floor (which Rousseau (1992:102) argues are functionally linked to spearthrowers and dart technology), is heavily weighted in the poorer, eastern half of the house where spearthrower technology may have been most common (Fig. 9). This clearly makes sense in terms of the richer and more elite members of a community being the first to adopt new, more costly, and risky technologies while poorer members continued to use less expensive, simpler, more reliable, and more traditional technologies. A similar situation has been recorded archaeologically on the Coast where Ken Ames (personal communication) and Chatters (1989:176–7) have documented the division of houses into elite and nonelite halves characterized by different hunting technologies (see Vol. I, Chap. 17).

Finally, the curious occurrence of Late Plateau (arrow) points only in the *roof* deposits of HP's 3 and 7, but not in the floor deposits, would make sense if they had only been used for a brief period at the initial introduction of the bow and arrow, and had been subsequently replaced by Kamloops points. In this case, full sized Plateau points would have continued to be used as part of the spearthrower technology alongside the subsequent Kamloops points with their bow and arrow technology. Thus, in the last occupation, Plateau style dart points and Kamloops style bow and arrow points could be used in the same house, being deposited as part of the same living floor assemblage. However, because Kamloops points had replaced the Late Plateau style arrow points, the Late Plateau points would not be found in the floor deposits, but only in the cleaned out previous floor deposits that had been incorporated into the roof or rim deposits. This is precisely the pattern that does occur, i.e., there are no Late Plateau arrow points found in floor deposits. They are all found in roof deposits. The above scenario assumes that Plateau corner notching is more suited to hafting on darts while side notching is more suited for hafting on arrows.

Furthermore, given the differential occurrence of Late Plateau points only in the roofs but not on the floors of HP's 3 and 7, it also seems unlikely that any significant proportion of the overall point assemblage contained in the floor deposits had fallen through the roofs onto the floors during the house occupations; otherwise some Late Plateau points should have occurred in floor deposits.

Thus, both the occurrence of Late Plateau points in the roof but not on the floors, and the predominant distribution of Plateau points in the poorer domestic areas of HP 7, seem to indicate that a large proportion of the Plateau points associated with these floors

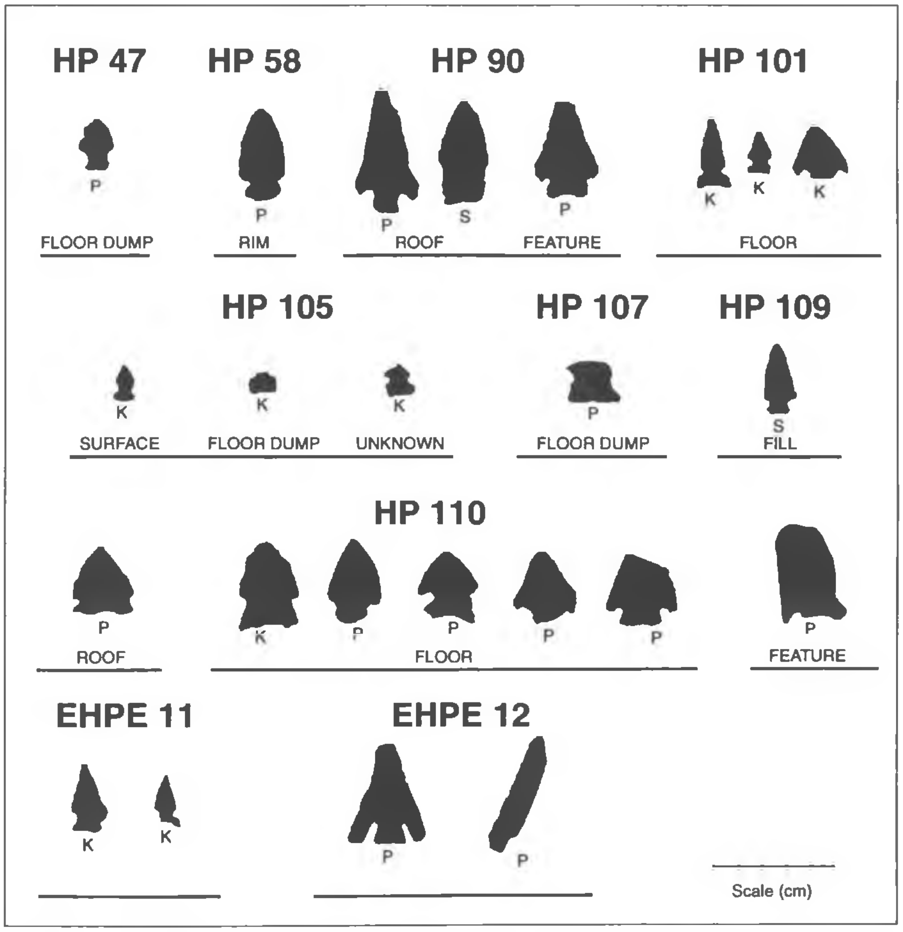

Figure 6. Outline shapes of projectile points from HP's 47, 58, 90, 101, 104, 105, 107, 109, 110, and EHPE's 11 and 12. K = Kamloops points, LE = Lehman points; P = Plateau; S = Shuswap points.

represent the use of the spearthrower technology by some of the poorer inhabitants, while other more affluent members of the same household were using bows and arrows. If this is the case, it is also possible that some smaller, poor housepits containing only Plateau style points in their floors (e.g., HP 90) were actually contemporaneous with some of the larger and wealthier housepits that contained a mixture of Plateau and Kamloops points in their floor deposits.

In sum, it seems likely that retrieval and recycling of earlier points, as well as excavating out pit fill with early materials, and the sloughing off of earlier materials from the midden layers of the inside walls contributed modestly to the mixed nature of the point styles in the floor assemblages. Failure of excavators to clearly distinguish between the uppermost (last) floor and earlier floor levels has added to this mixing in analyses where all points are considered (as in this chapter), but should not have affected other distributional analyses where only the uppermost floor was used in analysis. However, on the basis of the floor areas where Plateau points are most concentrated, and distributions in other strata, it would seem that one of the major sources of the mixed point styles may have been the coexistence of spearthrower and bow technologies during the formation of the last floor deposits at Keatley Creek, and probably for one or two hundred years preceding that time. Certainly, the strong patterning across housepit floors as documented in the other analyses of stone tools and debitage, faunal remains, botanical remains, and soil chemistry in relation to hearths and sleeping areas display little evidence of any significant mixing of deposits outside of general background random occurrences. Indeed, if there had been any substantial mixing of deposits, it is difficult to see how these artifact patterns could have been created or maintained.

Rims

Rim deposits were largely formed as the floors of previously occupied or new housepits were cleared by occupants to create a new floor surface (see Vol. I, Chaps. 15 & 17). In general, the sequence of early points (Shuswap or earlier) at the base of the rim, followed by

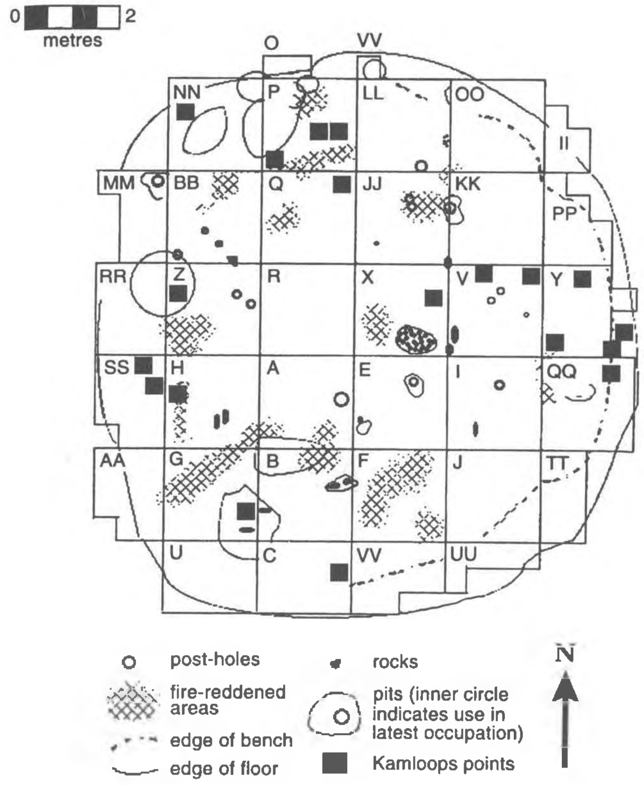

Figure 7. The distribution of Kamloops (arrow) points on the floor of HP 7. Note the general trend of these points to occur on the west side of the house except for one concentration in the eastern sector.

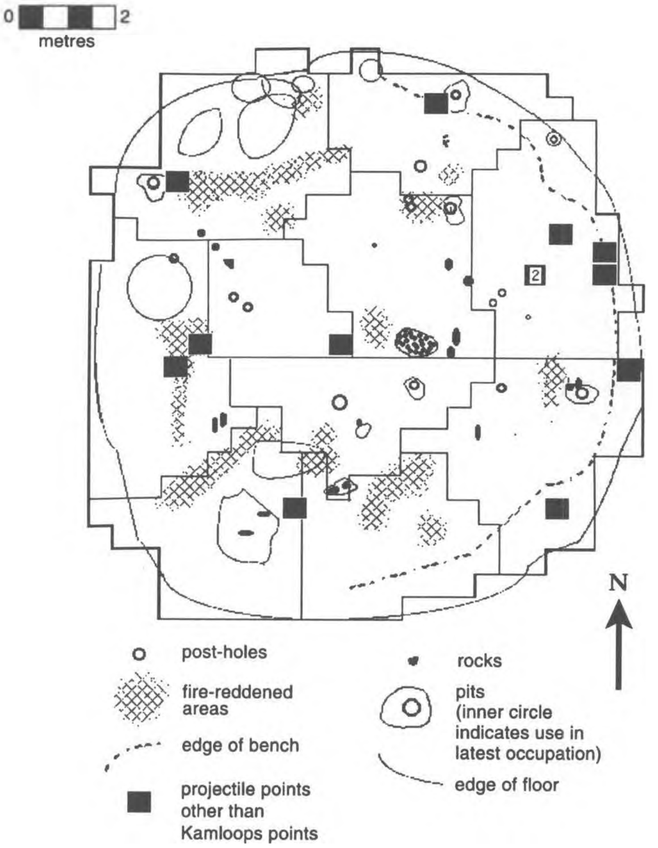

Figure 8. The distribution of non-Kamloops (dart) points on the floor of HP 7. All Plateau points occur in the east half of the floor. Much earlier Lochnore and Shuswap style points are probably present due to chance finds and recycling or due to earlier Lochnore deposits underlying the last floor that were not adequately distinguished from the Kamloops floor.

Plateau points in the middle of the rim, and mixed Plateau, Kamloops, or other points in the upper part of the rim (when dirt roofs presumably began to be used) is evident in all the housepits where rims were intensively tested (see Vol. I, Chap. 15; Table 1). During excavation, the temporal and stratigraphic coherence of the rims seemed to be fundamentally intact although rodent and other sources of turbation have undoubtedly created some vertical mixing.

Summary

The projectile point types at Keatley Creek conform to the regional types and time periods as established by Richards and Rousseau (1987). In stratified rim deposits, point types generally follow the expected seriation sequences, although occasional points do occur "out of sequence" as might be expected in deposits that were occasionally reworked by digging emplacements for joists and reworked by burrowing animals and insects. Roof deposits were very mixed as expected, and the absolute frequency of points in earth roofs provided a basis for estimating how long earth covered roofs had been in use at the site (about 200 years).

Floor assemblages proved to contain unexpectedly mixed Kamloops (bow and arrow) and Plateau (atlatl and dart) points. Many factors may have been responsible for representatives of both of these technologies being attributed to the same floor deposit. There has undoubtedly been some mixing due to sloughing off of rim material onto the edge of floors and due to excavator errors in distinguishing floor from other deposits. Recycling of old points by Indians is also documented. However, it seems unlikely that these factors would account for the large proportion of Plateau points found in Kamloops floors. We suggest that the "bow and arrow" and "atlatl and dart" technologies co-existed for several hundred years and probably characterized different socioeconomic classes, with the bow and arrow being preferentially used by higher classes and the spearthrower being largely used by lower classes.

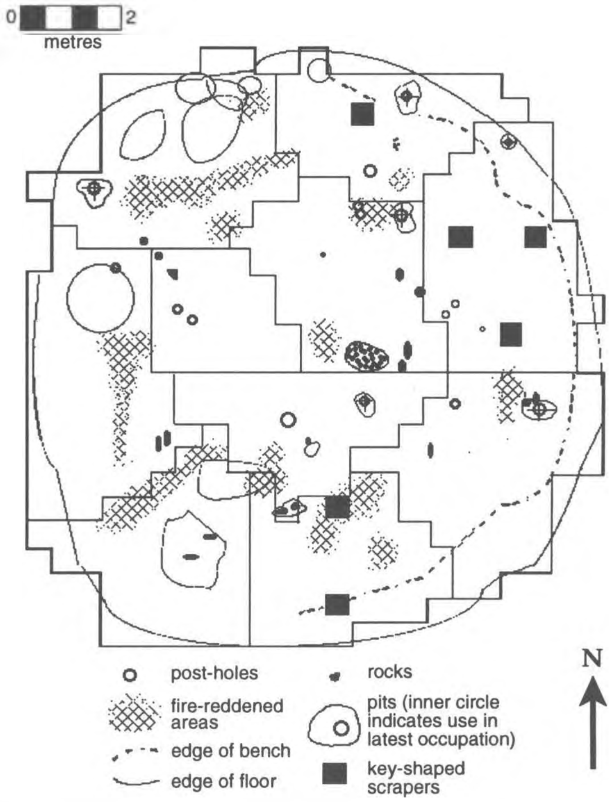

Figure 9. The distribution of key-shaped scrapers on the floor of HP 7. Rousseau (1992) associates these tools with spearthrower darts, and it is interesting that they strongly cluster in the poorer half of the house where we suspect spearthrower technology may have persisted the longest.

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GEOLOGY AND SOILS

Chapter 4

Holocene Climate in the South-Central Interior of British Columbia

Rolf W. Mathewes & Marlow G. Pellatt

Modeling the economic organization of prehistoric sites such as Keatley Creek is predicated on an accurate understanding of the local and regional environment, especially the types and extents of plant communities. While some idea of past plant communities and climates can be obtained from the types and distributions of plants that exist in the region around Keatley Creek today, significant changes have taken place at various times in the past. In order to accurately model the Keatley Creek economy during the last period of occupation (1,100–1,500 BP), it is necessary to determine to what extent the climate and plant communities were different at that time from today's environment. That is the goal of this chapter.

Recent geochemical investigations of ice cores from Greenland (O'Brian et al., 1995) and other climatic indicators (Stager and Mayewski, 1997) have emphasized that the Holocene (last 10,000 years) has experienced several abrupt climatic transitions. Some appear to be reorganizations of atmospheric circulation patterns that affected ecosystems around the world (Stager and Mayewski, 1997). The most dramatic of these abrupt climatic changes occurs between ~7,500–7,000 radiocarbon years BP (8,200–7,800 calendar years ago). This is significant for British Columbia, since Mathewes (1985) emphasized that peak early-Holocene warm and dry conditions ended around 7,500–7,000 radiocarbon years BP. The early Holocene xerothermic interval, which peaked in warmth and dryness between 9,000–8,000 BP (Clague and Mathewes, 1989; Clague et al., 1992) had a profound effect on vegetation (Mathewes, 1985; Hebda, 1995) and therefore probably also on animals and humans. This transition, just a few centuries before the Mazama ashfall at ~6,800 BP, should therefore be represented in the archeological record of the Lillooet area.

Since publication of four pollen diagrams in the southern Fraser River drainage by Mathewes and King (1989), little new work has appeared that bears directly on the vegetation and climate history of the Lillooet area. The recently published review by Hebda (1995), however, provides a good summary of available data on paleoenvironments in British Columbia, with an emphasis on the mid-Holocene interval (6,000 BP). In this review Hebda provides a new pollen diagram from "Pemberton Hill" lake, a palynological study site from the Interior Douglas-fir Zone near Kamloops, as well as summarizing interpretations of grassland vegetation history and climate for the southern interior.

Hebda identifies two major periods of change during the Holocene, the first at about 8,000 BP, when the warm and dry early Holocene begins to change to a warm but wetter period between 8,000–4,500 BP. During this interval, dry grasslands with abundant sage and few trees gave way to mesic grasslands with expanding populations of trees such as Douglas-fir and Ponderosa pine. The second major change was designated around 4,500 BP, when modern grassland distributions developed, and cooling to modern climatic conditions took place.

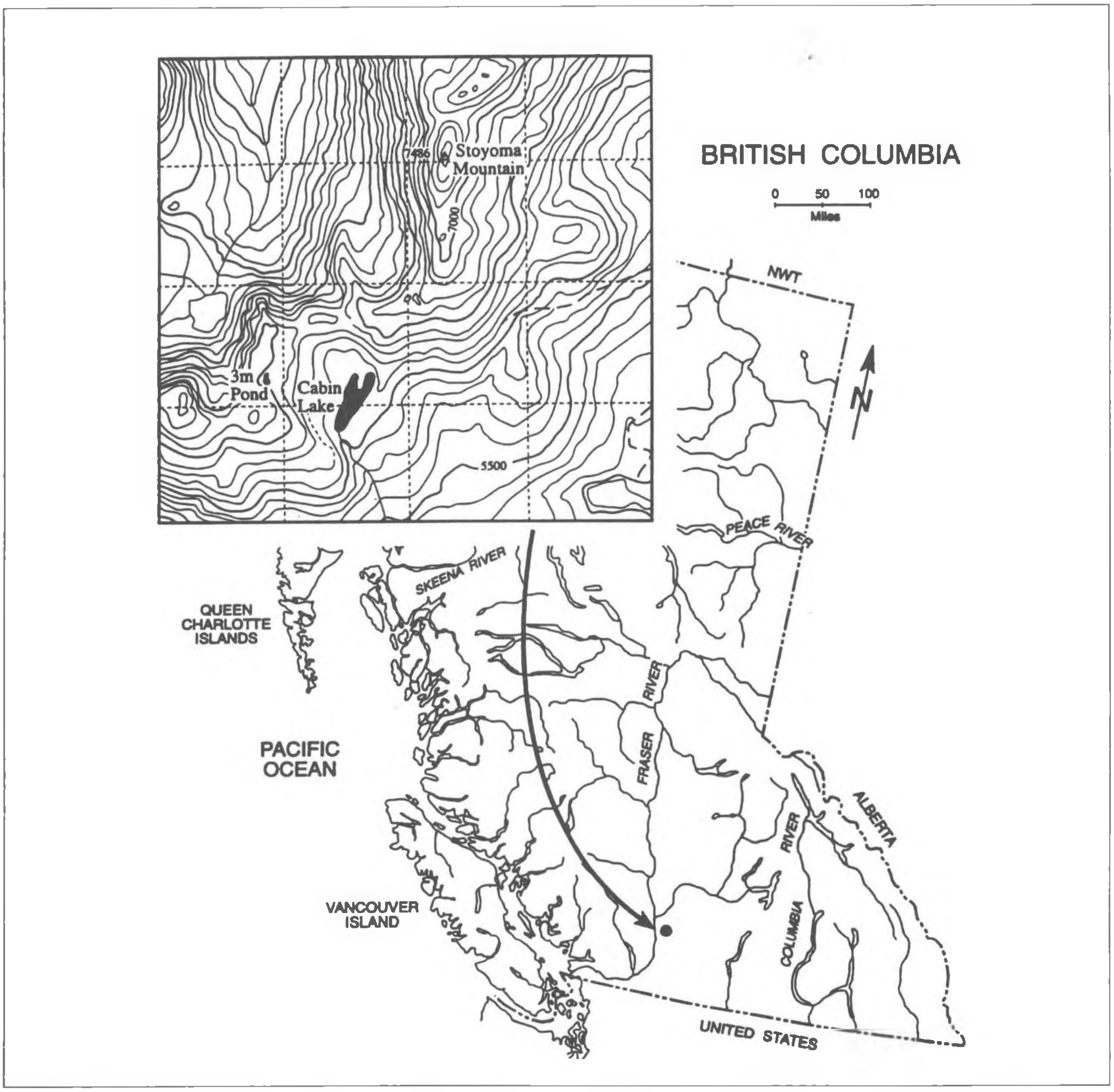

Figure 1. **Map of British Columbia showing the Cabin Lake and Stoyoma Mountain sampling localities.**

Hebda's (1995) conclusions differ somewhat from those of Mathewes and King (1989) who place the major post-Mazama periods of change at about 5,650 BP, during the early neoglacial period (Ryder and Thompson, 1986), and at about 2,000 BP, based on pollen and aquatic molluscs in Phair and Chilhil lakes near Lillooet.

New paleoecological investigation of lake sediments at Cabin Lake on Mount Stoyoma (Pellatt, 1996; Smith, 1997) also reveal significant changes in vegetation and climate in the southwestern interior of British Columbia since deglaciation. Mount Stoyoma is located in the northern Cascade Mountains (Fig. 1) and represents the typical subalpine environment for the southwest interior. A pollen diagram (Fig. 2) from Cabin Lake summarizes the Holocene vegetation changes in this area. Pollen, plant macrofossil, and chironomid (midge) head capsule analyses indicate five major changes in environmental conditions (Pellatt et al., 1995; Pellatt, 1996; Smith, 1998). These changes are summarized as follows:

1) Cold continental conditions during the late Pleistocene (>10,000 BP) supporting an open alpine tundra environment and cold-stenothermous chironomid population.

2) Warm and dry (xerothermic) conditions in the early Holocene (10,000 to 7,000 BP) supporting a non-analogous open spruce parkland and warm-adapted chironomids.
3) Relatively warm and moist (mesothermic) conditions in the mid-Holocene (7,000 to 4,800 BP) supporting a closed spruce forest and a mixture of warm and cold-adapted chironomids.
4) A transitional period of climatic deterioration in which temperature decreased from 4,800 to 3,200 BP, and in which the characteristics of the modern Engelmann Spruce Subalpine Fir (ESSF) forest began to be established.
5) Modern subalpine conditions established between 3,200 BP and present, with minimum Holocene temperature and relatively high precipitation occurring between 2,435 and ca. 1,700 BP. A cold-adapted chironomid community also becomes established at this time. The modern Engelmann Spruce Subalpine Fir forest around Cabin Lake appears to have been relatively stable for the last 1,700 years.

Paleovegetation and climate change at Cabin Lake corresponds well with changes observed elsewhere in the southern interior (Fig. 3), three phases of climate change have been noted. These periods are the early Holocene xerothermic period (10,000 to 7,000 BP), a period of climatic transition to modern conditions in the mid-Holocene (7,000 to 3,200 BP) with a warm/moist mesothermic phase occurring between 6,800 to 4,800 BP, and the establishment of modern climatic conditions after 3,200 BP. The climate change at ~3,000 BP corresponds well with neoglacial conditions identified throughout the Canadian Cordillera (Ryder and Thompson, 1986).

None of the available palynological studies in the southern Interior has so far been able to document environmental changes during the Little Ice Age, the period within the last millennium when many alpine glaciers re-advanced to their maximum positions (ca. 1300–1850 AD) since the end of the Pleistocene. Such advances have been well documented in the southern Rocky Mountains (Luckman et al., 1993) and elsewhere, and have been shown to affect vegetation distributions (Clague and Mathewes, 1996). Since peak cooling is generally attributed to a few centuries between about 1550–1850 AD, such an event is difficult to detect by the coarse sampling intervals used in standard regional pollen analytical investigations. Close-interval core-sampling and analyses of tree rings are two approaches that should be applied to high-elevation sites around Lillooet to determine if the Little Ice Age altered the vegetation in this area, and if it could have affected native subsistence, settlement, or migration patterns.

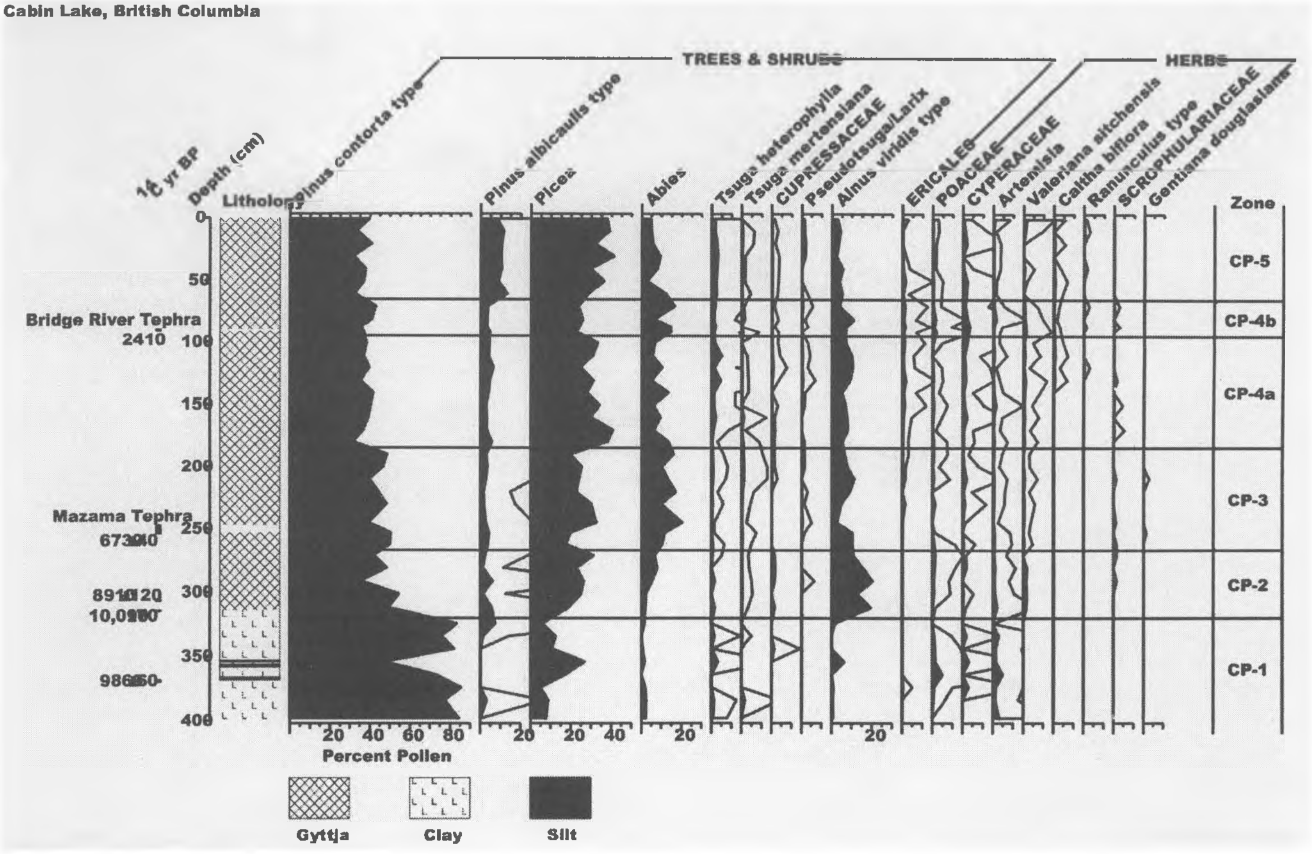

Figure 2. The pollen diagram and dates from Cabin Lake.

Archaebotanical investigation has been undertaken at sites near Lillooet, British Columbia. Recent palynological analysis was performed by R. Holloway on non-human coprolites recovered from Bridge River archaeological site EeRl 4 (ca. 1,100 BP) and by R. Vance on soil recovered under a dog skull from Housepit 7 at the Keatley Creek archaeological site (ca. 1,080 BP). The recovery of pollen from the coprolites was very low (Fig. 4), but the taxa recovered are present in paleoecological study sites from the Interior Douglas Fir (IDF) biogeoclimatic zone (Mathewes and King, 1989; Hebda, 1995). The presence of sedge (Cyperaceae), *Sparganium/ Typha* pollen, and *Equisetum* spores in some of the coprolites is probably due to water ingestion by the animals. Due to the extremely low values of pollen in the coprolites no palaeoecological inferences can be made.

Similar to the coprolites, the pollen recovered from housepit soil at HP 7 (Keatley Creek) contains taxa common in the IDF (Fig. 5). There are exceptionally high levels of Chenopodiaceae and Polygonaceae pollen in the sample, suggesting bias due to differential pollen preservation in the pollen assemblage. Based on the pollen recovered from the coprolites and housepit soils, it appears that these archaeological remains may be useful in determining the presence of vegetation at a regional level, but caution must be used in making palaeoecological inferences from such biased pollen assemblages.

Another technique that should be tried in the Lillooet area is the analysis of pollen, plant macrofossils, and fossil insects preserved in packrat middens. Such studies have been shown to be very useful in arid and semi-arid areas in the American Southwest in reconstructing local vegetation and climate. Since middens are available in British Columbia (Hebda et al., 1990), they could contribute significantly to a multi-proxy approach to climate history.

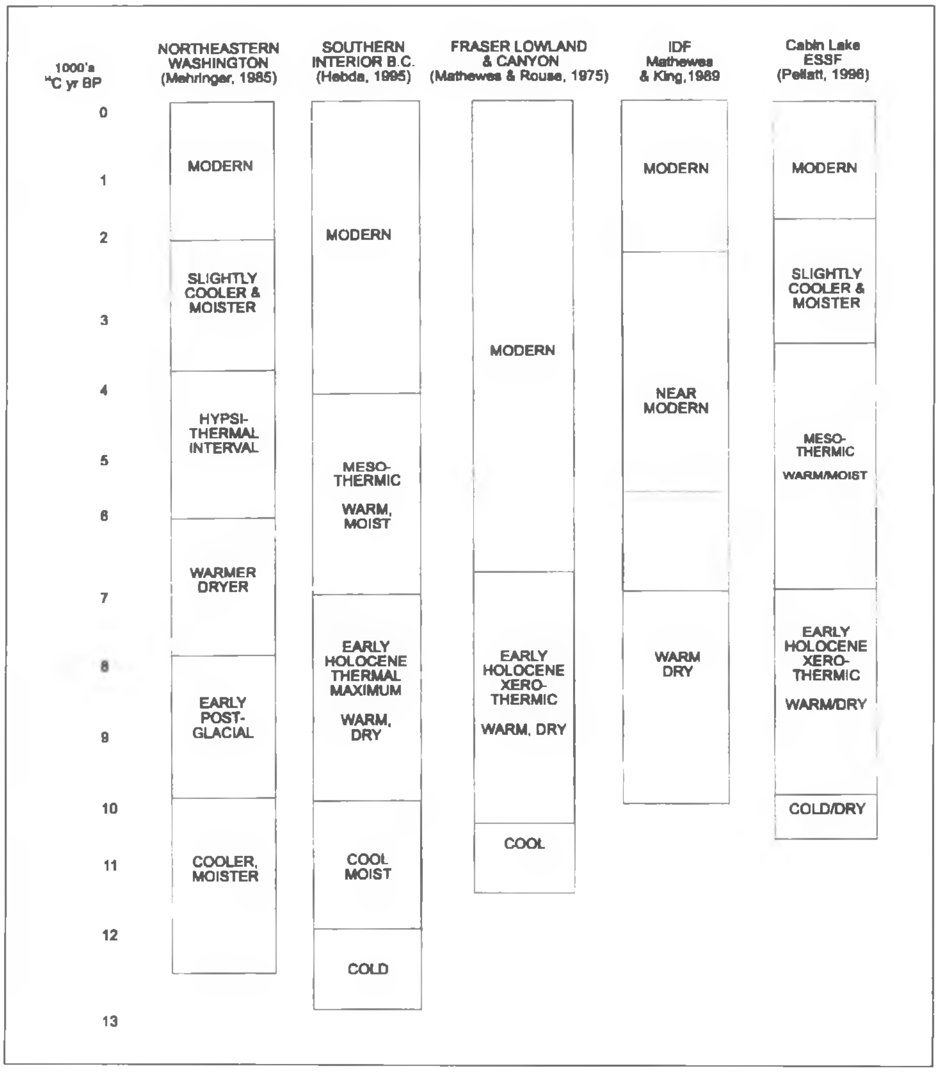

Figure 3. Regional interpretations of paleoclimates and vegetation changes since deglaciation in southern British Columbia.

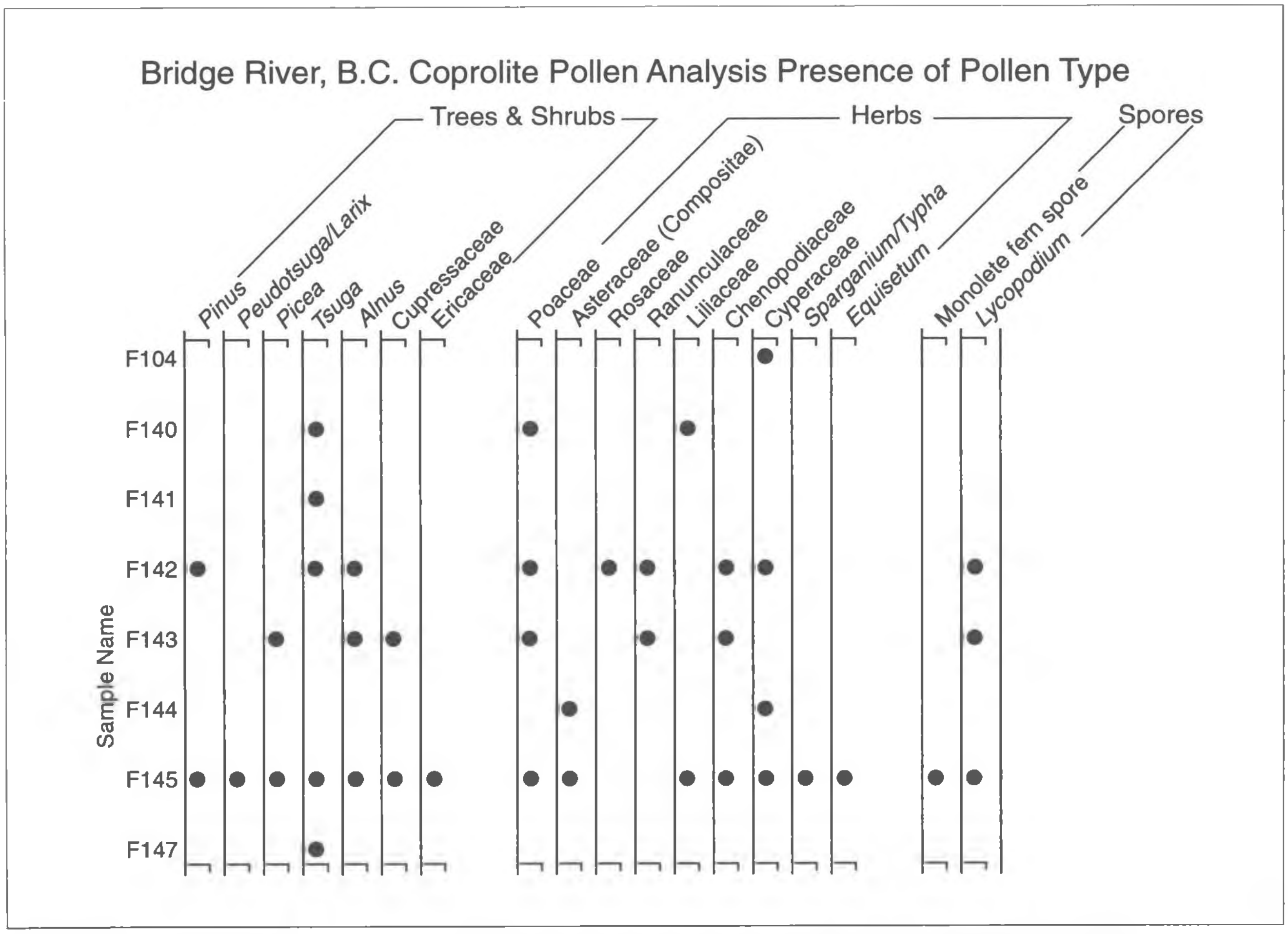

Figure 4. Pollen counts from Bridge River site dog coprolites analyzed by R. Holloway for Arnoud Stryd.

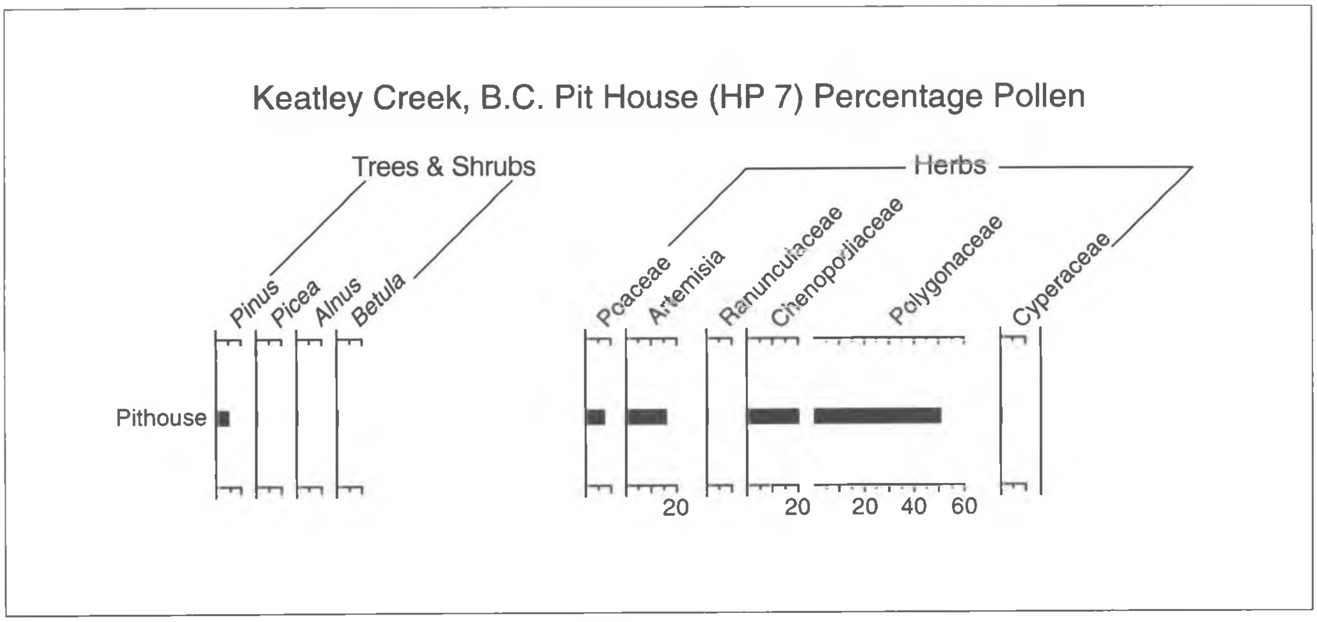

Figure 5. Pollen counts from floor sediments underlying a dog skull on the floor of HP 7 (analysis by R. Vance).

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Chapter 5

The Evolution of Landforms at Keatley Creek, near Lillooet, British Columbia

Pierre Friele

Introduction

The objectives of this chapter are to describe the basic geological context of the Keatley Creek site and to outline the evolution of landforms at the site. Understanding the nature of the geological matrix and processes at archaeological sites is fundamental in documenting and understanding site formation processes. This chapter involves 1) a brief description of the regional setting and bedrock geology; 2) a review of the local Quaternary history, providing a conceptual model for the formation of the main landforms at the site; and 3) an airphoto analysis and field examination, providing insight into post-glacial processes that have modified the main landforms and which may have affected the prehistoric inhabitants or contributed to the post-depositional modification of archaeological features.

Physiography

At Keatley Creek, the Fraser River forms the boundary between the Camelsfoot Ranges to the northwest and the Clear Range to the southeast. These ranges constitute the southwestern edge of the Fraser Plateau, a subdivision of the Interior Plateau (Holland 1976). This is rugged country, with steep slopes rising from about 250 m elevation along the deeply incised Fraser River, to summit elevations in excess of 2,250 m in the Camelsfoot and Clear Ranges.

Bedrock Geology

The main bedrock mass underlying the Clear Range consists of fine grained sedimentary rocks (argillite) and intercalated chert, including smaller outcrops of limestone and volcanic rock (basalt and tuff). These rocks are middle to late Triassic in age and are part of the Cache Creek Group. This marine assemblage is intruded into by younger, plutonic rocks (granodiorite, diorite) of Jurrassic age put into place during the formation of the Coast Mountains (Monger and McMillan 1984).

Quaternary sediments underlie the study site and fill the Fraser Valley to an elevation of about 350 m. However, bedrock directly underlies the steep hillsides to the east of the site. On the slopes on the south side of Keatley Creek are outcrops of dioritic rock; on the north side of the creek are volcaniclastic rocks (tuffs) containing minor basalt and andesite flows (Monger and McMillan 1984).

Late-Quaternary History

Surficial materials and landforms in the study area are the product of Quaternary glaciation with minor post-glacial modification (Ryder 1976). Thick glacial drift has filled the Fraser Valley to depths between 250–350 m. These sediments, consisting of sequences of glaciofluvial, glaciolacustrine and till materials, represent Early Wisconsinan and the Late Wisconsinan, Fraser Glaciations (Huntley and Broster 1994).

During the onset of the Fraser Glaciation (29,000–20,000 years BP), montane glaciers in the Camelsfoot Range to the west built up and began to advance downvalley. In front of the ice, glaciofluvial outwash sediments filled the lower reaches of montane valleys and prograded into the Fraser Valley. Eventually, large outwash fans, debris flow fans, and then tributary ice, blocked southerly drainage of the Fraser River, forming an extensive proglacial lake. This feature, extending from the study area, as far north as Williams Lake, has been called Glacial Lake Camelsfoot (Huntley and Broster 1994). As climate continued to deteriorate, tributary glaciers coalesced in the main valleys and eventually spilled onto Plateau areas to the east. During the climax stage (19,000–13,500 years BP), montane glaciation gave way to true piedmont glaciation, with the direction of ice flow controlled by the rheology of an extensive ice dome rather than by topography. In south central British Columbia, the location of the ice divide was situated almost directly over the northern Camelsfoot Range. Following the climax stage, climate rapidly ameliorated, and deglaciation began. In montane areas, ice thinned, exposing summits and ridges, while valley glaciers gradually retreated into the headwater areas. In the Interior, the piedmont dome stagnated, becoming widely disintegrated, locally blocking drainage, and causing the formation of large postglacial lakes. Deglaciation was largely complete by 11,000 years BP (Ryder et al. 1991).

During and immediately following deglaciation, valley fill materials were rapidly incised, leaving broad drift terraces along the Fraser River. At the mouths of steep tributary basins, large debris flow fans developed (Ryder 1971). Gradually, as sediment supplies declined, these alluvial fans became incised, leaving the landscape much as we see it today. Holocene processes consist of minor fluvial reworking of drift materials, minor debris flow activity, and aeolian reworking of fines scoured from terrace scarp faces (Ryder 1976).

Site Description and Formation Processes

Air photo interpretation (approximate scale 1:14,000) has been used to map the terrain features at the Keatley Creek site. Interpretations based on this analysis have been augmented with experience gained from excavation and field examinations in the vicinity of the site. The following discussion refers to specific landforms depicted in Figure 1.

In the vicinity of the Keatley Creek archaeological site, the Fraser River, graded to about the 250 m elevation, is incised to a depth of 330 m below the valley fill terraces. The valley fill surface meets the bedrock hillslope at about the 640 m elevation. Above the terrace surface, bedrock-controlled slopes climb steeply into the Clear Range. The Glen Fraser and Keatley Creeks flow from small, steep-sided basins which drain the west side of the Clear Range. These creeks are intermittant and ephemeral, partially drying up during the summer months.

The valley fill terrace surface has two main levels: the upper terrace extends from the hillside at 640 m elevation to a scarp at about 585 m elevation, about 500 m west of the hillside. The lower terrace is a gently sloping feature with a scarp at 485 m elevation overlooking the Fraser River below. The upper terrace surface is flat to undulating, and is underlain by about 10–15 m of Fraser Glaciation till overlying advance glaciolacustrine silts. This sequence is exposed in the upper terrace scarp and in the steep gully sidewalls of Glen Fraser Creek. The base of the lacustrine materials was not seen. The lower terrace is underlain by coalescing, immediate postglacial, debris flow fans which have issued from Glen Fraser, Keatley, and Sallus Creeks (Ryder 1976). Older drift materials are exposed in the steep scarps that descend directly to the Fraser River. Transverse to the orientation of the Fraser River terrace scarps, are deep gullies incised by Glen Fraser, Keatley, and Sallus Creeks. Aeolian silts and sands, varying in thickness from .10–0.5 m, have capped the surface of the drift terrace.

The housepit site is situated on the upper terrace, on the height of land between the Keatley and Glen Fraser gullies. The main concentration of housepits is located in a southernly sloping swale. Given its sloping, channel-like form defined by scarps to the east and west, this swale was probably carved by a transient, ice-lateral meltwater channel. The location of the housepits on the floor of the channel feature, a relatively sheltered position, would have offered some protection from the strong, cold winds that blow down the Fraser Valley during the winter.

The lower bedrock slopes, just above the drift terrace, are blanketted with 2–4 m of till. This till blanket gradually thins upslope over a distance of 50–75 m Upper slopes consist of a mixture of thin rubbly colluvium, thin till, and exposed bedrock. Post-glacial hillslope processes, including slope wash and small debris flow activity, have gullied the till blanket and redeposited the material in small fans which spread out over the inner 50–100 m of the upper terrace. The stratigraphy in HP 106 suggests that these processes were active into the late Holocene, during the period of housepit occupation. HP 106 was originally excavated into till or colluvial material, and then abandonned for some time allowing 10–15 cm of well sorted aeolian silt and sand to accumulate on the rim. Overlying the aeolian material is 20 cm of poorly sorted sediment containing an angular volcanic clast about 25 cm in diameter. The angular clast is clearly derived from the nearby hillslope, thus the layer may represent a thin debris flow layer.

The large hummocky feature that occupies the mouth of Glen Fraser basin (Fig. 1) truncates the head of the creek gully. This feature is interpreted as a large slump, probably of early to mid-Holocene age, although possibly later. Presently, Glen Fraser Creek flows to the north side of this feature, along a relatively shallow gully, before entering the main gully at the toe of the deposit. The creek arises from a spring near the apex of the deposit. Examination of this area revealed recent sediment trim lines 50 cm high on Douglas fir tree trunks and a number of small, fresh debris lobes indicating active debris flow activity issuing from the Glen Fraser basin. These debris flows have the potential to divert Glen Fraser Creek to the south, towards the housepit site. Topographic and stratigraphic evidence suggests that diversion has happened in the past. The southern tributary gully to the main Glen Fraser gully was probably carved when the creek flowed along the south side of the main lobe. The fine sediment which has filled HP 119, and adjacent pits in the west corner of the site, represents fluvially transported materials that have washed down from the south side of the Glen Fraser lobe. The roof materials of HP 119 contained a Kamloops point preform indicating that the infilling took place in the last 1,200 years BP (Vol. III, Chap. 10.21).

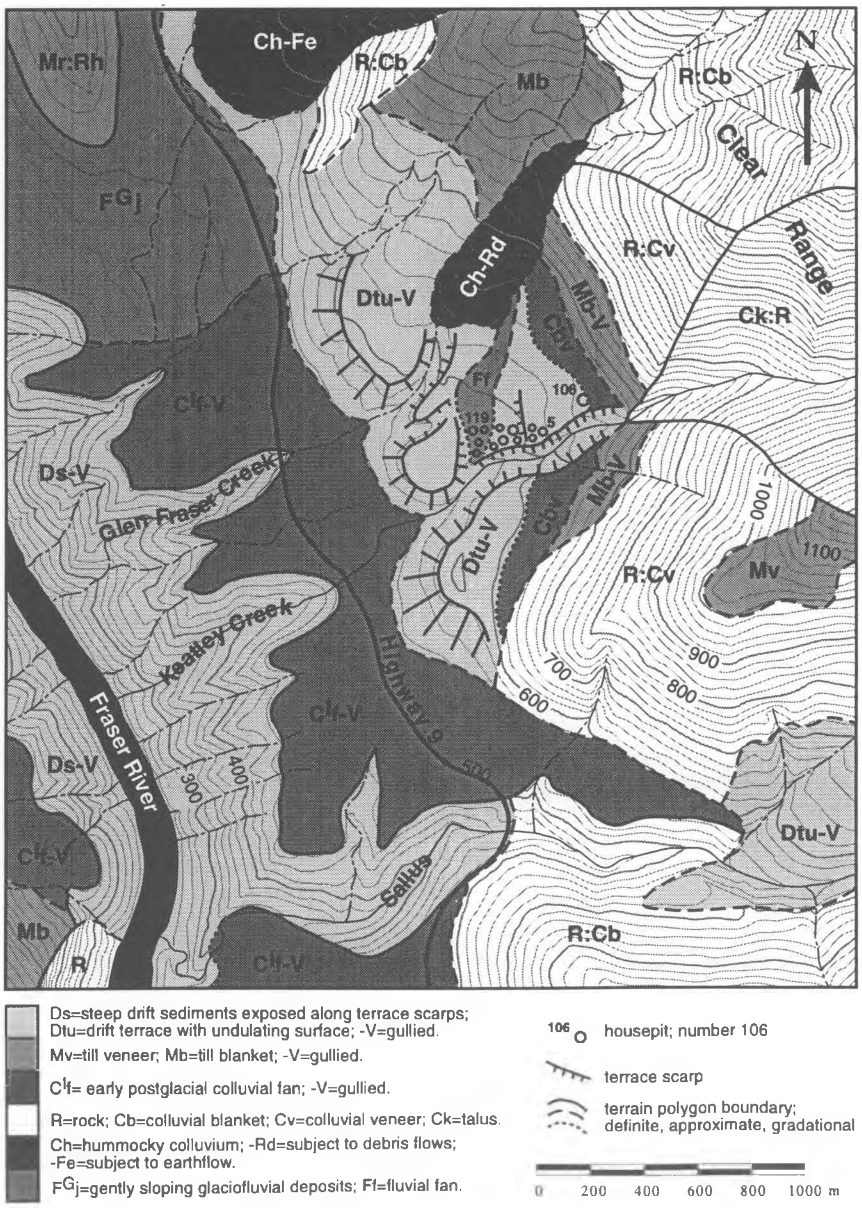

Figure 1. Terrain map for the Keatley Creek housepit site (EeR1-7) and surrounding area. [Source: Modified after Ryder (1976). Topographic base from TRIM; 20 m contour interval.]

Where Keatley Creek crosses the upper terrace near the main housepit site, its channel is about 10–15 m deep and has a broad bottom about 35 m wide. The floor of the draw has a slightly lobate topography, with relief on the order of 2 m, and is wet and swampy in places. Recent, sandy sediments blanket the draw floor and overlie silty glaciolacustrine materials. It is the presence of these underlying impermeable silts which explains the perched water table along the draw bottom, providing a nearby water source for the local inhabitants.

A dissected fan-shaped feature occupies the north and south side of the draw, near the mouth of the bedrock canyon and extends as far down as Housepit 5. This feature would have filled the draw at one time, but has since been largely removed by erosion. This fan terrace represents an early post-glacial debris flow deposit, which Keatley Creek has subsequently dissected.

The recent sandy sediments on the draw floor indicate the ongoing recurrence of small floods and/or debris flows affecting the channel. The bedrock canyon from which Keatley Creek flows is wooded and choked with talus from the steep valley sides. Thus, recent debris flows are not originating from the headwaters of Keatley Creek. Small debris flows could originate from the gullied till slopes at the back of the site, and from small draw sidewall slumps. These materials have then been reworked by Keatley Creek.

Conclusions

The terraced landforms that exist at Keatley Creek and underly the housepit site are the product of glacial and immediate post-glacial processes. Post-glacial processes include minor slope-wash and debris flow activity from the steep slopes and drainage basins east of the site. These processes have formed colluvial fans along the inside edge of the valley fill terrace. A large slump and ongoing debris flow activity issuing from the Glen Fraser basin has led to the periodic diversion of that creek. At times during the Holocene, Glen Fraser Creek seems to have followed a southern channel around the slump deposit. During these times, the housepits in the vicinity of HP 119 would have been susceptible to flooding and sediment infilling. The broad creek bed of Keatley Creek south of the main housepit site contains fresh sediment lobes derived from minor sediment flood activity. The high water table in this reach probably results from groundwater perching on the impermeable glaciolacustrine materials that underly the gully.

By the time the first peoples arrived at the site, sometime in the early Holocene, the landscape probably appeared much as it does today. The site must have been an attractive locality because it offered some shelter from cold winter winds that blow down the Fraser Valley, and it has a small, but reliable source of water in Keatley Creek that is easily accessible from the village site. Flooding due to periodic diversions of Glen Fraser Creek may have led to temporary abandonment of some housepits in the west corner of the site.

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Chapter 6

Soils Report: Keatley Creek 1987

Dale Donovan

Introduction

In 1986, the primary goal of excavations was to discover if living floor deposits could be successfully separated from roof deposits. The ability to successfully distinguish living floor deposits from other types of deposits was critical to identifying activity patterns and areas in houses and subsequently inferring social and economic organization in those structures. To determine if living floor deposits could be separated from other deposits, several specialists were incorporated in the research design, including myself, a soil scientist with a background in natural rather than cultural history. The aims and results of the 1986 soils work is briefly summarized below.

Textural Analysis

Since Project personnel theorized that the roof might act as a filter to coarser materials and as well create a dead air space into which fine aeolian materials could fall, it was thought that floor deposits might have fewer gravels than roof deposits. Floor deposits might also be enriched in wind deposited silts and fine sands.

Initial results seemed to indicate that to at least some extent this hypothesis was true. With few exceptions, gravel contents in the housepits examined were at least 10% higher in the sediments identified as roof deposits than in those identified as floor deposits. In fact, the gravel content of the roof was much closer to that of the sterile material.

Analyses of the fine fraction did not show such positive results, as hydrometer textural procedures could not separate the floor from the roof (Appendix, Table 1). Since wind certainly does play a role in sediment formation in the area, these negative results could be explained by several factors. First and foremost, at the time of floor formation, the amount of material deposited by the wind was probably quite small in comparison to that which fell through planks in the roof. Second, biological factors since collapse of the roof (cicadas, root growth) may have served to mix the fine fraction between the strata.

Bulk Density

It was also hypothesized that the trampling of the floor deposits by the original inhabitants of the pithouses could have compressed the sediments to such an extent that bulk density differences could still be noted today. In addition, mixing of roof deposits upon collapse of the roof would have had the opposite effect. Thus, attempts were made to measure bulk densities of housepit sediments.

Unfortunately, differences in gravel content and the often shallow depth of floor deposits made bulk density nearly impossible to measure and compare objectively. However, subjective estimates by excavators often did support this hypothesis.

In 1987, excavation of housepits was continued with slightly broader goals. Work concentrated primarily on the large HP 7 and the much smaller HP 3 structures. Specific goals for sediment analysis were as follows:

1) To analyze samples of roof and floor deposits for gravel content to determine if the differences indicated in 1986 could be confirmed.
2) To measure samples from roofs, floors, and sterile materials for pH to determine if acidic etching of calcites noted in 1986 by Paul Goldberg could be explained by sediment reaction.

In addition to specified assignments, I was also called upon to interpret natural as opposed to cultural phenomena at the site. Some of these are summarized below.

1) Beneath the west half of HP 7 was a sterile loam that contained very few gravels in comparison with other sterile materials. Was this natural or transported on to the site by man?
2) Rim spoils were very hydrophobic. Why was this and how might this affect preservation?
3) Extra Housepit Feature 5 (HP 119) was a flat area of fairly well sorted materials and few gravels. Was this a natural phenomena or transported on to the site by man?
4) Aeolian fine sands and silts were a common veneer over the glacial till parent materials. How does the depth of this veneer vary across the site? In addition, to what depth were cultural materials found in this material?
5) What kinds of soils were found in non-cultural areas.

Materials and Methods

Particle Size

In 1987, the majority of the particle size analysis was carried out only by means of the dry sieve method whereas in 1986 a hydrometer was also used.

Sieve sizes used for mechanical analysis were as follows:

> 63 mm	cobbles
4 mm	course gravels
2 mm	fine gravels
1 mm	very coarse sand
0.500 mm	coarse sand
0.250 mm	medium sand
0.125 mm	fine sand
0.063 mm	very fine sand

Materials that fell through the 0.063 mm sieve were considered to be of the clay and silt size range although technically this range does not begin until .050 mm in the Canadian System of Classification (CSSC 1978).

Sediments were shaken mechanically for 15 minutes through the 63 mm to 1 mm sieves. Material passing through the 1 mm sieve was then shaken through the 500 mm to 63 mm sieves for 15 minutes.

All size fractions were weighed and their percentages determined on an air-dried basis.

Soil Description

Soils were described by digging both shallow and deep pits at various locations across the site. To determine the depth of aeolian capping, the amount of cultural material away from the housepits, and descriptions of natural soils, nine pits were dug in a straight line from HP 7 to HP 1 and others were dug in selected areas (Fig. 1). Type, depth, color, texture, and parent material of the soil horizons were described. Texture was determined by the hand texturing method. Samples were taken and later measured for texture by the dry sieve or hydrometer method. The pH of the sediment was then measured at Pacific Soil Analysis Incorporated (Vancouver).

Results

Particle Size Analysis

The dry sieve method of particle size analysis showed a higher percentage of sand in the fine sediments than found by the hydrometer method employed in 1986 (see Appendix Tables 1 and 4). This would indicate that either a longer shaking time is required to separate the sand from the silt and clay or that calcium carbonate and/or organic matter is binding the smaller particles together. Probably a combination of the above is true and the percentage of sand, silt, and clay reported in the 1987 results should be regarded with some reserve. Gravel contents should be fairly accurate, however.

In most housepits analyzed in 1986, a lower percentage of gravel was found in the floor than in the roof (approximately 10% lower). This was not true for 1987 results from HP 3 (see Appendix Tables 1 and 4). In all but Square I, the percentage of gravels in the floor were greater than in the roof. This may indicate that either this pithouse was not in use for as long a period of time as some of the other housepits, or that it sits on glacial till with a higher gravel content than elsewhere on the site. Gravel content on the floor averaged 47%, while gravel content on the roof averaged 40%.

Except the northeast corner of HP 7 (Squares P, Q, and X), floor deposits from this housepit have much less gravel than the roof, or both the floor and the roof have very low gravel contents. Two explanations could explain this finding: 1) the last inhabitants of the housepit occupied it for a period long enough to allow fines to build up on the floor. These may have been tracked in from outside, sifted through the roof supports, or been introduced as aeolian particles that fell in the dead air space of the entrance, or; 2) the low gravel content of the floor may be a direct result of its origin from the sterile material of low gravel till found directly beneath it (see below).

If the latter case best explains the difference between roof and floor gravels of HP 7, it supplies more evidence that we have actually located the living floor.

Sediment Reaction

In 1986, Goldberg (personal communication) noted that calcites found in the cultural sediments seemed to be etched by acid. Could this etching be explained by a low pH of the sediment?

Measurement of roof, floor, and sterile materials from HP's 3 and 7 revealed a neutral pH in all strata of HP 3, and in the floor of HP 7. The roof of HP 7 was slightly acid but probably not enough to account for etching of calcium carbonate. The sterile till material of this housepit was alkaline (see Appendix Table 3).

Perhaps the etching resulted when organics in localized areas decomposed. Another possibility is that the people that lived in the pithouse were doing something with the calcites to cause their disintegration.

Low Gravel Sterile Material Found Beneath HP 7

The sterile material found beneath much of the floor of HP 7 was loamy in texture and had a very low gravel content (see Appendix Table 2). It has been suggested that this material could have been brought in by the pithouse inhabitants for use as a ceremonial or dance floor. In contrast, a natural explanation for the low gravel content of the sterile material must also be considered.

The sterile material found within all house pits examined was of glacial till origin. Till is deposited directly by glacial ice with little or no sorting by water. Beyond this definition, till is very diverse. It often consists of every size range of soil particle from clay to boulder, but depending upon the source of the debris, the way in which it was laid down, and on fluctuations in the grinding action of ice, all particle sizes my not be represented. For example, assuming pithouses were constructed of the soil materials immediately at hand and not from deposits transported any great distance, HP's 1 and 3 seem to be from tills with greater than 50% gravels, whereas HP 4 is from a till with only 35% gravels.

Evidence that the low gravel sterile material is just an anomaly in the naturally occurring till rather than a floor brought to the site by the pithouse inhabitants includes the following: The loamy nature of the sterile material indicates a till origin. Sand, silt, and clay are all well represented in the fine fraction. This is in contrast to aeolian deposits which consist primarily of silt and fine sand—clay is not carried by the wind as the particles tend to stick together forming aggregates too heavy for the wind to carry. It is also in contrast to materials deposited by water which would be much more sorted—the heavier sand particles deposited in a different strata than the fine clay particles. Also, although this gravel-free sterile loam is found over a large part of HP 7, it is not found at the surface around the outer perimeter. However, along the west wall a pit was dug through a gravely sterile till and after 10–20 cm of gravels, the loamy material was also found. The gravel-free sterile loam could also be found beneath the rim on the north wall and the layer could be seen down postholes that originated in gravel sterile. The layer therefore, occupies a much broader area of the site than just beneath the floor of the pithouse.

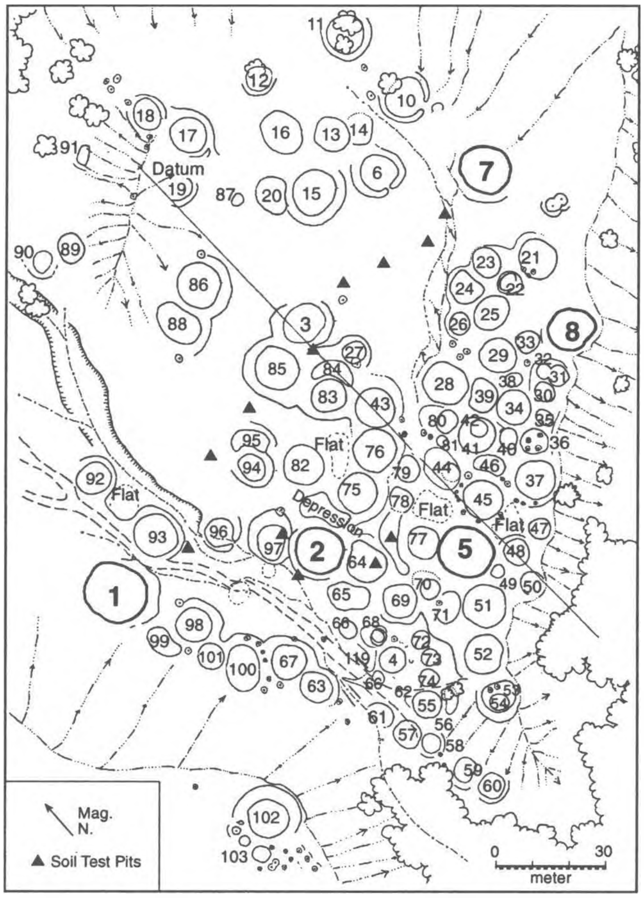

Figure 1. Map of the core of the Keatley Creek site showing the location of soil test pits dug to determine the nature of sediments between housepits.

Hydrophobicity of the Rim Deposits

In the 1986 soils report, the hydrophobicity of the rims was attributed to the high organic content of these deposits. Once the organics were allowed to dry out—

due to their topographic position on the collapsed housepit—they would be difficult to "wet up" again. However, an additional factor contributing to the hydrophobicity of these materials would be their high ash content. In the 1987 report by P. Goldberg, a high proportion of ash was seen in thin sections of the rim. Ash is by its nature hydrophobic. Perhaps the inhabitants of the pithouse regularly cleaned ashes from their fire pits and deposited them, with the rest of their garbage, on the rim. This would certainly add to the hydrophobicity of the entire structure.

Interpretation of the Plaza Area

A flat area (EHPE 5—later redesignated as HP 119—see Vol. III, Chap. 10.21) is found in the southwestern portion of the study site at Keatley Creek. This "plaza" consists of a fairly large and level section of ground surrounded by housepits, but in which no cultural depressions are obvious. A test pit, dug in the northern end of the excavation trench, exposed light and dark layers of fine material in which little cultural material could be found. The fines continued to 110 cm, but below this was a gravely deposit which contained, surprisingly, a great deal of cultural material (see Table 5). The fine material was obviously deposited on top of an occupation layer.

Two theories for the origin of this plaza area were proposed. The fine material may have been transported to the site by the aboriginal peoples for use as a dancing area or the fines may have arrived naturally through aeolian or alluvial deposition over earlier housepit remains.

Scenarios to account for natural deposition may be as follows:

1) Deep fines over till may represent a combination of aeolian deposits and slope wash. The aeolian deposits would have occurred in areas of low activity in periods of intense occupation, i.e., when a large number of people occupied the site, trampling vegetation, and using anything burnable as firewood or kindling. Vegetation would then have been scarce and with nothing to stabilize the soil, fine sands and silts could be picked up by air currents and deposited in depressions. This material may have gradually filled unused and collapsed pithouses. Clays and small gravels and sands may either have been washed or scuffed onto the surface at regular intervals. Also, because this was a winter camp, most of the vegetation and stabilized soil structure may have been destroyed by trampling in the winter, but the actual wind erosion may have occurred in the summer when the soils dried out and there were no occupants to scuff it up once it settled. Between periods of occupation of nearby pithouses, the vegetation would have grown up, stabilizing the soil and adding organic matter to it. This would account for the dark banding.
2) A second scenario for the origin of the fine material could be alluvial deposits made during periods of higher rainfall. In Volume I, Chapter 5, Pierre Friele outlines a network of gulleys that extend southwest across the site. Water may have run down these gulleys carrying clays, silts, and sands with it. These would be deposited as the water pooled in the depression. If this is the case, the gulleys should be examined for large concentrations of gravels and larger stones too heavy for the water to move, and therefore left behind in the gulleys.

If we examine the till material under the sediments, we may find well preserved material left from occupations hundreds of years previous to the final period of occupation.

Depth of Aeolian Capping

With the help of Dr. June Ryder and a visiting geography graduate student, shallow pits were dug from HP 7 to HP 1 (Fig. 1). The variability in the depth of the aeolian capping over the glacial till was measured and cultural remains noted. Actual results are given in the soil descriptions in Table 5 of the Appendix. In summary, aeolian fine sands vary in depth from 0–25 cm, with the shallowest aeolian occurring in areas of heavy traffic and the deepest occurring in more protected areas. Cultural materials were usually limited to a few flakes occurring within the top 10 cm. Soils below this depth appeared undisturbed by man.

Soil Descriptions

Soil descriptions can be found in Table 5 of the Appendix. All soils between housepits appear to be eutric brunisols, although, because of cultural activities, some may meet chernozem criteria. Till ranged from loose and sandy (rare) to compact (common). Many were hard to dig through with a shovel, not to mention with only a digging stick—the only such tool available to the original inhabitants.

Conclusion

In the majority of the house pits examined in 1986 and 1987, living floor deposits (located just above the sterile) could be separated from roof deposits by gravel content. They could not be separated by fine fraction textural analysis or by bulk density procedures. This may be in part due to limitations in the methodology or in the case of textural analysis, be a reality of their formation as both the floor and roof originated from the same parent material.

Soils work was also able to make contributions to the interpretation of archaeological data. By eliminating a natural genesis for site anomalies, cultural origins could be assessed.

Keatley Creek was an extremely interesting project from a pedological viewpoint.

Appendix: Tables

Table 1. 1986 Textural Data on Keatley Creek Sediments (Including percent clay [%C], percent silt [%Si], percent sand [%S], bulk density [B.D.], and percent organic matter [%OM])

Stratum Level		% gravels	> 25	25–8	8–4	4–2	%C	%Si	%S	B.D.	%OM
Housepit 1, Square A, Subsquare 11											
I	surface	24	53	21	8	18	15	27	68	1.41	9
II-1	roof fill	51	23	35	22	20	20	27	53	1.99	12
II-4	roof fill	45	36	21	22	22	12	18	70	1.89	5
III-1	floor	35	3	25	34	38	12	21	66	1.92	3
III-2	floor	54	21	32	25	22	12	18	70		2
IV?	sterile	54	18	40	19	23	18	21	61		4
Housepit 1, Square B, Subsquare 15											
I	sterile	7	0	16	21	63	17	29	54	1.71	9
II-1	roof fill	48	15	36	25	24	17	27	66		7
IIa	floor	35	4	31	28	37	4	21	75		5
III	floor	38	0	27	34	39	11	17	63		3
IV	sterile	53	31	29	20	20	14	24	62		2
pit fill		41	16	29	26	29	12	22	66		7
Housepit 1, Square D, Subsquare 3											
II-2	roof fill	43	0	26	37	37	12	20	68	1.85	5
III	floor?	56	44	21	16	19	15	21	64		5
IV	roof fill	67	28	41	18	13	13	21	66		7
V	floor	41	19	28	24	29	12	41	47	1.94	5
Housepit 3, Square B, Subsquare 3											
I-2	surface	15	0	28	19	53	33	29	38		18
II-1	roof fill	53	0	42	32	26	18	26	56	1.86	11
II-2	roof fill	47	0	31	35	34	17	25	58		9
Housepit 3, Square B, Subsquare 11											
I	surface	12	0	16	18	66	20	32	48		9
II-1	roof fill	44	0	41	31	28	13	25	62	1.9	8
Housepit 3, Square C, Subsquare 3											
I	surface	18	0	17	18	65	18	23	59	1.53	12
II-1	roof fill	51	0	33	34	33	15	24	61	2.03	10
II-5	roof fill	48	16	28	28	28	12	24	64	1.62	7
III-1	floor	32	0	28	35	37	13	25	62		3
IV	sterile?	43	12	25	31	32	14	28	58	2.43	5
V	fill?	44	12	34	27	27	17	24	59		5
Housepit 3, Square C, Subsquare 11											
I	surface	10	0	4	12	84	15	20	65		9
II-1	roof fill	52	9	28	49	32	19	27	54	1.71	10
II-4	roof fill	48	3	29	31	37	14	25	61		7
II-5	roof fill	35	0	24	45	71	14	28	58		5
III-1	floor	23	21	28	23	28	16	23	61		6
III-2	floor	27	0	9	37	54	16	22	62		5
Housepit 4, Square A, Subsquare 7											
II-2	surface	8	0	19	39	42	20	25	55	1.29	8
III-1	roof fill	56	29	33	20	18	15	22	63	1.80	6
III-2	roof fill	34	0	30	31	39	15	22	63	1.88	5
IV	floor	33	0	33	31	37	13	21	66	1.65	6
Housepit 4, Square B, Subsquare 7											
II-2	surface	17	0	31	24	45	11	27	62		7
III-1	roof fill	35	23	31	20	26	11	22	67	1.79	5
III-2	roof fill	34	5	35	27	33	14	23	63	1.46	4
IV-3	floor	31	5	23	31	41	8	20	72	1.73	3
Housepit 7, Square A, Subsquare 7											
I21	roof fill?	12	0	33	22	45	17	36	47	1.79	8
II	floor	10	0	45	28	27	19	33	48	1.08	6
Housepit 7, Square C, Subsquare 7											
V-1	roof fill	51	8	40	26	26	13	31	56	1.17	12
II	floor	17	17	23	23	37	11	21	68	1.33	6
XII	roof fill	31	14	26	27	33	10	30	60	1.65	5

Table 2. Percentages of Heavy Fractions in Sterile Tills and Loams Under Housepit Floors

Square	Subsquare	63 mm	4 mm	2 mm	Gravels
Sterile Till					
Housepit 3					
A	6		67.8	9.8	77.6
E	11		36.1	12.3	48.4
F	11		31.8	17.9	49.7
F	13		34.7	11.3	46.0
G	2		43.5	13.9	57.4
J	9		14.9	12.8	27.7
AA	14		60.5	9.1	69.7
Housepit 7					
G	7-1		0.0	0.0	0.0
G	7-2		3.6	3.6	7.5
I	4		27.6	9.0	36.6
I	13		45.3	8.8	54.1
J	1		34.3	10.3	44.7
J	10		46.5	8.1	54.6
Q	10		1.7	2.9	4.6
V	5		62.8	9.5	72.3
V	9		5.6	2.9	8.5
R	15		0.0	0.0	0.0

Table 3. pH Values for Housepit Sediments

Sediment Reaction					
HP	Square	Subsquare	Stratum		pH
3	EE	7	II/2	roof	6.9
3	I	4	22/1	roof	7.1
3	EE	4	III	floor	7.0
3	E	4	III/1	floor	7.1
3	J	13	III/1	floor	6.6
3	F	11	sterile		7.1
3	E	11	sterile		6.8
7	Y	4	V/2	roof	6.5
7	BB	4	V/1	roof	6.3
7	V	10	V/1	roof	6.6
7	Y	4	II	floor	7.2
7	BB	8	II/1	floor	6.9
7	Z	3	II/1	floor	6.5
7	J	1	sterile		8.2
7	I	13	sterile		8.0
7	V	5	sterile		7.6

Table 4. Percentages of All Soil Fractions in Housepit Deposits

PERCENTAGES—All Fractions			Gravels			Fine Fraction (<125 m)					
Square	Subsquare	Stratum	63 mm	4 mm	2 mm	1 mm	500 m	250 m	125 m	63 m	<63 m
Roofs and Floors											
Housepit 3											
A	10	II/1 roof		3.1	8.6	20.0	17.5	14.9	17.3	11.4	18.9
A	10	III floor		60.8	7.7	21.5	18.5	15.9	16.1	12.2	15.8
A	14	II/2 roof		35.8	13	26.9	17.7	13.2	14.7	11.5	16.0
A	14	III floor		39.7	12.3	19.6	18.1	16.6	17.3	10.9	17.5
E	4	III/1 floor		29.5	13	18.1	15.2	15.5	18.1	12.7	20.4
E	10	III/1 floor		41.9	12.9	21.3	17.9	16.9	16.6	total	27.3
F	3	II/1 roof		19.7	12.1	20.0	17.4	17.1	17.3	11.1	20.8
F	3	I/1-f1 pit-floor		14.9	11						
F	10	III/1 floor		30.6	12.4	16.3	15.0	16.1	20.7	11.1	20.8
G	4	II/5 roof		26	15.3	20.0	15.5	13.3	15.1	total	36.0
G	4	III/1 floor		32.1	10.9						
G	6	II/4 roof		40.6	16.1	27.9	17.3	11.8	12.8	11.3	18.9
G	6	II/6 roof		23.4	14.3						
G	6	III/1 floor		41.7	11.4						
G	10	II/5 roof		15.7	12						
G	10	III/2 floor		18.1	14.6						
I	4	II/1 roof		28.7	15						
I	4	III/1 floor		12.8	13.6						
I	10	II/1 roof		35.7	15.9						
I	10	III/1 floor		20.6	15.8						
J	4	II roof		29	14.8	20.0	15.3	14.4	17.5	11.9	20.8
J	4	III floor		26.3	14.5	19.7	15.5	15.3	19.3	11.6	18.6
J	10	II/1 roof		24.9	14.2	19.2	15.4	13.4	14.7	10.0	27.3
J	13	III/1 floor		33.1	16.2	24.7	17.8	14.7	14.3	10.1	18.4
AA	8	II roof		28.3	12.8	21.0	15.6	14.9	16.2	8.4	23.9
AA	8	III floor		33.9	15.8	19.8	15.5	15.5	16.6	total	32.7
AA	10	III floor		33.1	13.3						
EE	4	III/3 floor		28.9	13.8						
EE	7	II/2 roof		41.6	10.9	17.0	14.8	15.6	17.8	13.7	21.2
EE	10	II/2 roof		16.5	10.8						
EE	10	III floor		33.3	14.9						
Housepit 7											
F	1	II/1 floor		12.3	8.2	12.2	13.4	13.7	18.0	17.3	25.4
G	4	II floor		6.4	7.6	11.4	10.8	10.2	18.0	24.9	24.7
G	4	V roof		21.7	13.6	18.3	11.4	9.4	16.1	19.4	25.5
G	10	II/1 floor		11.7	9.4	13.1	12.0	12.2	18.1	15.2	29.2
G	10	V/1 roof		20.7	7.8	15.7	9.7	14.6	19.5	18.2	22.4
H	4	II/1 floor		8.1	8.7	11.3	11.9	11.9	17.0	total	48.0
H	4	V roof		15.4	12.4	17.6	12.6	9.2	15.7	22.0	22.8
H	10	V/1 roof		4.1	8.5	15.3	11.9	11.8	21.2	15.3	24.5
H	15	II/1 floor		14.3	10.4	13.9	12.5	12.5	21.0	16.1	23.9
I	4	II floor		9.7	8.3	14.1	11.9	12.0	19.8	19.7	22.5
I	4	V roof		9.6	7.3	12.0	11.0	12.4	16.9	13.9	33.8
I	9	II/2 floor		10.2	10.9	21.4	16.4	14.7	18.1	10.9	18.5
I	10	II floor		15.6	11.8	19.7	17.6	15.6	19.0	12.7	15.5
I	10	V roof		20.6	10.4	14.1	10.9	10.3	15.8	17.3	31.6
J	4	II/1 floor		9.5	7.5	12.3	12.4	12.8	20.8	20.8	21.0
J	4	V/1 roof		17.8	8.4	12.6	11.1	10.8	17.8	22.6	25.0
J	4	V/1 roof		14.6	10.2	14.3	11.3	11.1	15.3	total	47.9
J	10	II floor		9.0	7.3	12.0	14.2	13.0	19.3	18.7	22.8
J	10	V roof		31.1	15.9	23.1	12.3	7.8	14.9	16.3	25.6
N	tr	V roof	17.2	28.5	8.6	15.1	11.7	13.6	16.9	12.6	30.1
O	4	V roof		33.3	10.2	13.1	10.9	13.0	17.2	12.0	33.8
P	4	II floor		17.3	8.9	12.3	11.3	12.4	20.3	12.5	31.1
P	4	V roof		5.1	10.3						
P	10	II floor		25.2	7.7	11.6	11.3	12.2	17.0	13.3	34.6
P	14	V/1 roof		18.6	6.8						
Q	4	II floor		19.5	8.6						

(continued)

Table 4. Percentages of All Soil Fractions in Housepit Deposits *(continued)*

PERCENTAGES—All Fractions					**Gravels**				**Fine Fraction (<125 m)**			
Square	**Subsquare**	**Stratum**		**63 mm**	**4 mm**	**2 mm**	**1 mm**	**500 m**	**250 m**	**125 m**	**63 m**	**<63 m**
Q	4	V	sw/r		11.4	5.7	8.1	8.9	16.9	22.7	16.5	26.9
Q	10	II/1	floor		8.5	8.8	12.5	9.1	13.5	20.2	14.1	30.6
R	1	V	roof		14.6	11.9						
R	4	II	floor		15.3	9.3						
R	7	II/1	floor		6.7	7.3						
R	14	V/1	roof		13.5	8.9	16.0	17.2	14.5	15.3	total	37.1
V	10	II/1	floor		15.4	8.1	9.8	10.5	10.4	15.0	20.6	33.6
V	10	V/1	roof		43.6	9.6	13.9	12.7	11.6	14.5	13.8	33.5
W	4	V/1	roof		19.1	9.9						
W	10	II	floor		10.6	8.9	13.6	14.3	13.0	15.7	total	43.5
W	10	V	roof		30.1	9.3	14.3	11.9	10.9	14.8	total	48.5
X	4	II	floor		19.7	12.2						
X	10	II	floor		23.9	11.3						
X	10	V	roof		11.9	9.0						
Y	4	II	floor		11.8	9.6	14.3	12.0	12.0	14.1	13.8	33.9
Y	4	V/2	roof		16.2	6.9	14.4	9.9	9.5	15.3	20.2	30.7
Z	3	II/2	floor		10.4	8.3						
Z	3	V/1	roof		31.9	10.9	14.3	10.4	11.9	17.5	15.7	30.2
Z	10	II/2	floor		14.0	9.8						
Z	10	V/1	roof		26.0	11.5	12.8	10.3	12.0	18.3	16.4	30.3
BB	4	V/1	roof		40.1	8.9						
BB	8	II/1	floor		13.2	9.4	14.3	12.3	12.8	17.9	15.6	27.1
BB	10	II/1	floor		10.3	9.2	14.0	12.9	13.4	21.2	15.2	23.4
BB	10	V/1	roof		35.1	10.2						
Rims												
Housepit 7												
D	tr	XIIIC	rim		18.8	8.7	13.1	11.7	11.5	17.6	12.2	33.8
D	tr	XIIID	rim		28.3	4.9	8.1	8.7	9.4	17.8	16.3	39.7
K	tr	XIIIA	rim		19.5	10.5	14.0	11.9	12.1	14.7	21.4	25.8
K	tr	XIIIB	rim		21.9	10.3	15.9	14.3	15.1	17.9	21.7	15.1
K	tr	XIIIC	rim		31.8	7.5	13.3	16.1	15.9	17.2	15.2	22.3
K	tr	XIIIC7	rim		28.4	8.7	13.6	12.4	11.9	15.3	21.1	25.7
L	tr	XIIIA	rim		17.9	8.9	12.7	11.9	10.7	15.4	26.2	23.0
M	tr	XIIIA	rim		32.7	10.7	15.8	12.0	11.0	14.2	14.3	32.7
M	tr	XIIIB	rim		39.4	9.0	14.8	12.0	11.7	15.2	12.0	34.2
M	tr	XIIID	rim		43.5	13.2	21.6	16.2	15.6	16.3	total	30.2
N	tr	XIIIA	rim		31.6	9.8	15.5	13.1	12.9	14.7	14.2	29.6
N	tr	XIII?	rim		39.4	8.9	18.5	23.1	20.4	17.6	6.8	13.7
Pits												
Housepit 3												
F	3	I/1-f1	pit-floor		14.9	11.0						
F	3	III/1	pit		24.3	14.5						
F	3	IV/1	pit		20.6	13.6						
I	16	4	pit		30.0	14.1						
Housepit 7												
G	1	I/3, 4	pit		19.0	9.7	13.7	11.7	11.2	14.4	26.6	22.4
G	2, 6	I/7	pit		14.9	9.8	13.4	13.5	13.8	17.4	21.4	20.6
Z	10	20	pit		21.3	9.0						

Table 5. Description of Soil Test Pits

Depth	Soil Class	Texture	% cobbles	% gravel	Color	Parent material
Pit 1						
0–7	Ah1	SL	0	5	10 YR 4/2dry 10 YR 2/2moist	aeolian grading to till
7–12	Ah2	gSL	5	25	10 YR 4/2d 10 YR 3/2m	till
12–29	Bm	gSL	5	25	10 YR 4/2d 10 YR 2/2m	till
29–50	Cc	gSL	5	25 0	10 YR 5/4d 10 YR 3/2m	compact till
Cultural deposits: 1 flake in aeolian						
Pit 2						
0–14	Ah	SL	0	2	10 YR 4/1d 10 YR 2/1m	aeolian
14–28	Bm	gSL	5	30	10 YR 6/3d 10 YR 3/2m	till
28–50	Cc	gSL	5	20	10 YR 5/4d	compact till
Cultural deposits: 1 flake in aeolian Notes: aeolian grades to till						
Pit 3						
0–8	Ah	SL	0	5	10 YR 5/2d 10 YR 2/2m	aeolian
8–16	Bm1	gSL	5	20	10 YR 5/2d 10 YR 3/2m	till
16–38	Bm2	gSL	5	20	10 YR 6/3d 10 YR 3/3m	till
38–50+	C	gSL	0	20	2.5 YR 4/4m	loose till
Cultural deposits: None						
Pit 4						
0–12	Ah	SL	0	5	10 YR 4/2d 10 YR 2/2m	aeolian
12–35	Bm	gSL	5	55	2.5 YR 5/4d 2.5 YR 4/4m	loose till
34–66+	Cc	gSL	5	35	2.5 YR 6/4d 2.5 YR 5/4m	compact till
Cultural deposits: None						
Pit 5						
0–10	Ah	SL	0	15	10 YR 4/1d 10 YR 2/1m	till
10–26	Bm	gSL	5	20	10 YR 5/4d 10 YR 3/2m	till
26–54+	C	gSL	5	45	2.5 YR 5/4d 2.5 YR 4/4m	loose till
Cultural deposits: 4 flakes and knife in first 10 cm. Pit is quite close to HP 3, so would expect more cultural material. Notes: no obvious aeolian layer.						

(continued)

Soil Class:

Ah: a mineral soil horizon (layer) formed near the surface, modified from the parent material by an accumulation of organic matter.

Bm: a mineral soil horizon, usually found beneath the A horizon, modified from the parent material by the development of soil structure and a change in color due to the oxidation of iron.

C: a mineral soil horizon that has been relatively unaffected by soil forming processes.

Cc: a C horizon cemented (in this case) by $CaCO_3$.

Texture:

SL = sandy loam
gSL = gravelly sandy loam
SiL = silt loam
L = loam
FSL = fine sandy loam
FLS = fine loamy sand
d = dry
m = moist

Table 5. Description of Soil Test Pits *(continued)*

Extra Housepit Feature 5 (HP 119). Pit into north half of square A. Consists of 1.05 m of fine sediments (few gravels, some sand) over till. Light and dark alternating bands. Light bands have a silt loam texture.

Depth	Soil Characteristics	Texture	% cobbles	% gravel	Color	Parent material
0–10	dark	gSL	0	<5	7.5 YR 5/2dry 10 YR 2/1moist	
10–24	light	SiL	0	<5	10 YR 5/2d 10 YR 3/2m	
24–29	dark	SiL	0	<5	10 YR 4/2d 10 YR 2/1m	
29–33	light	SiL	0	<5	10 YR4.5/2d 10 YR 2/2m	
33–42	dark	SiL	0	<5	10 YR 4/2d 10 YR 2/1m	
42–46	light	SiL	0	<5	10 YR 5/2d 10 YR 3/2m	
46–53	dark	SiL	0	<5	10 YR 4/2d 10 YR 2/1m	
53–56	light	SiL	0	<5	10 YR4.5/2d 10 YR 2/2m	
56–59	dark		0	<5	10 YR 4/2d 10 YR 2/1m	
59–110	light		0	<5	10 YR 5/2d 10 YR 3/2m	

Material appears to be well sorted silts, but occasionally small gravels were found.
110–130, gravelly loam (probably till). Cultural material present, including charcoal, bone, and flakes. Very loose consistency. Many cicada plugs throughout. Occasional bit of bone and charcoal in fine sediment.
Perhaps banding indicates periods of site occupation where vegetation was inhibited by trampling vs. Periods of abandonment when vegetation returned to stabilize aeolian material.

Pit 6

Depth	Soil Characteristics	Texture	% cobbles	% gravel	Color	Parent material
0–10	Ah	SL	0	15	10 YR 4/2d 10 YR 2/2m	till
10–25	Bm	gSL	5	20	10 YR 5/4d 10 YR 3/3m	till
25–40	C	gSL	5	35	2.5 YR 4/4m	till

Cultural deposits: Flakes were found in the top 10 cm. and charcoal was seen from 10–26 cm. The latter could be due to a burnt root.

Pit 7

Depth	Soil Characteristics	Texture	% cobbles	% gravel	Color	Parent material
0–10	Ah	SL	0	2	10 YR 4/3m	aeolian
10+	Bm				10 YR 4/4m	till

Cultural deposits: None
Notes: Aeolian thickness ranges from 9–13 cm. The A horizon is not very dark, perhaps indicating fewer cultural activities occurred here.

Pit 8

Depth	Soil Characteristics	Texture	% cobbles	% gravel	Color	Parent material
0–20	Ah	SL	0	2	10 YR 2/1m	aeolian/till

Cultural deposits: None
Notes: no clear aeolian layer. Seems mixed with till.

(continued)

Soil Class:

Ah: a mineral soil horizon (layer) formed near the surface, modified from the parent material by an accumulation of organic matter.
Bm: a mineral soil horizon, usually found beneath the A horizon, modified from the parent material by the development of soil structure and a change in color due to the oxidation of iron.
C: a mineral soil horizon that has been relatively unaffected by soil forming processes.
Cc: a C horizon cemented (in this case) by $CaCO_3$.

Texture:

SL = sandy loam
gSL = gravelly sandy loam
SiL = silt loam
L = loam
FSL = fine sandy loam
FLS = fine loamy sand
d = dry
m = moist

Table 5. Description of Soil Test Pits *(continued)*

Depth	Soil Class	Texture	% cobbles	% gravel	Color	Parent material
Pit 9						
0–25	Ah	SL	0	2	10 YR 2/1	aeolian
Cultural deposits: None						
Notes: Aeolian deposits are composed of fairly well sorted sands with some silt and only very fine gravels. Till deposits have more clay and coarse gravel.						
Pit 10						
0–5		L	0	7	10 YR 3/2dry 10 YR 2/1moist	
5–16		SiL	0	1	10 YR 3/2d 10 YR 2/1m	
16–32		SiL	0	1	10 YR 4/2d 10 YR2/1m	
32–46		SiL	0	1	10 YR4.5/2d 10 YR 3/1m	
46–54		FLS	0	0	10 YR 5/2d 10 YR 3/1m	
54+		SL	0	25		till
46 cm fine sands and silts fairly well sorted over well sorted fine sand over till. Screened 3 buckets of till. Found lots of flakes, charcoal, including a bone awl. Sampled sand over till and silt loam from 16–32 cm.						
Pit 11 (silt loam well sorted over till)						
0–15	Ah1	L-SiL	0	5	10 YR 5/2d 10 YR 3/1m	
15–40	Ah2	L-SiL	0	<5	10 YR 3/2d 10 YR 2/1m	
40+		gSL	0	20	10 YR 2/2m	till
Cultural deposits: Found bone, charcoal, and flakes in till.						
Pit 12						
0–20		CS	0	15	10 YR 2d 10 YR 2/1m	
20–45		FLS*	0	5	10 YR 5/3d 10 YR 2/2m	
45–62		FSL	0	0	10 YR 3/2m 2.5 YR 4/4d	
62–73		FSL	0	0	10 YR 3/3m	
* well sorted sand with a few lines of gravel indicating working by water. 73+ loose till cultural material with both large and small gravels. Cultural deposits: Found bone, lithics, and charcoal in till.						

Soil Class:

Ah: a mineral soil horizon (layer) formed near the surface, modified from the parent material by an accumulation of organic matter.

Bm: a mineral soil horizon, usually found beneath the A horizon, modified from the parent material by the development of soil structure and a change in color due to the oxidation of iron.

C: a mineral soil horizon that has been relatively unaffected by soil forming processes.

Cc: a C horizon cemented (in this case) by CaCO$_3$.

Texture:

SL = sandy loam
gSL = gravelly sandy loam
SiL = silt loam
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Chapter 7

Micromorphological Aspects of Site Formation at Keatley Creek

Paul Goldberg

Introduction

The aim of the research described in this chapter is to clarify the nature of the deposits and soil materials of Keatley Creek—e.g., their composition and texture—and to attempt to better resolve the field identification and characterization of floors, roofs, rim spoil, and other soil materials using the technique of micromorphology. Integrating this information at a higher level, we also wanted to elucidate the nature of site formation processes. The ability to reliably identify floor deposits during field excavations was essential for being able to detect artifact patterning across the floors which could reveal aspects of social and economic organizations in the housepits at Keatley Creek.

Field observations of deposits (e.g., color, texture, structure, and consistence) are a useful means to describe sediments and to make tentative inferences about relevant depositional and post-depositional processes, including geogenic, pedogenic, and anthropogenic processes. However, the use of simple field data alone limits our ability to fully interpret the stratigraphic record. One strategy employed to supplement field observations subjects the samples to a variety of laboratory analyses. These analyses—which employ bulk samples—generally include grain-size and chemical analyses, such as pH, calcium carbonate, organic matter, cation exchange capacity, and soluble and exchangeable ions (see Vol. I, Chap. 6 and Vol. II, Chap. 6).

One of the limiting aspects of the usefulness of interpreting both the field and laboratory data is the typically complex nature (e.g., composition, texture and fabric) of soils and sediments associated with archaeological sites. What, for example, is the significance of a grain-size analysis of a "grey," "ashy" dump deposit, commonly found in archaeological sites, such as the ones studied here? The results generated by a grain-size analysis in such a case do not discriminate between the mineral (e.g., quartz sand, silt, etc.; calcareous ash crystals; phytoliths; bone) and non-mineral components (charcoal, or disseminated organic matter), and one would simply observe a poorly sorted sediment. In other words, bulk samples do not provide the resolution necessary to unravel the complex depositional and post-depositional sequences associated with archaeological sediments (Courty et al. 1989). Thus, grain-size analyses, for example, often do not discriminate between silt or clay that has been translocated through a profile from an overlying surface (translocation), from silt or clay that was deposited as coarser, sand size aggregates composed of these fine materials. This inability is due to the procedures associated with grain size analysis, which attempts to break down the sample into its individual components. In addition, many analyses using bulk samples are limited in their ability to discern a succession of pedological, geological, or anthropogenic events that have been superimposed

Table 1. Keatley Creek: Location and Brief Description of Micromorphology Samples

Sample No.	House Pit	Location	Strat. Unit	Depth[1]	Description
KC-86-7	1	All	2	6–20 bs	Black stony layer; fewer roots than at surface. Laterally greyer and more ashy/less humic.
KC-86-26A	6	B		5–10 bs	Dark brown humic loam (roof) and upper half of lighter colored occupation level.
KC-87-15	7	S rim		12–20 bs; ~15 bd	Slightly compact, grey brown massive, gritty powdery silty sand with angular burnt stones 'floating' in matrix. Some rootlets; some $CaCO_3$ spots on a few stones. Generally sub-horizontal and truncates underlying silty rim spoil. Charcoal throughout.
KC-88-2	104	S end			Gritty black/dark brown silts resting sharply on very hard, sterile stony light brown (calcareous?) silt. Calcareous till could explain preservation of ash.
KC-88-3	104	Pit			Dry, powdery, gritty dark brown/black silt with reddish mottles. Burrowed or dumped hearth material.
KC-88-8	plaza (119)			50 bs	Interbedded light and dark ashy beds with roots and charcoal and perhaps thin ashy stringers in the middle. Laterally some rubefied areas.
KC-88-9	plaza (119)			65 bs	Interbedded light and dark ashy beds. Generally massive but some 1 cm thick layers; at base is compact, very fine silts; laterally insect and cicada burrows.
KC-88-10	plaza (119)			90 bs	Interbedded light and dark ashy beds, riddled with small [1–5 mm] root or insect burrows. Dark, organic-rich layers undulate and laterally thicken and thin.
KC-88-11	plaza (119)			145 bs	From contact between basal massive silts and underlying dark reddish brown stony silty ash. Contact not sharp and punctuated by cicada burrows.
KC-88-12	7			70 bd	Roof (dark grey brown stony/gravely silt) overlying slightly finer and lighter brown fine gravely silt (floor?). Burnt wood (charcoal) and reddening at contact.
KC-88-15	105	Sq. B	Stratum III		Stratum III plus roof fall above it (II). Living floor marked by think scatter of fish bones, partially articulated; sample parted along this floor. To N, more clearly bedded; to S, no evidence for living floor. Sediment grey brown stony sandy silt.
KC-88-16up	105	Sq. A			Living floor and reddened horizon beneath it. Upper part: light medium grey silts with abundant bone; lower part: living floor represented by grey/white sand with bone just above it.
KC-88-17	105	Sq. A		15 bs	Whitish grey occupation zone with underlying material partially reddened. White/grey unit overlies black floor and is locally truncated. White/grey overlain by roof deposits.
KC-88-19	EHPE 12	pit			Dark grey ash dump overlying fire reddened earth from roasting pit (EHPE 12) next to 105. Top of organic matter (grey) resting on jumbled, slightly granular charcoal-rich silts. Bottom part is reddened gritty silts on stony till.
KC-88-20	105	Sq. C: E wall		228 bd	In general, compact gravely clayey silt. Dark grey brown from center of pit fill. Darker at top, and gets lighter with depth. Laterally, large angular stones. Compact due to inclusion of clayey till.
KC-88-21	105	Sq. C		12 bd	~88-15, encompassing roof (Stratum II), floor (III) w/ fish bones, and dark band 3 cm thick below it. Below black band is hard compact grey tan (= reworked till?).
KC-88-22	7	Sq. I			Alternating diffuse and continuous bands of lighter till like sediment and darker organic rich cultural material.
KC-88-24	7	S rim			Below contact between organic rim spoil and burnt loessial deposits at base. Generally fine sandy silts with some grit and stones scattered throughout. Upper part characterized by 5–7 cm thick charcoal rich medium brown silts with stones.

[1] bs = below surface; bd = below datum

upon the same material or substrate. For example, a calcium carbonate analysis may represent both primary (depositional) and secondary (pedogenic) carbonate; a dark layer within a Holocene archaeological site context may represent a soil horizon, an occupation layer, or both.

A technique that is proving increasingly valuable for avoiding many of the above-mentioned limitations is that of micromorphology, the study of undisturbed soils, sediments and other archaeological materials (e.g., ceramics, bricks, mortars) at a microscope scale. Samples are marked in the field so as to retain their original vertical and horizontal orientation. The use of undisturbed, oriented samples conserves the original components and their geometrical relationships, and permits direct observation of composition (mineral and organic), texture (size and sorting), and fabric (the geometric relationships among the constituents) of the intact sample. Within an individual thin section it is therefore possible to observe micro-stratigraphic sequences which reflect temporal changes in depositional and post-depositional processes (Courty et al. 1989).

During the seasons of 1986, 1987, and 1988, samples for micromorphological analysis were collected from a variety of contexts at the Keatley Creek site. These contexts included roof and floor deposits, hearths and ash layers, rim spoil, pit fills, and horizontally bedded water-laid sediments from the "plaza"-like area (HP 119). In 1986, samples from different housepits and stratigraphic units were collected. During the 1987 season, samples were taken mostly from HP 7, where emphasis was placed on studying deposits from the rim, floor, and inter-housepit areas. In 1988, samples were collected from the "plaza"-like area, as well as various housepits (HP's 7, 104, and 119).

Samples were collected in the field as undisturbed blocks, roughly 15 × 7 × 7 cm in size. These blocks were imbedded in polyester resin from which 14 × 7 cm thin sections were prepared (courtesy of the Institut National Agronomique, Grignon, France) following the procedures of Guilloré (Courty et al. 1989). The thin sections were examined with a microfiche viewer and a petrographic microscope under plane polarized (PPL), cross-polarized light (XPL), and oblique incident light (OIL) at magnifications ranging from ~20×–200×. Observations were noted using the descriptive terminology of Bullock et al. (1985) and Courty et al. 1989; definitions of micromorphological terms can be found in Jongerius and Rutherford (1979). The samples used in this study and their locations are presented in Table 1.

Micromorphological Observations

Rim Deposits

A number of samples from rim deposits were collected from HP 7 (Table 1). These are described and discussed below.

Sample **KC-87-15** (Figs. 1 and 2) is a typical rim example. This sample is composed of poorly sorted rock fragments and some pieces of charcoal (1–10 mm in diameter) within a coarse, non-calcareous silt/fine sandy matrix. The latter consists predominantly of rock fragments and finely divided charcoal mixed with clay and undifferentiated organic matter; the charcoal is generally angular, with a shredded appearance. Phytoliths are quite abundant within the organo-mineralic fine fraction.

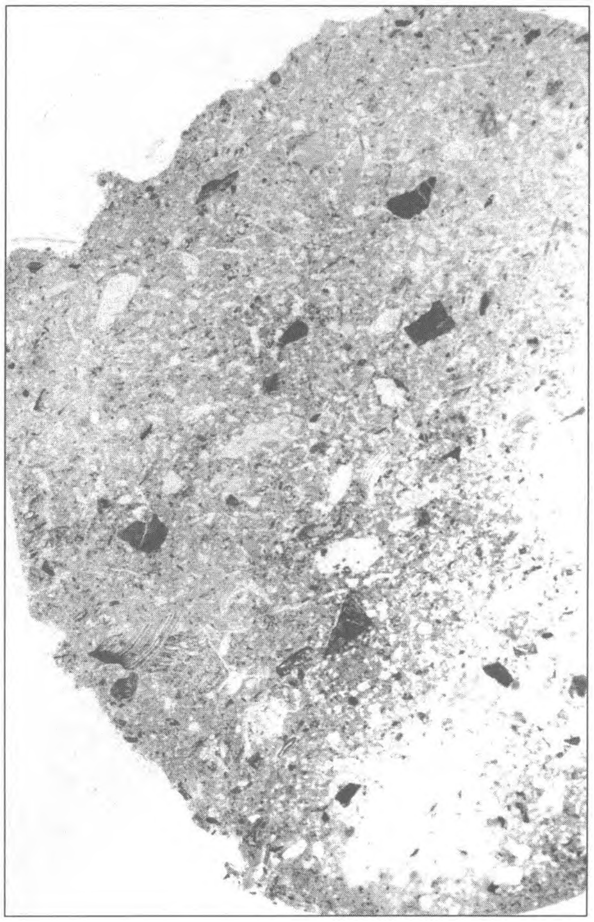

Figure 1. Sample KC-87-15. This macrophotograph of rim spoil shows the poorly sorted and rocky nature of the deposit. Note also the abundance of charcoal. Length of frame = ca. 9 cm.

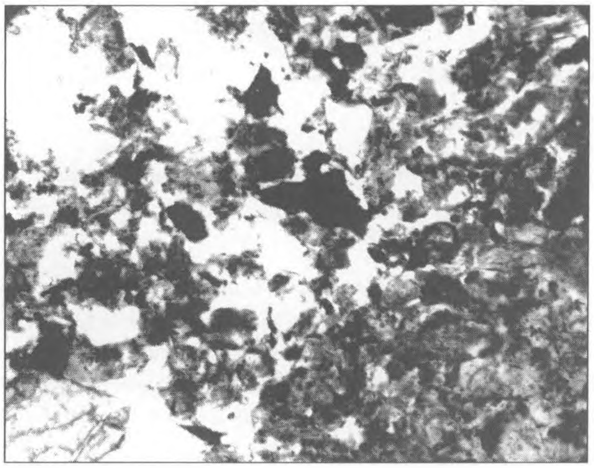

Figure 2. Sample KC-87-15. Illustrated in this photomicrographic detail of Figure 1 are fine grained organic matter and charcoal, as well as numerous phytoliths all well integrated in the matrix. Plane polarized light (PPL); Length of frame = ca. 350 µm.

The fine, shredded nature of the charcoal within the fine fraction and the overall abundance of charcoal and organic matter is strongly reminiscent of a decalcified ash deposit. The presence of phytoliths as well as charcoal indicates that both wood and grasses were burned, although the latter may have decayed in place. The fine grained nature of the sediments suggests the possibility of their representing the finer sweepings of a hearth which would be relatively impoverished in coarser stones. The fine coatings around the coarser rock fragments suggest dumping. The absence in these deposits of any calcareous ash rhombs (Wattez and Courty, 1987) is probably due to post-depositional dissolution of the calcite, since calcite is not stable in these slightly acid soils (Valentine and Lavkulich, 1978).

Elsewhere, e.g., in the proximity of sample **KC-88-22** (Fig. 3), exposed rim sediments consist of alternating diffuse bands of lighter, till-like material and darker, organic-rich cultural material; a pink, fire reddened zone occurs in the middle of this sample and a large cicada burrow was observed at the base.

In thin section, the reddened layers or zones situated within the grey till appear to have been the result of in situ heating because of a visible color gradient of red to tan with depth. On the other hand, rubefied fragments are relatively abundant elsewhere in the sample, but they occur mixed with non-rubefied grains, thereby indicating that these are mixed deposits and that heating of the fragments occurred elsewhere.

The upper part of the sample, closer to the modern surface is more clay-like and contains finely comminuted charcoal, as well as some bone fragments. Phytoliths occur within the darker, charcoal-rich units.

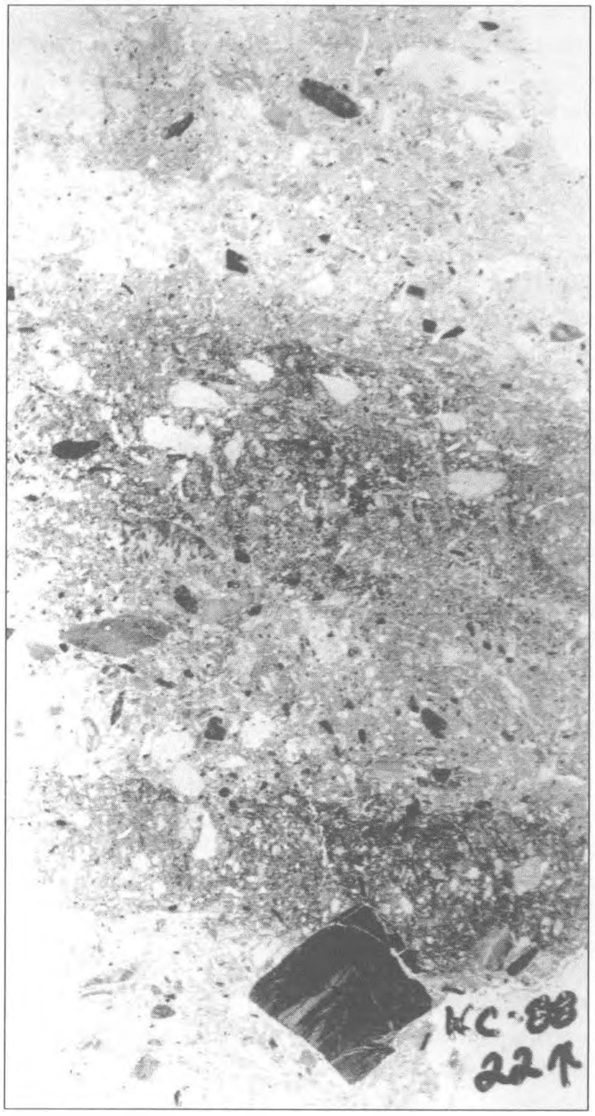

Figure 3. Sample KC-88-22. Macroview of rim spoil showing variegated bands of lighter silts and darker, organic rich silts. The circular features are cicada burrows whose sharp boundaries are clearly evident here. PPL; length of sample = ca. 11 cm.

A final example of rim deposits, sample **KC-88-24** (Fig. 4), comes from below the contact between the organic-rich rim spoil and the burnt loessial deposits at the base. Overall, the sample consists of fine sandy silts with some grit and stones scattered throughout. The upper part is characterized by 5–7 cm thick charcoal-rich medium brown silts with stones and marbling of charcoal in a tan silty matrix that gets lighter with depth. Below this the silts are more massive and lack bedding.

In thin section, the *lower part* consists of compact, moderately sorted silt with millimeter size stony fragments; charcoal is relatively rare in comparison to the upper parts. Phytolith and coprolite fragments are

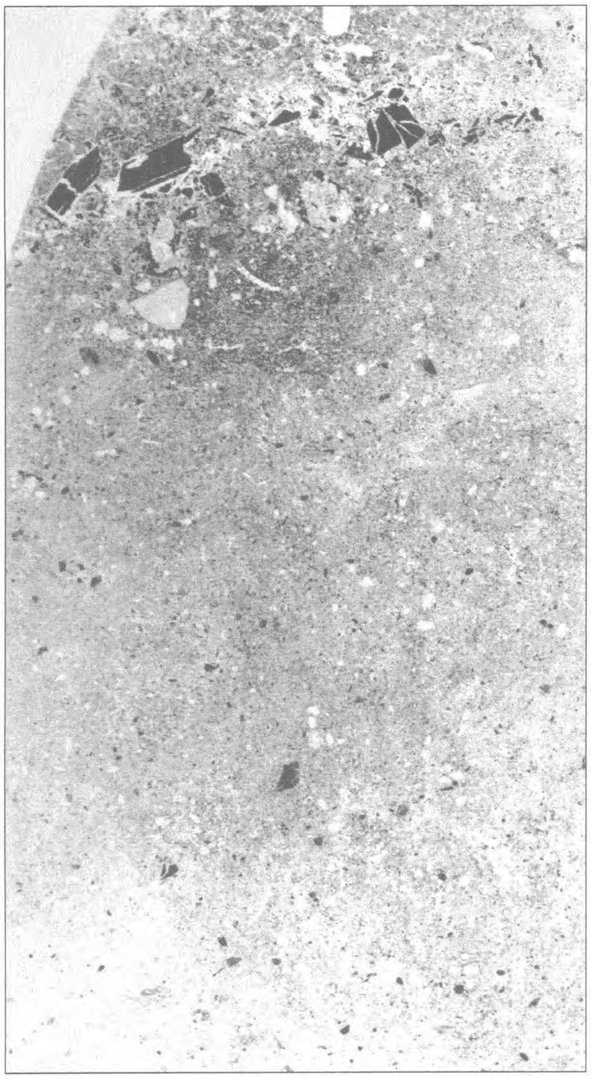

Figure 4. Sample KC-88-24. Illustrated here are charcoal-rich rim deposits in the upper part overlying burnt loessial deposits in the lower part of the photograph. PPL; length of sample = ca. 11 cm.

moderately abundant. Many grains are coated with well sorted tan silt.

The *middle part* contains noticeably more charcoal and exhibits domains where the matrix is more loosely packed and with irregular micro-layering (banded-like fabric probably produced by freeze-thaw processes [Brewer, 1976; van Vliet-Lanoe, 1985]). Phytoliths are more prominent.

Finally, the *upper portion* contains considerably more charcoal, and some of the charcoal is over 10 mm in size. Banded-fabric is locally prominent. Although the material looks reddened (oxidized) by heating, there is no evidence to indicate in situ burning, as for example, the presence of a fire-reddened substrate.

The poor sorting of the sample and the coatings around the coarser grains suggest that this is not an aeolian deposit but one that has been rolled or reworked by gravity. The charcoal-rich middle and upper parts reflect anthropogenic additions to originally sterile sediments, but whether these additions were produced by dumping or colluvial reworking is not certain. The banded fabric is likely a relatively recent phenomenon tied to freeze/thaw activity in the soil.

Discussion of Rim Deposits

The rim deposits from HP 7, particularly those from the base, are not composed strictly of sterile material. Rather, they appear to be a mixture of mostly sterile, poorly sorted silts and stony silts with no cultural debris that are locally mixed with charcoal-rich sediment of cultural origin that have been likely dumped in place. Evidence for intermittent in situ burning activity on the rim is also present, but recognition of criteria for undisturbed fabrics is made difficult by extensive local burrowing by cicadas (as is the case for much of the Keatley Creek deposits; see below). The presence of pedogenically produced banded-fabrics has also resulted in a loss of resolution of information that might have been present in the original depositional fabrics. As mentioned above, although the rim samples are relatively rich in charcoal of various sizes, no traces of calcareous ash were found, likely a result of post-depositional dissolution of calcite.

In sum, the sediments from the rim of HP 7 appear to have accumulated as the combined result of dumped sterile till and charcoal- and phytolith-rich ash deposits, upon which occasional fires were made. Both types of deposits were later reworked by cicadas and their burrowing activity. Moreover, it is possible that the high till content is associated with cleaning in the central part of the structure, or is related to construction and cleaning near the East wall; the proximity to the East wall favors the latter possibility.

Plaza Fills

Several samples from the "plaza"-like area overlying HP 119 were collected during the 1988 season (Table 1). The 2.5 m section studied consisted of buried roof material at the base overlain by massive silts and thin, alternating beds of tan silts and darker powdery silts, with some reworking of reddish layers. Since many of the samples from the plaza area are similar, only a few are described below.

Sample **KC-88-8** (42–55 cm below surface) is relatively rich in organic matter and charcoal, and contains many sand size aggregates of silt that appear to be the result of bedding disrupted by biological activity, such as (horizontal) passage features that contain more loosely packed, lighter material and irregular lighter and darker domains, probably produced by the burrowing of cicadas or other insects. The entire sample displays horizontal, feather-like cracks resembling banded fabrics that are produced by alternate freezing and thawing (see above).

Sample **KC-88-9** (58–75 cm below surface) consists of interbedded light and dark silts, with a number of insect and cicada burrows. In thin section, the silts are overall moderately sorted, homogeneous, with horizontal layering, and contain notably less charcoal than in the overlying samples. Traces of sand size bone and charcoal fragments were observed as well as some burrowing; however, most of the biological disturbance occurs as a vertical system of voids produced by roots.

Sample **KC-88-10** (85–90 cm below surface) (Fig. 5) exhibits interbedded light and dark ashy beds (~1–2 cm thick) that are riddled with small root and insect burrows. Dark, organic-rich layers undulate and laterally thicken and thin. In thin section, the contacts of these broadly diffuse bands of lighter and darker gray, tan, and reddish brown are clear, but blurred by biological activity, mostly root and insect burrows.

Evident at lower magnifications in different strata within the thin section are a number of features:

- generally coarse shreds of organic matter/charcoal, elongated to chunky in shape, with sub-horizontal bedding.
- coarse organic matter mixed with rounded clay papules/rip-up aggregates derived from underlying clayey silts. Aggregates are generally subangular and many look sub-articulated, as if they were broken in place and not transported. In certain layers, parts seem to have been penetrated by insect burrows ("fingers") filled with loosely aggregated material, locally with a bow-like structure.
- One layer contains a band of moderately well-sorted clay that becomes increasingly rich in fine organic matter derived from an underlying unit, possibly representing individual slaking events. Clasts of clay are clearly broken and rounded, suggesting transport or at least breakage in place.

Lithological variability between layers is also quite evident at higher magnifications: The uppermost gray ashy unit in this sample (85–90 cm below surface) is marked by a relative abundance of phytoliths associated with charcoal shreds and modern roots. In coarser silt units, there is a greater abundance of organic matter as well as phytoliths. It is not possible to determine whether the phytoliths result from natural decay of grasses deposited in place or are directly associated with burning activity, and both processes are likely in this context. And, in one of the clayey units, many of the angular clay clasts have different birefringence-fabrics (b-fabrics), indicating that the particles are derived from elsewhere and not broken apart in situ. Locally, the clay aggregates are clearly welded together.

Sample **KC-88-11** (145 below surface) comes from the distinct contact between basal massive silts and underlying dark reddish brown stony silt. Both units are riddled with circular to elliptical tubules 2–15 mm in diameter displaying bow-like fabrics that are produced by burrowing activity of cicadas. The number of these tubules decrease toward the base of the brown, which also becomes stonier at the base. The matrix in the lower unit is dense and quite rich in finely comminuted organic matter. It contains some bone. Its overall stoniness and densely compacted organic-rich

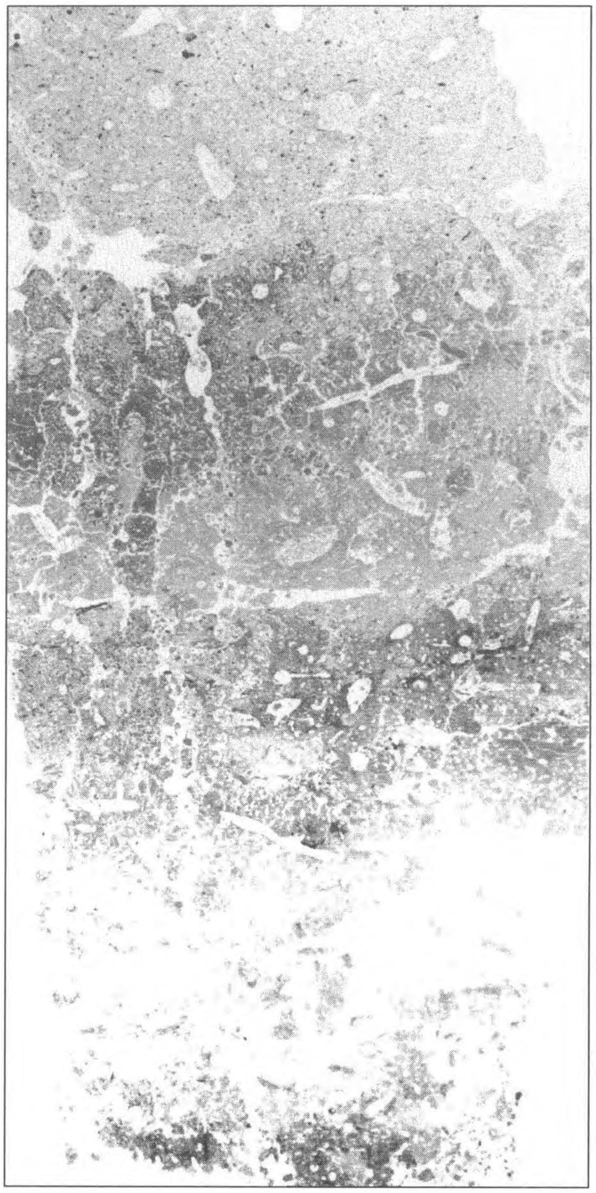

Figure 5. Sample KC-88-10. The "plaza" deposits shown here are interbedded light and dark ashy and clayey sediments that are punctuated by numerous root and insect burrows. PPL; length of sample = ca. 12 cm.

matrix is quite reminiscent of roof collapse observed from excavated structures (see below).

Discussion of the "Plaza"-like Section

Both field and microscopic observations show that the material exposed in the plaza section has some anthropogenic material (charcoal, organic matter) that has been reworked by running water. The presence of redistributed clay curls and rip-up clasts indicate multiple episodes of reworking in which clay settled in water, and after drying, became modified and deformed by desiccation or possibly trampling, and then was picked up by water again during the next runoff event. The very base of the profile contains organic-rich material that is similar to roof collapse observed from in situ housepits and suggests that some roof deposits are buried beneath the "plaza" fill. As has been observed in most of the Keatley Creek samples, evidence of burrowing activity of cicadas and other insects, as well as by roots is quite strong.

Pit Fills

A few samples were examined from interior pits in HP's 104 and 105. The sediments from the pit in the center of HP 104 (sample **KC-88-3**; Fig. 6), for example, are composed of dry, powdery, gritty dark brown/black silt that exhibits a broad reddish band in the middle, and in the field was thought to have been burrowed or to represent dumped hearth material.

In thin section, many of the grains, particularly those rich in clay, are reddened, presumably as a result of having been heated. Furthermore, there are numerous loose pockets of mm-sized charcoal, and bone fragments are relatively common at the base. Modern roots occur at the top of the sample, which exhibits a loose, granular structure and much more sand-size charcoal. Finally, there are numerous cappings of coarse silt over coarser (~1 cm) rock grains.

The sediment within this pit would appear to have an origin similar to the sediments from the south end of the excavation trench (sample **KC-88-2**), which would seem to represent an accumulation of anthropogenic deposits that were dumped upon a sterile, stony silty substrate. In this case, the sediments contain fire-reddened debris that is intermixed with non-heated material. These occurrences indicate that the fire-reddening did not occur in situ, but was inherited from elsewhere.

Sample **KC-88-20** from HP 105 comes from the top, just underneath the fire-reddened part of Stratum VI and within the lighter colored, stony grey silt of Stratum VII. In general, the deposit consists of compact, gravelly clayey silt that is dark grey-brown in the center of the pit fill, but becomes darker at the top and lighter with depth.

In thin section the sediment overall is quite coarse and as in the field, becomes darker towards top. The fine fraction is composed of a mixture of fine sand and silt intermixed with finely comminuted, silt size charcoal; phytoliths are relatively abundant in the fine fraction. Much of the sediment is disturbed by numerous cicada burrows that have homogenized a great deal of the deposit, and several periods of burrowing occurred, as indicated by superposed lighter and darker burrows. Areas that appear to be non-burrowed are characterized by looser material.

Although this sediment is associated with the pit and is rich in charcoal, it exhibits only very few bone pieces. This paucity of bone indicates that the fill might not be associated strictly with cooking of meat as was suggested in the field. The abundance of charcoal, on the other hand, and the coarseness of the sample are reminiscent of deposits associated with roof collapse (see below). The noticeably darker color in the upper part of the sample would support the addition of

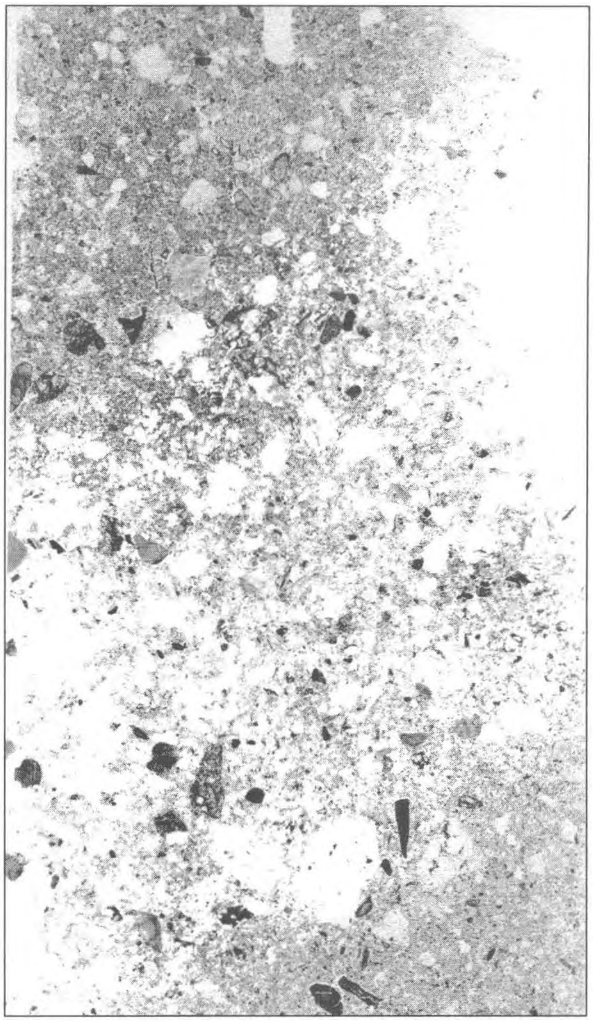

Figure 6. Sample KC-88-3. Macro view of pit fill from the center of HP 104 showing an overall loose mixture of charcoal, silt and rock fragments. PPL; length of sample = ça. 10 cm.

charcoal-rich, roof collapse material. In any case, the sediments are not uniform from top to bottom which in itself might suggest two depositional phases.

Finally, sample **KC-88-19** (Figs. 7 and 8) was collected from a roasting pit (EHPE 12) adjacent to HP 105. The fill consisted of a dark grey ash overlying fire-reddened, gritty silts and stony till. In the field, the deposit gave the impression of being dumped, reddened material.

In thin section, this sample displays an overall uniform, fluffy texture, consisting of finely comminuted pieces of sand-size lithoclasts and reddish loessial aggregates, grains of charcoal, organic matter, bones and a relatively high proportion of phosphatic carnivore coprolites; these range in size from ~0.5–10 mm. The base is redder and is apparently due to an increase in ferruginous grains and loessial aggregates, many of which seem rubefied because of heating; several grains also display thin (20 µm) clay coatings that also enhance the reddish color. Notable in this sample is the striking abundance of charcoal and phytoliths. Some isotropic volcanic glass fragments were also observed, but their small size (sand) would suggest an aeolian origin and not a cultural one, such as obsidian micro-debitage.

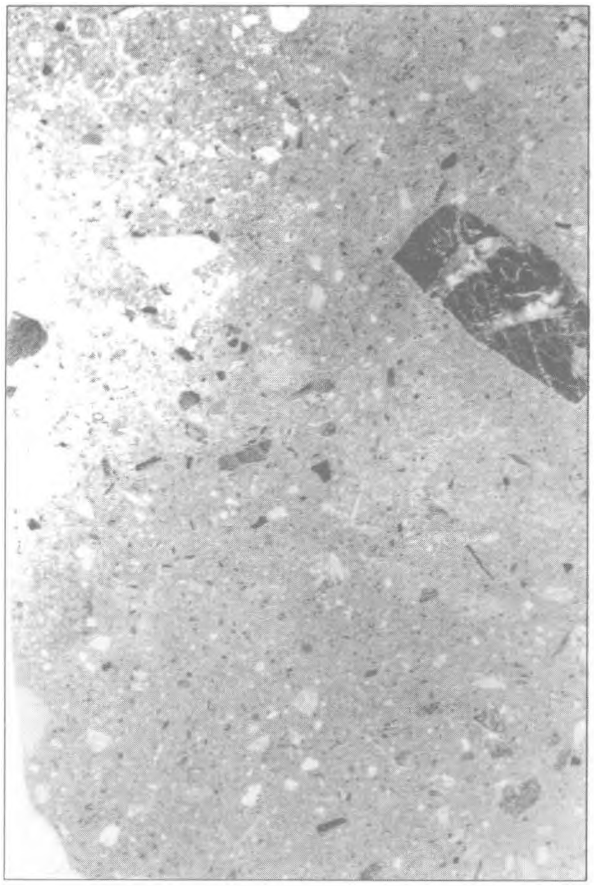

Figure 7. Sample KC-88-19. The sediments illustrated in this macrophotograph from a roasting pit are generally fine grained, uniform and have a fluffy texture. Numerous rock fragments and charcoal pieces are also visible. PPL; length of sample = ca. 8 cm.

In all, the sample appears to represent a charcoal-rich deposit that was dumped in place. In situ burning did not take place as indicated by the aggregated nature of the grains and lack of layering or organization of the charcoal. In light of the abundance of charcoal it is interesting to note the lack of calcareous ash. It is presumed that any traces of original calcite have been leached, as is the case for most sediments in this area.

Discussion of Pit Fill Sediments

The sediments from the pit fills studied here tend to be enriched in charcoal and phytoliths, and also contain traces of bones and some carnivore coprolites, as in the case of sample **KC-88-19**. No indications of in situ burning were evident, as suggested by the lack of any fire-reddened substrates. Rather, grains appear rubefied by having been heated elsewhere and dumped in place. The absence of calcareous ash is likely explained by the fact that soils in this area are slightly acidic and not amenable to the preservation of calcite.

Roof Deposits

Many samples were collected from what appeared to be roof deposits in the field. Due to limitations of space, only some of these deposits will be described and illustrated here.

Micromorphological examination of sample **KC-86-7** from HP 1 yields results similar to field observations. The sediment is generally loosely packed, consisting

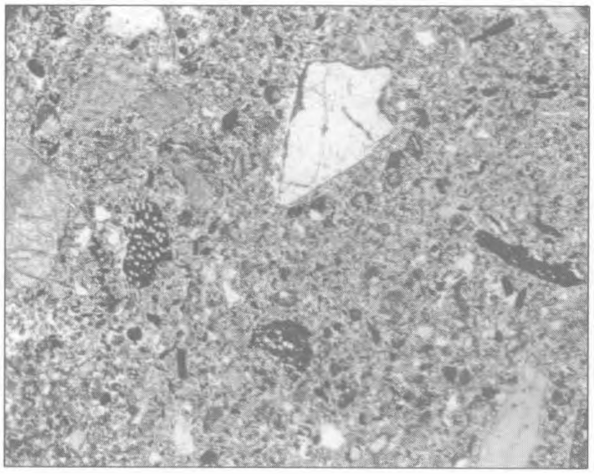

Figure 8. Sample KC-88-19. Detail of Figure 7, showing the abundance of larger and finer size pieces of charcoal. A small, sand size fragment of coprolite is situated in the center-right part of the photograph, just below the large clear grain. PPL; length of sample = ca. 3.5 mm.

of assorted mm and cm size rock fragments within a finer grained matrix. The latter is a well sorted, intimately mixed combination of silt size (~40 mm) angular mineral matter (principally quartz) and undifferentiated organic matter, including charcoal; traces of phytoliths occur, whereas large (mm size) pieces of charcoal are not abundant. In addition, two rounded, yellow sand size coprolites are presumably from carnivores that produce coprolites of similar character; a few angular bone fragments were also noted. Finally, much of the sample is pierced with modern roots that have produced large vughs (irregular voids) and channels.

This homogeneous sample shows an abundance of charcoal. The good integration, sorting and rounding of the mineral and organic (charcoal) grains within the finer matrix, however, points to reworking of these materials by biological activity including the action of insects, rootlets or possibly people, the last perhaps by trampling.

Sample **KC-86-26a** (Fig. 9) from HP 6 traverses roof fall (Stratum III) and deposits constituting part of the underlying occupation (Stratum IV). Three distinct zones could be discerned in thin section, the lower of which includes part of the occupation level.

1) The *upper part* is characterized by loosely to moderately packed mm size mineral grains mixed with finer sized fragments of charcoal and organic matter; phytoliths are relatively abundant. Locally, where these elements are compacted in cicada burrows, the relative proportion of charcoal increases.
2) The *middle part* is similar to the above but displays a marked increase in coarse pieces of charcoal and contains a few large fragments of bone.
3) The *lower part* resembles the upper but tends to contain less charcoal. Significantly, however, it has distinct areas of very dense fabrics, again due to cicada burrowing. At the very lowest part of the sample, where the microstructure is more open and granular (as at the top), some of the rock grains are coated with poorly oriented, fine silt and clay, presumably due to rolling of these grains.

Figure 9. Sample KC-86-26a. This sample reveals loosely packed rock fragments at the top, overlying a similar layer but which is richer in charcoal, which in turn overlies a slightly finer grained, denser material; the latter representing cicada burrows. PPL; length of sample = ca. 8.5 cm.

As appears to be typical of roof samples, the upper part is relatively loose and rich in charcoal, whereas the lower part is commonly denser and exhibits a greater degree of burrowing. Consequently, any extant occupation surfaces have been modified by this biological activity. The occurrence of a few bone fragments might support the presence of an original occupation horizon, although these bones are so scarce that it is difficult to make far-ranging conclusions based on these sparse numbers. In sum, this sample appears to be roof material (zone a) overlying a possible living floor (zone b) that has been partially reworked by biological activity; zone c is essentially sterile material disturbed by bioturbation.

Sample **KC-88-12** (Figs. 10 and 11) from HP 7 in the field was described as dark grey brown stony/gravelly silt (roof) overlying slightly finer and lighter brown fine gravelly silt (floor). At the contact is a fragment of burnt wood (charcoal) with reddening just beneath it.

Thin section observation reveals that the upper part is composed of mm-sized rock fragments in a fine sandy silt matrix. Included within the finer fraction are quartz and rock fragments, large (mm-sized) charcoal pieces as well as finely comminuted charcoal, some bone, and carnivore and herbivore coprolites. The latter consist of rounded, yellow to reddish-brown sand size aggregates with numerous phytoliths, quartz inclusions, and what appears to be volcanic glass or possibly obsidian. In the lower part, the matrix is generally lighter colored and contains less charcoal; it is also aggregated and shows numerous burrows. The latter seems to be responsible for the disarticulation of several pieces of charcoal that have been broken in place and moved a few mm.

In sum, this sample consists of the remains of burned cultural deposits (roof sediments) that have been extensively reworked by burrowing activity of cicadas and rest upon less charcoal-rich silts. The large charcoal pieces could likely be derived from burned wooden beams.

Discussion of Roof Deposits

Although only a few examples of roof deposits were illustrated here, they are overall quite similar, and are typified by a relative abundance of rock fragments and coarse and fine pieces of charcoal that are typically well worked together into the matrix by cicada burrowing. Also quite striking in thin section is the abundance of phytoliths, which seem to be mostly from grasses, although it should be noted that wood phytoliths are generally more difficult to recognize and consequently may be in greater abundance. The presence of grass phytoliths in roof deposits could reflect a number of different factors. It might indicate that either sod or grass thatching was used on the roof, possibly for insulation. When the roof eventually burned, both wood charcoal from beams as well as grass sod/ thatching would be combusted, leaving behind a mixture of charcoal and phytoliths. Alternatively, the phytoliths could represent discarded grass bedding on roofs or possible chinking material.

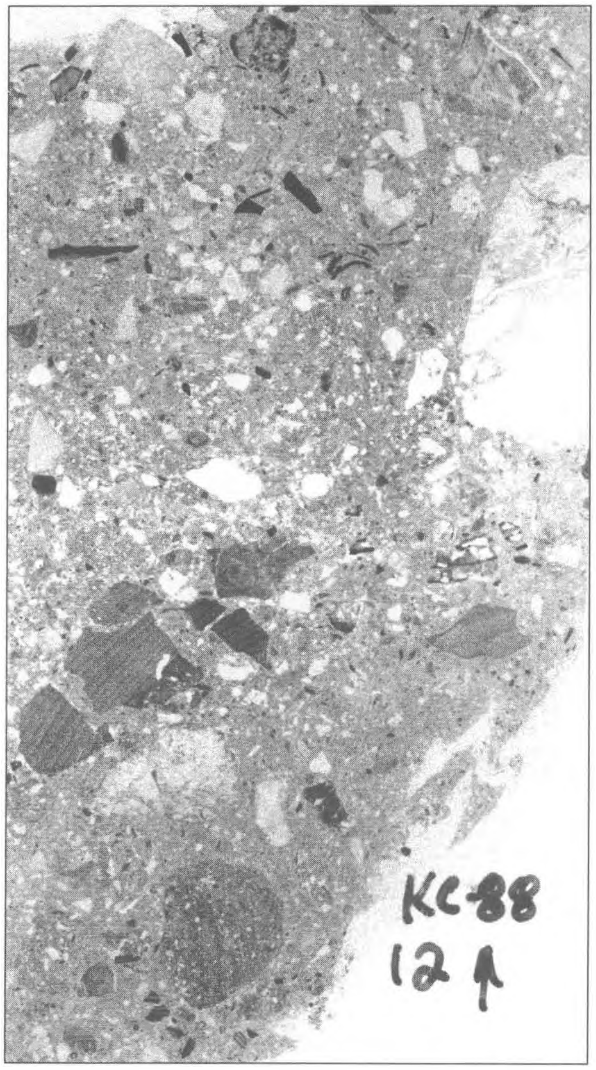

Figure 10. Sample KC-88-12. Macrophotograph of roof deposit overlying somewhat finer grained and lighter colored fine gravelly silt of a floor. Note the charcoal dispersed throughout. PPL; length of sample = ca. 9.5 cm.

Also included in the roof sediments are less abundant remains associated with human activity. These include fragments of bone and occasional pieces of yellow and reddish brown carnivore coprolite, possibly dog. The presence of these items in trace amounts could be explained by the occasional gnawing of bone by a dog, sitting close to the roof. The fact that most of the roof deposits analyzed here are not rich in these items suggests that the roofs were not places of accumulation of fine grained cultural-waste material dumped from somewhere else, such as the house interior. Fire-cracked rock, however, was observed in the field to be a common element in roof deposits. Based on the analyses of rim deposits (see above), it is more likely that rims might have been a preferred locus of accumulation of fine grained cultural waste materials.

Floors

As shown in Table 1, many samples include parts of what were ascribed in the field to floors. Limitations of space preclude a detailed presentation of all the samples, and here we will provide only an eclectic view of the floors; those of the most striking samples. Among the localities which in the field had the clearest examples of intact floors is HP 105.

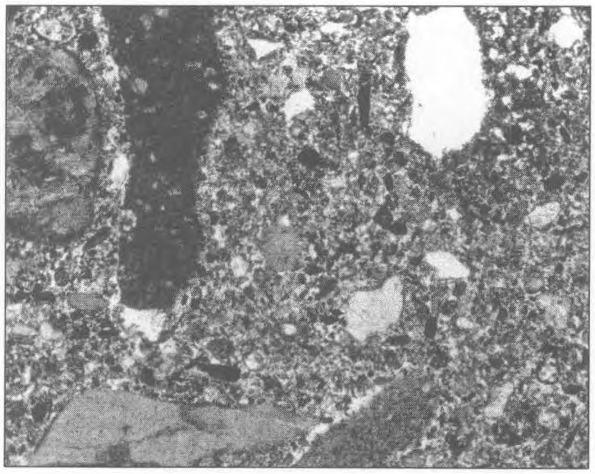

Figure 11. Sample KC-88-12. Detail of upper part of Figure 10 showing finely comminuted charcoal dispersed within the rocky silty matrix. A yellowish carnivore coprolite fragment is visible in the center right of the photograph. PPL; length of sample = ca. 1.7 mm.

Several samples were collected from pronounced living floors excavated in HP 105. In the field the floor of HP 105 was identifiable as a relatively flat surface that was covered with a distinct, ~1–2 mm thick layer of salmon bones. Upon excavation sediments above and below the floor separated easily at the contact.

In sample **KC-88-15** (Figs. 12, 13, and 14), which includes the occupation layer (Stratum III) plus the roof fall above it (Stratum II), the living floor (lf. on Fig. 12) was distinguished in the field by a thin scatter of partially articulated fish bones. The sedimentary matrix is comprised of grey brown stony sandy silt, which in the north of the housepit displays more distinct bedding, with diffuse layers of tan gritty sand.

In thin section the contact between the upper stony, charcoal-rich stratum and the lower is clear. The *upper part* is silty and charcoal rich, with finely comminuted charcoal in a loose matrix that likely is produced by burrowing activity of cicadas. In addition, this upper part of the matrix contains a greater number of aggregates than the lower half. Some phytoliths were observed and in greater quantities than in the lower unit.

The *lower part* is locally reddened, and laminations are exhibited near the top where the matrix has been separated along horizontal cracks. These elongated voids appear to be associated with vegetation (fir needles) that have since partially decayed; they also locally resemble "banded fabric" described above. Just at the contact between the upper and lower parts, some of the matrix is visible as a locally denser band, about 2 mm thick. Although this band is discontinuous across the slide, it does correspond to the level containing salmon bones, and suggests that its dense nature may result from compaction by trampling or other human activity.

Elsewhere, the lower stratum is locally burrowed, and the burrow fillings are compact and rich in organic matter. Micromorphologically, it is not clear why the lower part was slightly redder than the upper part as was observed in the field.

Sample **KC-88-16** also comes from the living floor in Square A. In the field two distinct layers were observed: an *upper* part consists of light medium grey silts with abundant bone, and a living floor (with microfauna) represented by grey/white sand with bone just above it. This upper zone overlies a dark, 1 cm thick more organic layer that rests upon the *lower* part, consisting of a fine reddened horizon that seems disturbed by rodents and insects; a large bone rests just above the floor.

In thin section, the deposit is quite homogeneous, although the lower third is poorer in charcoal. The upper part is characterized by cm thick diffuse zones that are richer and poorer in charcoal; these appear to be alternating sterile and cultural sediments that have been mixed by either burrowing or trampling. A relative abundance of sand size bone fragments and traces of coprolites were observed in this upper part, but these did not appear to be confined to a distinct horizon as would be expected from field observations. Some phytoliths were also observed. The cm thick dark layer is richer in charcoal fragments and could represent the remains of an earlier roof deposit. The lower, reddened part of the sample was not particularly evident in thin section, although it was more compact, slightly clayier and richer in finely divided charcoal. Several cicada burrows occurred throughout the sample.

In sum, the lighter part could be associated with the dumping of sterile till on the floor which was later mixed with more charcoal-rich material. Moreover, this sample, although relatively rich in bone and charcoal, did not reveal any suggestions of the presence of a distinct surface, as was the case for the compacted layer in **KC-88-15**. This observation was somewhat surprising, in light of the proximity of the two samples and their similar nature in the field. This sample was considerably more burrowed, however, which may explain its lack of vertical differentiation. The origin of the more reddish zone at the base is problematic. It is clearly more compact, clayey and richer in organic matter than the overlying deposits, but these materials do not appear to have been heated. This area in the thin section when viewed macroscopically is roughly circular, with a diameter of about 2–3 cm, suggesting that this could represent a rodent burrow. Otherwise, its origin is not clear.

Sample **KC-88-17** (Figs. 15 and 16) was taken 1 m to the north of KC-88-16, where a whitish grey occupation zone (i.e., floor) overlies black floor deposits that rest upon slightly reddened silts. Dark roof deposits cap the entire sequence.

The generally clear lithological variation seen in the field is poorly expressed in thin section, and the abundance of cicada burrows may explain this. Instead, there is considerable local variability of lithology and fabrics, although the upper part is clearly richer in charcoal than the lower one, as shown by a diffuse layer of dispersed charcoal in the upper quarter of the slide. A banded fabric is visible, especially near the top of the sample. Some silty coatings on larger (~1 cm) size rock fragments also occur. Finally, some (fire?) reddening was observed on the grains and silty matrix, and the presence of two calcined bones certainly indicates intensive heating, although no evidence for in situ burning was visible. The red color does not appear to be due to ochre mixed in with the matrix. In any case, the reddened silts observed in the field are

Figure 12. Sample KC-88-15. Macroview of rocky roof deposits overlying a 2 mm thick occupation band just below the horizontal crack near the center of the photograph. In the field, numerous salmon bones were scattered on this surface. The lower part of the slide shows numerous horizontal, elongated cracks that are associated with voids created by the decay of fir needles. PPL; length of sample = ca. 11 cm.

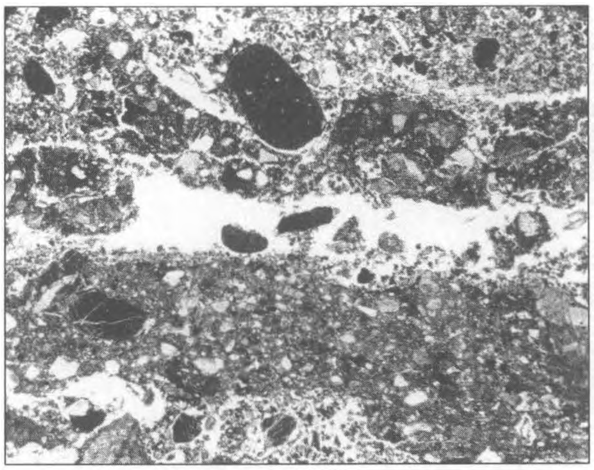

Figure 13. Sample KC-88-15. Detail of Figure 12 showing dense (compacted?) nature of the occupation layer in the lower part of the photograph. PPL; length of sample = ca. 3.5 mm.

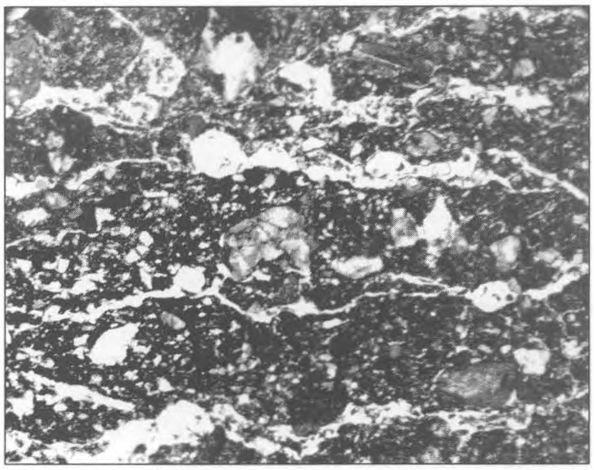

Figure 14. Sample KC-88-15. Detail of lower part of Figure 12. Note the horizontal joint planes and sand size coprolite fragment in the upper left-hand part of the photograph. PPL; length of sample = ca. 3.5 mm.

likely associated with fire-reddening of culturally-enriched (bone, charcoal) silty parent material. Because it exhibits extensive burrows, it is not possible to determine whether it was burned in place.

Sample **KC-88-21** (Square C) is similar to KC-88-15 in the field, encompassing roof (Stratum II) and floor (III) deposits, with fish bones and a dark band 3 cm thick below it. These deposits, in turn, overlie a hard compact grey tan silt (reworked till?).

In thin section, the *upper part* (roof) has a fluffy, aggregated structure, with some coarser charcoal and bone fragments but relatively little charcoal in the matrix. There is a diffuse concentration of bone at the base of this part and at the top of the middle unit. At the bottom of this zone the floor with salmon bones, clearly expressed in the field, is not evident in thin section, and bones are found scattered throughout the slide.

The *middle part* (floor) is darker and richer in fine grained charcoal, which is locally compacted, probably by cicada burrowing. Bone is present and remnants of some calcareous ash occur in this part of the sample. The ash is associated with shreds of organic matter, charcoal and phytoliths. It is interesting that ash does not appear in the lower parts of the sample, although there are abundant phytoliths and charcoal there as well. Some remnants of more compacted areas, similar to that found in **KC-88-15**, can be observed at the base of this part of the slide, although they have been locally disturbed by burrowing.

The *lower part* (till) of the slide displays several burrows and a dense fabric, similar to one that has been produced by cicadas. Some of these burrows are filled

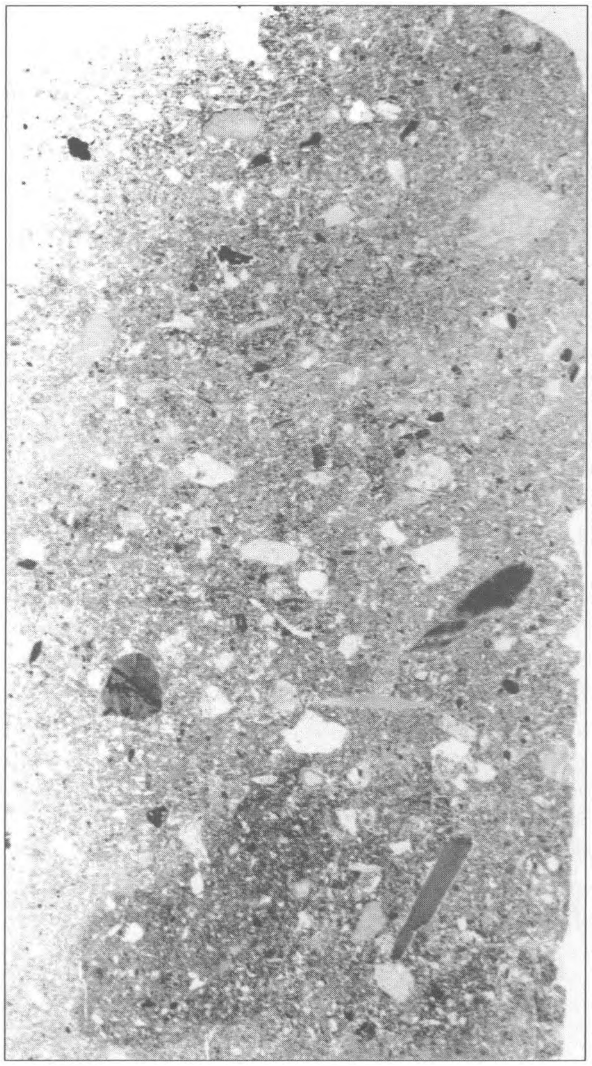

Figure 15. Sample KC-88-17. Macro view of an area identified in the field as a whitish grey occupation zone overlying black floor deposits. This differentiation is not evident here, possibly due to extensive burrowing by cicadas as shown in the lower and central part of this photograph. PPL; length of sample = ca. 10 cm.

with reddened, burnt material, although evidence for in situ burning is absent.

In all, the sample appears to represent charcoal-rich roof deposits overlying ashy deposits (mostly decalcified, although some calcareous ash does remain) that both rest upon slightly rubefied sediment. Extensive burrowing by cicadas has occurred, although it appears that a slightly compacted, probable occupation layer at the interface between the middle and lower portions of the deposits has survived. The reasons for reddish color of the basal part of the section are not clear, but the color could represent the remains of an originally fire-reddened substrate that has since become altered by biological activity.

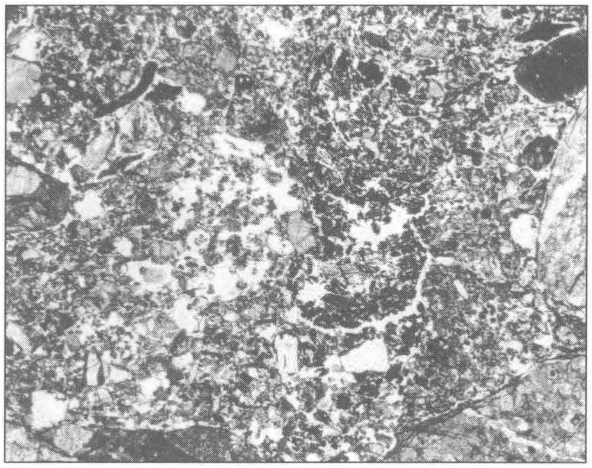

Figure 16. Sample KC-88-17. Detail of middle part of Figure 15 showing a "finger-like" arrangement of charcoal (cicada burrow) within a lighter, more mineral-rich matrix. Note the open nature of the sediment left of the burrow, also caused by burrowing. PPL; length of sample = ca. 3.5 mm.

Discussion of Floor Samples

Overall, the micromorphological expression of the living floors that appeared so evident in the field is not strong in thin section. In sample **KC-88-15** the presence of a living floor was indicated by the breaking of the sample at the layer containing the salmon bone concentration, and the fine, horizontal crack structure, apparently related to vegetation (perhaps matting?) that has since decayed. In sample **KC-88-16**, however, the correspondence between field and thin section sample was less clear, and bone was dispersed throughout the entire upper two-thirds of the slide. The reasons for this lack of correspondence are not apparent, although there is evidence for bioturbation (e.g., cicada burrows). In any case, these samples show that with careful examination thin, laminar compacted zones in thin section can be recognized and ascribed to former occupation surfaces. As noted here, however, often these zones can be locally altered or obliterated by biological activity, thus making their identification difficult or impossible.

Concluding Comments

If we consider the samples as a whole, there are no major differences in composition or texture, and large variations in the proportions of mineral *vs.* organic fractions exist in both the coarse and fine size fractions. Stratigraphic units that were interpreted or ascribed in the field as representing collapsed roof deposits tended to be relatively rich in charcoal, particularly large (cm sized) fragments, but also in finely divided charred vegetal remains. Roof deposits also seem to be richer in remains of the original calcareous ash.

On the other hand, deposits associated with floors or occupation surfaces are overall richer in finer mineral matter, which in the field produces the slightly lighter color of these layers, as for example in sample **KC-88-15**. "Occupation deposits" also did not seem to possess any features that would be associated with anthropogenic activity, such as increases in the amount of bone, ash, burned stones, or very finely divided charcoal. Many micromorphological features, however, may have been destroyed by pedogenetic processes, such as leaching of ash and biological activity. The latter is well expressed in many samples in the form of cicada burrows.

Phytoliths could be observed in most samples, including the supposedly "sterile" rim spoil. In this case, they are probably associated with extensive burning of wood and grasses in the area and their study should complement other palaeobotanical analyses. The relative abundance of phytoliths in roof samples could indicate that either the roofs were loci for organic dumps or that they were covered with grassy sod (see above).

It is hoped that this paper has demonstrated the usefulness of micromorphology in studying anthropogenic deposits, particularly those from Keatley Creek. Here the technique was applied to deposits associated with housepits and included, rims, roofs, floors, reworked sheetflow deposits (the "plaza"), and pit fills. In the case of rim spoil, for example, micromorphological analysis revealed that basal levels of these deposits are less "sterile" than apparent in the field, indicating not only that anthropogenic activities took place prior to their accumulation, but also that they might be associated with house cleaning during occupation. Similarly, micromorphological analysis of pit fills revealed no evidence of in situ burning activity; reddened sediments had been heated elsewhere and dumped in place.

Furthermore, micromorphology has proven very useful in identifying and addressing a wide range of issues that would not have been evident in the field. The identification of phytoliths such as in rims and roofs pointed to probable human discards in areas that such activities would not have been readily assumed. Dumped ash deposits might suggest maintenance of household space. The technique is also successful at isolating a number of post-depositional processes that can significantly affect the interpretation of archaeological date and site formation. These include extensive burrowing by cicadas, which not only obliterate the stratigraphy, but can result in displacement of artifacts. Secondary dissolution of carbonates as seen in thin section, can efface the presence of ashes (essentially composed of calcium carbonate) and result in not only a reduction in volume of the sediment but also elimination of evidence of cultural activity (e.g., in situ burning, or re-mobilization of ashes, such as dumping). Finally, micromorphological analysis of the "plaza" fills shows them to be composed of materials that are ultimately of cultural origin but have been reworked by sheet flow. Thus, the presence of the buried preexisting housepits that occur at the base of the "plaza" profiles has been obliterated by this deposition. Such reworking also suggests that these eroded cultural materials likely come from other housepits situated upslope that have been eroded. Again, such information reflects upon the integrity of the archaeological record at Keatley Creek.

Finally, although the examples presented here are eclectic in nature, additional, nuanced observations could have further illustrated the value of the technique. It is hoped that this study will encourage subsequent efforts to examine and understand anthropogenic deposits from other housepit sites that are common in the western part of North America.

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Chapter 8

Variations in Sediment Characteristics across Floors

Brian Hayden

Since one of the major goals of the FRICGA Project was to identify activity and social areas within housepits, considerable attention was paid to distinguishing living floor deposits from overlying roof sediments in excavating housepits at Keatley Creek. Initially, we had assumed that roof and floor deposits might constitute homogenous but distinct types of deposits. However, as excavations extended out over larger areas of floors, it became evident that there were significant changes in the characteristics of deposits from one floor location to another. The roof deposits, while also exhibiting some variability, tended to be much more homogeneous. The purpose of this chapter is to document the nature of sediment variability across housepit floors, examine possible patterning in the variability and offer some explanations for observed patterning.

Given the unexpected variability in the floor deposits, we thought the changes in floor characteristics might be related to differences in the activities that took place on various parts of the floor. It therefore seemed desirable to monitor the variations in floor characterisitics, even though such information would be lacking for the initial phases of excavations that occurred before we realized how variable floor deposits could be. We attempted to apply quantitative measures such as recording Munsell colors, penetration measures, and bulk density sampling. However, none of these measures proved to be sensitive enough to record the kinds of differences that excavators could plainly see in the field. Munsell colors, especially when sediments were wet, were too coarse grained to differentiate the distinctions that were visually apparent, besides which the colors also varied depending upon the degree of drying of the sediments. The high gravel and cobble content of the sediments rendered penetration and bulk density measures far too variable for the kinds of fine distinctions that were apparent to excavators using trowels.

Thus, if we were going to monitor variations in floor sediments, it was necessary to rely on evaluations of excavators. Traditionally, such observations have been treated as subjective and therefore unreliable, difficult to assess, non-replicable, or non-scientific. In an attempt to standardize observations between excavators, I developed an information field to be filled out by every excavator every time that a straum of a subsquare was excavated (Fig. 1). When the stratum was identified as a floor deposit, a nested hierarchy of additional floor sediments descriptions also had to be filled out with simple check marks. Since the roof deposits were generally relatively homogeneous, and a major goal of the excavations was to distinguish roof from floor deposits the roof deposits were used as a standard measure against which observations of floor characteristics were made.

Thus, once having identified a floor stratum, the first question (and the only question during the 1987 excavations) that excavators had to answer was whether the floor was easily distinguishable from the roof deposits. I thought that this information would provide a means of monitoring the relative reliability of floor identifications and provide a general indication of the variability in floor deposits. After one season and further extensions into the floors, it became obvious that more detailed observations would be far more useful. Therefore, in field seasons after 1988, additional information fields were added to excavation identification tags. If the floor could not be easily distinguished, no further information needed to be recorded although many excavators went on to indicate what slight differences they thought they could perceive. If excavators indicated that floor deposits were easily distinguishable from the roof sediments, then they had to indicate which of three basic characteristics made such distinctions possible: 1) whether the floor was darker, lighter, or equal to the roof in color; 2) whether the floor was coarser, finer, or equal to the roof in texture; 3) whether the floor was more looser, compact, or equal to the roof in compactness.

This information provided both a record of the reliability and accuracy that might be expected in distinguishing the floor from roof sediments in any particular housepit or portion of a housepit. It also provided us with a rough, but basic, quantifiable measure of variations in floor characteristics across the floor. We also found that the heavy fraction residue from the flotation samples taken across the floors of housepits provided an approximate measure of the relative abundance of the combined amount of coarse sands, gravels, and pebbles that occurred in different parts of the floor. Most flotation samples were standardized to 1 litre volumes. Therefore, student assistants simply weighed the heavy fraction that remained after each one litre sample had been floated (removing the light organic fraction and the fine clays, silts, and sands). We then plotted the weight of the coarse fractions across housepit floors. We also developed composite summary descriptions of each stratum for each housepit which are not being published due to their limited usefulness for the present purposes.

Certainly, the results presented below should be viewed with some reserve since the approach was entirely exploratory and considerable refinements appear possible in hindsight, especially in the realms of ensuring that all sample volumes were rigidly standardized, in recording the nature of the till deposits underlying the floors (since the floor was largely derived from these deposits and they could vary within a housepit from fine loams to gravels), field estimates of gravel and pebble contents of matrix, and other similar aspects. However, despite the many confounding factors, including observer subjectivity and differential observational abilities between excavators, there are some interesting patterns that emerge that are worth examining. These data are therefore discussed in the following pages. In all cases, observations made where floors could be easily distinguished from the roof should be more reliable than observations where it was difficult to distinguish the floors from the roofs.

Variation in Floor Color

There are substantial differences between housepits in the overall color differences between floors and roof deposits (Figs. 2–4). Floor deposits in the small housepit (HP 12) are uniformly darker than the roof deposits

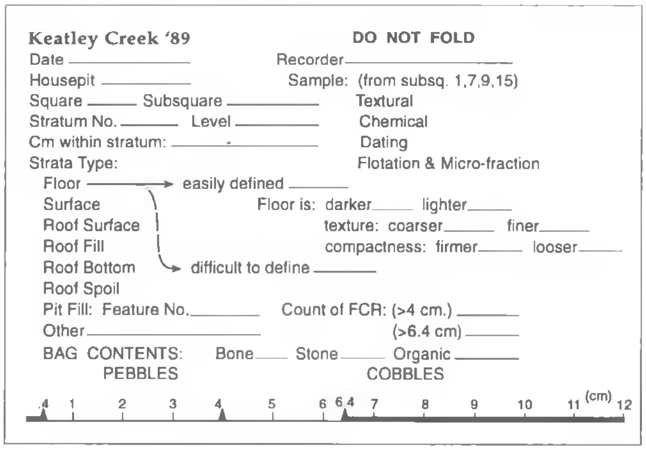
Keatley Creek '89 DO NOT FOLD
Date ______ Recorder ______
Housepit ______ Sample: (from subsq. 1,7,9,15)
Square ______ Subsquare ______ Textural
Stratum No. ______ Level ______ Chemical
Cm within stratum: ______ Dating
Strata Type: Flotation & Micro-fraction
Floor → easily defined ______
Surface Floor is: darker ______ lighter ______
Roof Surface texture: coarser ______ finer ______
Roof Fill compactness: firmer ______ looser ______
Roof Bottom → difficult to define ______
Roof Spoil
Pit Fill: Feature No. ______ Count of FCR: (>4 cm.) ______
Other ______ (>6.4 cm) ______
BAG CONTENTS: Bone ______ Stone ______ Organic ______
PEBBLES COBBLES

Figure 1. Recording card format used for bagging all artifacts and samples at Keatley Creek. Note the subfields under floor stratum type dealing with the ease of identification of the floor (compared to roof) on the basis of color, texture, and compactness.

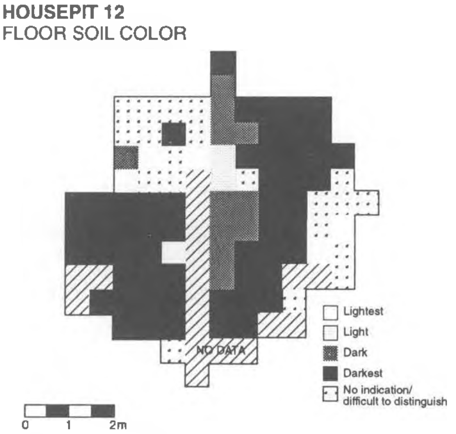

Figure 2. Color variation across the floor of HP 12. The almost uniform dark color of the floor in comparison to the roof is probably due to the low level of organic accumulation in the roof reflecting a relatively short occupation period and few if any reroofing events.

while the opposite is true of the larger housepits (HP's 3 and 7) where the floors tend to be lighter than the roof deposits. The difference between small and large housepits is undoubtedly due to the fact that the small housepits were probably only used at most for a generation or two while the larger housepits were continuously occupied for hundreds if not thousands of years. Thus, the roof deposits of the small houses were only slightly altered from the natural till color due to the short period that refuse and ash would have been discarded on the roofs and the very limited number (zero, one, or two) of reroofing events that would have incorporated the dark floor sediments into the roof matrix. Over the 10–20 years that a given floor deposit might have accumulated, however, considerable ash, charcoal, and other organic wastes would have been incorporated in the floor sediments darkening their color considerably.

In contrast, in the large houses, the greater total occupation length (hundreds or thousands of years) and the repeated reroofing events all would have built up rich organic concentrations of ash, charcoal, and organic wastes in the roof deposits making them quite dark, and in many areas darker even than the heavily stained sediments of the floors. In both HP 3 and 7, the peripheral areas, where the ease of distinguishing floor from roof is most pronounced, were uniformly observed as being lighter in color than the overlying roof. Unfortunately, observations on relative color were not recorded until 1989, after the major zones containing hearths in these housepits had already been excavated. However, photographs of sections near hearths clearly show that the floor zones near at least some of the major hearths were markedly darker in color than the overlying roof deposits (e.g., Fig. 5). This leads to the proposition that floor sediments should be darkest in the immediate areas surrounding hearths and perhaps in provisional ash or charcoal dump areas (possibly represented by the "dark" northwest corner of HP 7), while the peripheral zones of floors representing storage and/or bedding areas should be areas where the least amount of discoloration of floor deposits took place.

Variation in Floor Texture

There are two measures of floor texture: the subjective assessments of excavators and the measured weights of coarse sands, gravels, and pebbles from the litre flotation samples. Assuming a uniform till substrate from which both floor and roof sediments

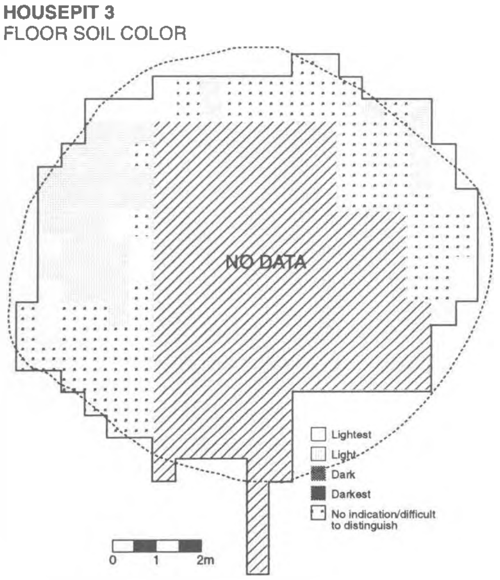

Figure 3. Color variation across the floor of HP 3. In this case, the generally lighter color of the perimeter floor in comparison to the roof may reflect the long-term accumulation of organic residues (especially ash and charcoal) in the roof compared to a relatively short use of the floor (since the last reroofing and cleaning event) prior to abandonment. Locations under benches or in storage areas may have also reduced organic accumulation in the perimeter zones. The lack of data from the first two seasons of excavation unfortunately prevents a more comprehensive analysis, especially in the center and the vicinity of the major hearths.

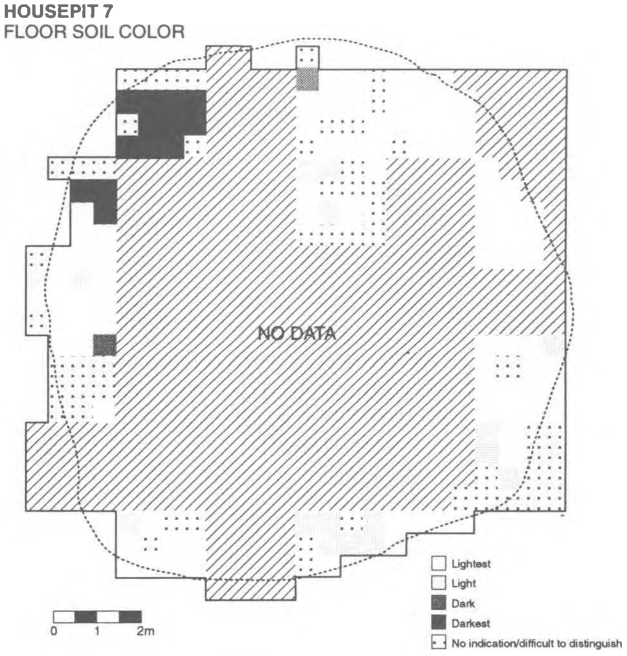

Figure 4. Color variation across the floor of HP 7. The generally lighter color of the perimeters of this floor probably is due to factors such as those suggested for HP 3 (Fig. 3). Of interest are the occurrence of dark patches in the northwest corner, and probaby the southwest corner (where only the "distinctiveness" of the floor was recorded). These locations are adjacent to two very large hearths which probably darkened floor sediments around them.

were derived, variations in sediment texture should reflect the differential effects of activities across floors. The subjective assessments of floor textures all indicate that floor deposits with finer textures than the roof tend to concentrate in the peripheral areas of the floors (Figs. 6–8). Some localized coarser zones also exist in peripheral locations, but the finer sediments seem uniformly confined to the peripheral zones. Again, it needs to be emphasized that we lack specific observations on most of the central floor areas of HP's 3 and 7, thus limiting the usefulness of these analyses. This is complicated by the fact that a very broad patch of unusually fine glacial loam comprised the till substrate from which the central area of the HP 7 floor was derived. This undoubtedly had a major biasing effect on activity differences in the relative coarseness of floor fabrics.

Before turning to the analysis of the heavy fractions, it is worth noting that as with color, the north edge of the HP 3 floor stands out as an unusual zone for reasons that are currently difficult to determine. It is similarly notable that in the small housepit (HP 12), the zones with finer or indeterminate floor sediments are confined entirely to the north and east half of the house. This is consistent with other indicators of a basic spatial division within the house supporting a communal organization and use of space, especially with food preparation, sleeping, and minor craft activities (employing utilized flakes) taking place in the north and east parts of the housepit, while traffic and more energetic activities appear to have taken place in the remainder of the house space (Vol. II, Chaps. 1 and 11).

Analysis of the heavy fractions of the small and medium housepits (HP's 12 and 3) shows that the highest weights of coarse clasts tends to occur in the center of the floors, although there are also some localized peripheral occurrences (Figs. 9 and 10). This is consistent with the subjective observations made about floor textures compared to roof textures. In fact, where relatively complete data exist as in the case of HP 12, the results of the subjective and quantified analyses are remarkably consistent. I interpret concentrations of coarser fractions to most likely reflect areas of heavy foot traffic and other activities that would stir up floor sediments. Such activities would act to concentrate the heavier clasts while dispersing the finer elements as dust or dirt to the less actively used parts of the house where the fine elements would settle and tend to remain due to low levels of activity. Accumulation areas for finer sediments would characteristically be storage areas and bedding areas, especially if beds were raised off the floor.

The above analyses are based on the presumption of a uniform till substrate from which floor sediments were largely derived. Some of the minor departures

Figure 5. A photograph showing the contrasting dark color of some floor sediments compared to roof sediments.

from the major trends (Figs. 9–11) may be due to localized variations in clast content in the underlying tills. Unfortunately, this variation was not monitored, although the striking occurrence of a loam patch within the till substrate of the center of the HP 7 floor provided a clear example of the impact that such variation could have in extreme situations. Once again, we lack adequate observations on the precise extent and position of this loam patch, although it occurred in most of Squares A, B, E, and F (Fig. 11). The low values of clast weights in these and portions of some adjacent squares undoubtedly clearly reflect the influence of the loam patch. Similar variability may be responsible for some of the other localized and difficult-to-interpret clast concentrations across the HP 7 floor.

Variations in Floor Compactness

Because roof sediments by their very nature have been churned up a number of times and have subsequently undergone either a gradual filtering or catastrophic collapse, it can be expected that they would be among the most unconsolidated sediments anywhere in housepit village sites. And indeed, only highly organic rim deposits and large single event pit fill deposits surpassed roof deposits in terms of looseness and lack of consolidation. Therefore, it is not surpising that some floor deposits could uniformly exhibit greater compactness than the overlying roof deposits (Fig. 12). The only important exceptions to this pattern tend to occur relatively close to housepit walls where either sleeping platforms could provide protected environ-

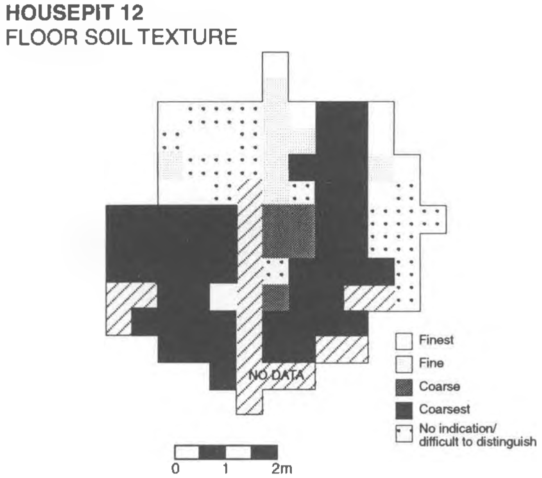

Figure 6. Texture variation across the floor of HP 12. Note the occurrence of finer textures in peripheral areas probably indicating areas that were sheltered from active use in the north, while most areas in the south had relatively coarser texture, probably reflecting active use areas.

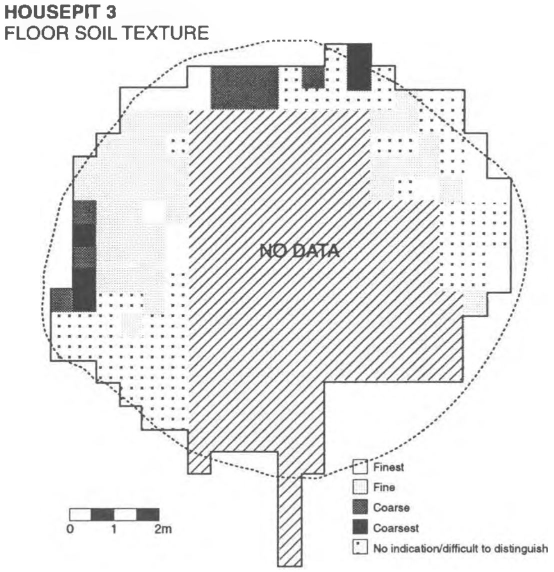

Figure 7. Texture variation across the floor of HP 3. The most distinctive fine textured sediments again occur in the peripheral areas of the floor, probably indicating sheltered areas. Unfortunately, critical data from the first two seasons was not recorded for most of the central part of the floor, however, see Fig. 10.

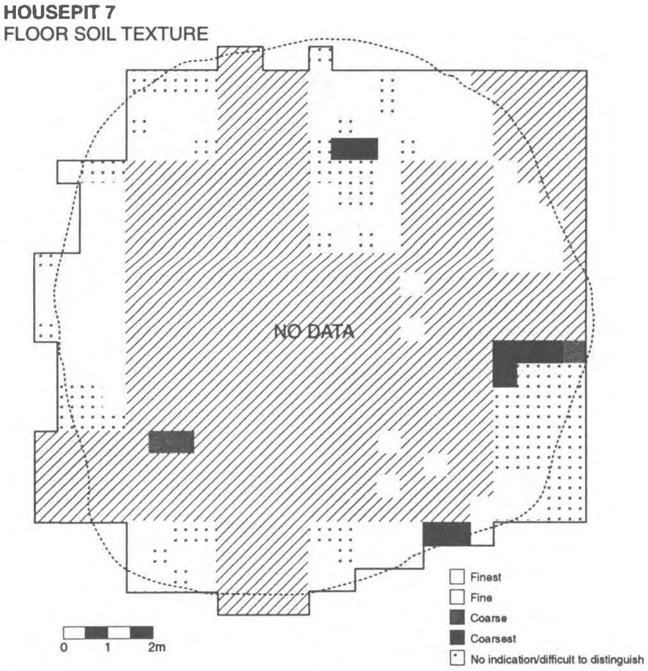

Figure 8. Texture variation across the floor of HP 7. Aside from a few small pockets, the peripheral areas of the floors again appear to have a distinctively finer texture than the roof materials. Lack of data for the center areas, hampers full interpretation, however, see Fig. 11.

ments for the accumulation of fine sediments and/or rim sediments could have sloughed off of walls and accumulated along the adjacent parts of floors. In some peripheral floor areas it became especially difficult to distinguish floor from overlying roof and/or sloughed materials. On the basis of my own excavation work in these areas I often concluded that there had been significant sloughing off of wall material that had accumulated at the base of the wall and rendered the identification of floors difficult in these zones. Roof sediments in parts of other housepits, such as HP's 3 and 7, seem to have compacted over time to the extent that they could not generally be distinguised from floors on the basis of compactness, except near the peripheries (Figs. 13 and 14).

Summary

Thus, in sum, the preliminary results of these techniques for investigating formation processes and activity induced variations in sediments across floor deposits have been both insightful and encouraging. Despite many uncontrolled factors, general patterns have emerged that not only make logical sense but are consistent with and support other types of analyses and inferences about the activity areas within housepits. Factors that complicated this analysis were the incomplete data sets and data of varying quality; the uncontrollable nature of subjective evaluations; the uncontrolled variability in our measurement standard (roof sediments); and the uncontrolled influence of variations in the till substrate on floor deposits. Despite these uncontrolled factors, it has been possible to show that 1) color variations can be expected to occur across floors, especially with proximity to hearths and in little used storage or bedding locations; 2) that floor colors should be particularly distinctive in small housepits with relatively short use-lives; 3) that high activity areas probably tend to concentrate heavier clasts while low activity areas act as accumulation areas for finer sediments (at least in dry, dusty environments); 4) and that floors can be more compact than collapsed dirt roofs except where protected floor areas permit the accumulation of fine sediments or materials sloughed off of walls. Having demonstrated the utility of this basic approach, I am confident that considerable refinement is possible and that even more powerful and significant results can be attained especially if underlying variations in the till substrate can be monitored simply and efficiently. Simple measures of gravels and pebbles remaining in screens from standardized pail screening samples might be one efficient way to achieve this level of monitoring for texture.

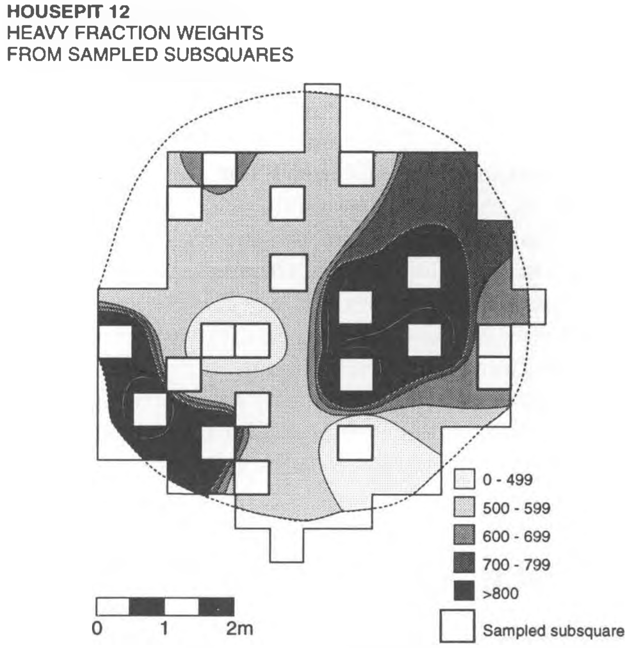

Figure 9. **Variation in the weight of heavy fractions of flotation samples across the floor of HP 12 reveals a pattern that generally corresponds to the field identification of coarse textures (Fig. 6.), and clearly shows the concentration of coarse sediments in the center of the housepit.**

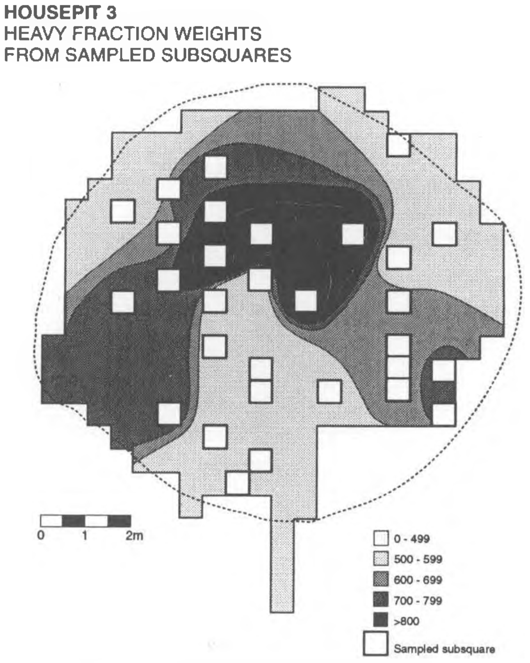

Figure 10. **Similar monitoring of the heavy fraction weight across the floor of HP 3 also generally corresponds to the field assessments of coarse versus fine textures (Fig. 7), and again clearly show the concentration of coarse sediments in the center of the floor.**

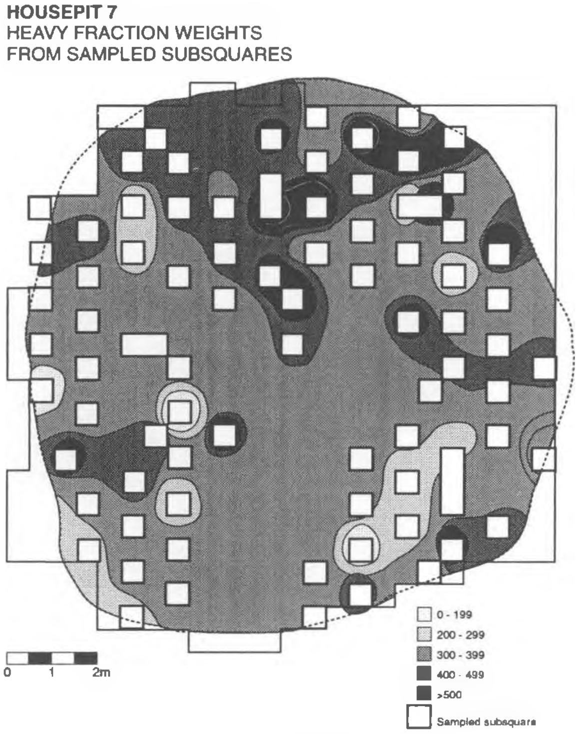

Figure 11. Although considerably more complex because of its size and multiple hearths, heavy fraction weights from the floor of HP 7 also display a general correspondence to the field determinations of texture (Fig. 8), again with some of the highest concentrations of coarse sediments occurring toward the central zone of the floor.

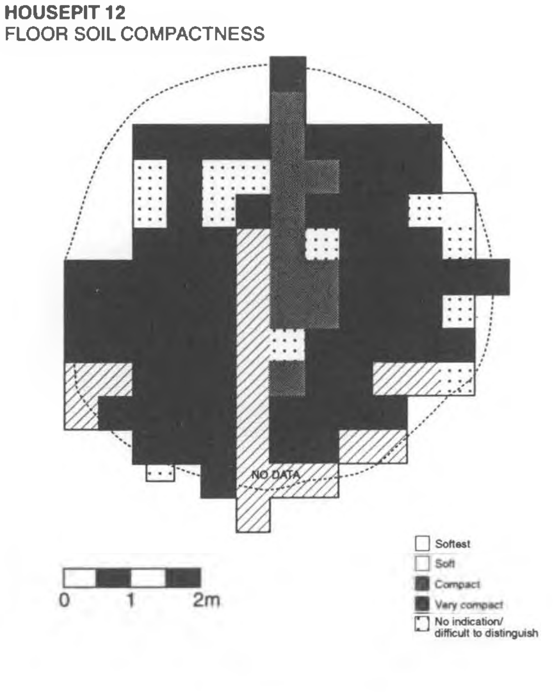

Figure 12. Compactness across the floor of HP 12 displays little variation.

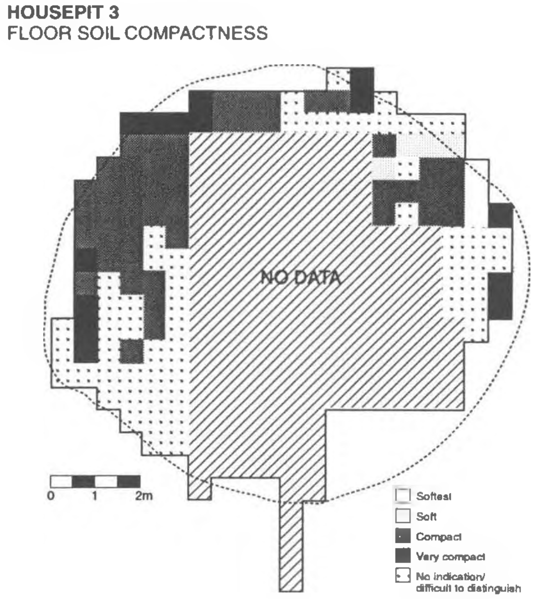

Figure 13. The compactness of the HP 3 floor displays general uniformity of compactness similar to roof deposits except near the walls. Lack of data from the first two seasons renders conclusions tentative.

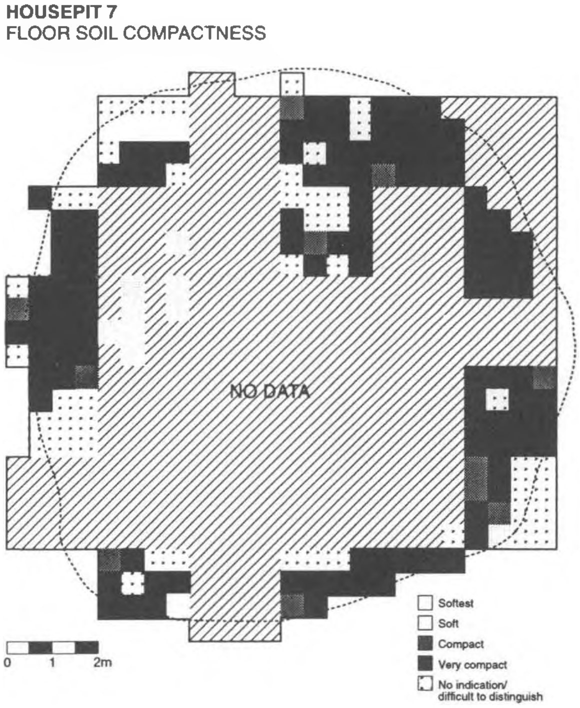

Figure 14. The compactness of the HP 7 floor is similar in its uniformity to HP 3. The lack of full data across the floor center similarly limits our inferences.

ORGANIC REMAINS

Chapter 9

Site Formation Processes at Keatley Creek: The Paleoethnobotanical Evidence

Dana Lepofsky

Introduction

A rich ethnobotanical record documents the significance of plants for food, technology, medicine, and ritual, among the First Nations of the Northern and Southern Interior Plateaux (Palmer 1975; Turner 1997; Turner et al. 1990). Despite this, few archaeological studies have attempted to independently evaluate the role of plants in the pre-contact era with archaeobotanical evidence. In the Northern Plateau, the Keatley Creek project was the first major research project to actively incorporate paleoethnobotanical analyses into its research design. Paleoethnobotany has been used throughout the 12 years of the project to answer a variety of research questions about life at the village of Keatley Creek.

The objectives of the paleoethnobotanical analysis at Keatley Creek were designed to address the larger goals of the project, specifically: 1) to gain an understanding of the formation processes of the Keatley Creek housepit deposits; and 2) to construct a model of prehistoric, economic, and social life at Keatley Creek. Both of the project goals are addressed in this paper, with particular focus on the former. Elsewhere, I present a more detailed analysis of the prehistoric socioeconomy at Keatley Creek as reflected in the archaeobotanical remains (Vol. II, Chap. 4; Lepofsky et al. 1996).

Given time constraints and the complexity of the deposits at Keatley Creek, we decided to focus the site formation component of the paleoethnobotanical analysis only on the largest of the three housepits investigated (HP 7). Specifically, we were interested in understanding the formation processes of the roof, rim, and floor deposits in that housepit. This involved determining how individual taxa entered the record, as well as how the remains came to be preserved. These data, combined with analyses of the density and diversity of archaeobotanical remains within and between deposits, provided insights into how the Keatley Creek deposits were formed. Such a detailed understanding of site formation processes was a necessary first step to deciphering the social and economic history of the Keatley Creek village.

In this chapter, I present an inventory of the plant remains recovered from HP's 7, 3, and 12. This is followed by an analysis of the site formation history of HP 7. Portions of this analysis are also reported in Lepofsky (in press). Finally, based on the foregoing, I present a model of prehistoric plant use at the village of Keatley Creek.

Methods

A total of 151 flotation samples were examined from the three housepits (HP 7, N=97; HP 3, N=38; HP 12, N=16). The bulk of the samples came from the floor of the three houses. The remaining samples came from the rim (N=18) and roof (N=10) of HP 7. In hindsight, the rim and roof deposits from all HP's should have been sampled far more extensively. Given the limited sampling of roof and rim deposits, some questions about site formation processes could not be dealt with in detail.

Samples collected from all deposits were generally "bulk samples" (Lennstrom and Hastorf 1992; Pearsall 1988). Those originating from the floors were collected from designated 50 × 50 cm sampling subsquares within a 2 m^2 excavation unit. Approximately 15% of the floor of HP's 7 and 3, and 12% of HP 12, were examined. Roof and rim samples from HP 7 were collected from judgementally selected excavation units or lenses, respectively. All samples were measured to a standardised volume of one liter and then floated using the "garbage can" technique (Watson 1976); most samples were floated in the field. The bucket mesh was 1.0 mm, and the scoop mesh was 0.45 mm The heavy fraction provided the material for the microfaunal and microdebitage analyses (Vol. II, Chaps. 7 and 9). The light fraction provided the material for the paleoethnobotanical analysis reported herein.

Generally, little sinking of floral remains was observed, and the recovery seems to be adequate. However, in some samples, considerable charred remains were observed in the heavy fraction. No effort was made to quantify this material, and as a result some bias has been introduced into the analysis.

Samples from the rim samples required special processing. Because the rim matrix is hydrophobic, almost the entire contents of some rim samples remained buoyant and could not be effectively floated. These samples were dry screened directly as described below for previously floated light fractions.

In the lab, I passed the dried light fraction remains through four geological sieve fractions (4.0, 2.0, 1.0, and 0.5 mm) to facilitate sorting. With the aid of a dissecting microscope (6–40×), I divided the 4.0 and 2.0 mm mesh fractions in all samples entirely into their constituent parts. To considerably reduce sorting time, sub-samples of the 1.0 and 0.5 mm meshes were taken from the samples with an abundance of small remains. This subsampling includes all the rim samples, and some of the samples from the roof deposits.

I determined the size of a subsample two different ways in the course of the analysis. The first method involved increasing the sub-sample size until redundancy for the percent of each species percents was reached. A sample was first divided randomly into several equal sub-samples. Floral remains in each sub-sample were tallied until the total percent of each species did not change more than 1.0% when a new sub-sample tally was added to the total. This defines "redundancy." In most cases, the samples were 35.5% of the original one liter sample. However, even when redundancy is reached, rare species may not show up in samples of such a small size.

In later analyses I determined the subsample size by first randomly dividing the sample into equal subsamples and then completely sorting one subsample of manageable size (approximately one petri dish-worth). I then sorted the entire remainder of the sample for remains which were not common in the subsample. "Common" species are charcoal and those seeds or needles represented by more than ten specimens. I determined the sample abundance of these common remains by multiplying their subsample count or weight by the proportion of the subsample of the whole sample. In contrast to the former subsampling method, the very rare species are always counted, but time is not spent enumerating the abundant species. All numbers presented in the report are either projected estimates based on subsamples or actual counts based on one full liter sample.

I identified charcoal with a reflected light microscope (with a maximum magnification of 450×), and used a transmitted light microscope (with a maximum magnification of 600×) for uncharred wood identification. Particularly rotted uncharred wood specimens were first charred in a furnace to facilitate identifications. Because neither the wood reference collection to which I had access nor the published reference material (Core et al. 1981; Friedman 1978; Panshin and deZueew 1980; Schweingruber 1982) adequately cover the flora of the Lillooet area, I was unable to identify a few specimens. I only identified charcoal from a portion of the flotation samples. After identifying several samples it became obvious that the results of the identifications were fairly redundant between samples, and no new information was gained by identifying additional specimens.

Seeds and other floral parts were identified with the aid of a dissecting microscope, my comparative collection, and published references (Delorit 1970, Montgomery 1977). Given the nature of the deposits at Keatley Creek, only charred floral remains from non-rim deposits were considered to be prehistoric (cf. Miksicek 1987). The rim deposits, however, with their highly hydrophobic matrix, preserved uncharred as well as charred archaeological floral remains. For this reason both charred and uncharred remains make up the archaeobotanical assemblage of the rim.

Plant Inventory

The following is an inventory of the plant taxa recovered from the flotation samples from the three housepits. The inventory is organised alphabetically by family. The discussion of each taxon includes a brief discussion of ethnobotanical uses, largely summarised from Turner (1992, 1997, 1998) and Turner et al. (1990). Habitat information comes from Hitchcock and Cronquist (1973), Hitchcock et al. (1984), Parish et al. (1996), and Turner (1992, 1997, 1998). For more detailed ethnobotanical and environmental descriptions refer especially to Turner (1992) and Parish et al. (1996).

The data comprising the archaeobotanical record at Keatley Creek are presented in Tables 1–10. Tables 1–5 present the raw data by species for all categories of remains except charcoal. Percent abundance of charred and uncharred wood taxa recovered from various contexts in the three housepits is presented separately in Tables 6–10.

For all remains except charcoal, raw counts/weights as well as ubiquity measures are presented. Ubiquity is a measure commonly used by paleoethnobotanists to minimize the effects of differential preservation and sampling (Dennell 1976; Hubbard 1975, 1976, 1980; Minnis 1981; Popper 1988; Wilcox 1974). In ubiquity measures, each taxon is enumerated by the number of times it is found at least once in each of the samples examined, expressed as a percent of the total number of samples analysed. The abundance of the taxon is not considered in ubiquity measures; a taxon represented by one seed in five of ten samples (50% ubiquity) has a higher ubiquity value than a taxon represented by 1,000 seeds in two of ten samples (20% ubiquity).

The appropriate method of quantification of the charred remains partly depends on the nature of the charring event. In the Keatley Creek samples, charred remains result from both accidental and purposeful burning during pithouse occupation, as well as during the final burning of the structure as a whole. Ubiquity measure is appropriate for remains from accidental burning because ubiquity considers frequency of occurrence rather than abundance, thus reducing preservation and sampling biases (Popper 1988). However, ubiquity measures are less appropriate for remains charred during the final burning of a housepit. In this case, because all remains have an equal chance of being preserved, using ubiquity measures may conceal cultural patterning (see Popper [1988] for additional drawbacks with this method of quantification). Both raw counts and ubiquity measures will be used throughout the discussion.

Gymnosperms

Cupressaceae (Cypress Family)

***Juniperus* sp. (Juniper).** The remains of juniper are rare in the assemblage in comparison to other woody species. This species is represented by only one piece of wood and a few stem fragments, all from HP 7. Both *Juniperus scopulorum* and *J. communis* are found at Keatley Creek today, in the Interior Douglas-fir Zone surrounding and at slightly higher elevation than the main part of the site. Both species likely grew in several biogeoclimatic zones in the general study area, with *J. communis* being far more ubiquitous. Ethnographically, boughs of both species were used for medicinal purposes and the wood of *J. scopulorum* was used for technological purposes. *J. scopulorum* berries were also casually eaten. *Juniperus* sp. could be harvested year-round as needed. Its relatively low abundance in the Keatley Creek assemblage indicates that it did not play a very important role at the site.

Pinaceae (Pine Family)

***Pinus* sp. (Hard Pines).** Unfortunately, based on minute anatomical wood characteristics, it is only possible to distinguish two general levels of pines—the hard and soft pines. Indeed, even this gross distinction is often difficult to make with archaeological specimens. The only soft pine in the study area is *P. albicaulis* (whitebark pine). The hard pines in the study area are *P. ponderosa* (ponderosa pine) and *P. contorta* (lodgepole pine).

All pine specimens that I was able to identify with confidence fall into the hard pine category. It is possible that some of the wood specimens which were more difficult to identify belong to the soft pine category, but it seems unlikely, given that they should be no more difficult to identify than the hard pine category.

Within the hard pine category, the majority of specimens are likely ponderosa pine. I say this because all other pine parts which I was able to identify (see below) are ponderosa pine. *P. contorta* may be also represented in the Keatley Creek assemblage; indeed this would not be surprising given its ubiquitous distribution in the study area.

Pinus charcoal is abundant at the site, and is second in abundance in some contexts only to *Psuedotsuga menziesii* (Tables 6–10). Its wood was used structurally in all three houses (Table 10). Teit (1895) notes that it was easily cut with stone tools. Ethnographically, *P. contorta* was used more frequently than *P. ponderosa* in house construction. Given that ponderosa pine

Table 1. HP 7 Roof – Plant Inventory

	SEEDS (N)											NEEDLES (N)			STEM	MISC. PLANT				CHAR † (g)
Provenience (sq. - subsq.)	*A. alnifolia*	*A.uva-ursi*	*Chenopodium*	Compositae	Cyperaecae	Ericaceae	Poaceae	*Phacelia*	*Ribes*	Unidentified	TOTAL	*P. mensiesii*	*P. ponderosa*	TOTAL	Poaceae (N)	Conifer cone part (N)	Unidentified bud (N)	Betula bark (g)	Unidentified tissue (N)	
A - 7										1	1	2**	2						1	
C - 7											0	126		126						5
I - 5	1		27			21	7	1	1	6	64	544	156	700			2	2	4	18
J - 1		1	10	1		2	2	2		3	21	1,485	1,007	2,492		3		1	8	18
Y - 1			2			6		1		1	10	67	37	104				2	2	4
HH - 1		3									3	172	45	217	1		1	1	1	13
II - 3						1	1			1	3	57	10	67		1				4
II - 3*											0	8	7	15						Neg‡
GG - 9		2			1?					2	5	73	50	123			2		3	10
GG - 9*	1	1	3			1					6	156	70	226		5		1	2	Neg
TOTAL	2	7	42	1	1	31	10	4	1	14	113	2,562	1,382	4,072	1	9	5	7	20	73
UBIQUITY (%)	20	40	40	10	10	50	30	30	10	60	.	100	100	.	10	30	30	50	60	.

* Samples originate from a stratum designated "walking surface below roof fill."
** Needles not separated by species. These counts used in total needle count but not in total species count.
† CHAR = grams of charcoal
‡ Neg = negligable

would have been much more plentiful than lodgepole pine in the immediate vicinity of the Keatley Creek village, the ease of transport may have outweighed any structural benefits that lodgepole might have had.

***Pinus ponderosa* (Ponderosa Pine).** This species is represented at Keatley Creek by many of its anatomical parts. Needle (including bundle bases), cone, stem, and bark fragments are found in abundance in the samples. Uncharred specimens of *P. ponderosa* seed coats were recovered from HP 7 rim deposits.

Ponderosa pine is a primary species in the forest surrounding Keatley Creek today, in both the Interior Douglas-fir and Ponderosa Pine Biogeoclimatic Zones. Its abundance in the archaeological assemblage indicates that it was a preferred species for a variety of functions. As a wood it burns relatively hot, is a good self-pruner (i.e., dead branches are easily removed from the tree) and would have been readily available to the site's inhabitants. Ponderosa pine is generally recognized as an excellent fuel source by Interior Salish Indians, and *Pinus* sp. is found in abundance at Keatley Creek in most hearths examined (Table 9). Ponderosa pine wood had a variety of other technological uses, and the cambium was eaten by the Nlaka'pmx and Lil'wet'ul.

Ponderosa pine needles are found in abundance in many of the samples examined. Their high concentration, along with Douglas-fir needles, around the periphery of the pithouses suggests that they may have been used for bedding material (see discussion of floors below). Ethnographically, dried pine needles were used for insulating houses, for filling crevasses in roofs or even covering roofs, were interspersed between layers of stored food, and were used in pit cooking. The ubiquitous nature of pine needles in all pithouse contexts suggests that the needles may have been used prehistorically in much the same manner. Ponderosa pine seeds were eaten by the Nlaka'pmx, and the seeds recovered in the rim of HP 7 may indicate it was a food source in the past as well. Wood and needles of ponderosa pine could be gathered year-round.

***Psuedotsuga menziesii* (Douglas-fir).** Douglas-fir is the single most ubiquitous and abundant wood species at Keatley Creek. Its charcoal, uncharred wood, and its needles are common in the deposits, and are generally much more abundant than the next most common species in these categories, *Pinus* sp. In a recent survey of cultural significance of plants among the Nlaka'pmx (Thompson) and Lil'wet'ul (Lillooet) conducted by Turner (1988a, 1988b, also 1992), Douglas-fir was rated

Table 2. HP 7 Rim – Plant Inventory*

	SEEDS (N)																						NEEDLES (N)			STEM		MISC. PLANT						WOOD (g)
Provenience (sq. - layer - sample)	*A. alnifolia*	*Amsinckia*	*A. uva-ursi*	Caprifoliaceae	*Carex*	*Chenopodium*	Collinsia	*Cornus*	Ericaceae	Poaceae (lg.)	Liliaceae	*Lithospermum*	*Opuntia*	*Phacelia*	*Pinus*	Polygonaceae	*Prunus*	*P. menziesii*	*Rosa*	*Sambucus*	Unidentified	TOTAL	*P.menziesii*	*P. ponderosa*	TOTAL	Poaceae (N)	*Juniperus* (N)	Conifer bud (N)	Conifer cone parts (N)	Unidentified bud (N)	Unidentified fruit (N)	Betula bark (g)	Unidentified tissue (N)	
D-a-24 charred					1				2		1?											4	2,800	1,200	4,000								4	23
uncharred	104		10			200			16			15	113		4		1	5				468	145	500	645							0.1	9	2
K-a-9 charred	36								3												3	42	3,434	961	4,395	100			2					12
uncharred	2	2				73			1													78	12	9	21									0
K-b-22 charred																						0	2,200	1,200	3,400			1	3				7	19
uncharred	778		6			19		2													1	806	1.530	3.100	4.630					2		0.8	1	9
K-b-28 charred																		3			9	12	1,180	2,710	3,890			1						20
uncharred	235		5			586							10								1	837	0	0	0									1
K-c-8 charred	1		1			1			12	1												16	5,000	1,600	6,600	12								9
uncharred	47	1	16			342							8									414	32.000	3.300	35.300		1	50				Neg#		5
K-c-10 charred						1				2											6	9	10,106	2,741	12,847				1				2	46
uncharred		1				311			9							1	1					323	5.764	5.843	11.607		7		2			0.3	2	42
K-c-11 charred	7																				2	9	4,658	1,193	5,851				2					23
uncharred	1.953	1	7			326						1										2.288	11.709	3.569	15.278			1	1	1		1.1		23
K-c-12 charred									10							1?						11	14,226	3,746	17,972	1,400		2					2	45
uncharred	134	2	12			1.200			2				2									1.352	4.080	4.642	8.722					1		Neg		4
K-c-13 charred									40										1		2	43	7,510	1,776	9,286	254		3					2	23
uncharred	72		235			1.296															1	1.604	2.138	1.310	3.448					6	1	0.6		4
K-c-26 charred													1								5	6	925	3,620	4,545				1					31
uncharred			39			102							6		1						1	149	1.100	2.800	3.900							4.5		18
L-a-28 charred	4		1	2			1		10	4											16	38	4,210	919	5,129	4	1	3	6	1			2	24
uncharred	2																					2	0	0	0									0
L-a-30 charred									1'												3	4	1175**		1,175								1	16
uncharred						16																16	2.600		2.600									0
L-a-23 charred			1						4					2						1		8	533	323	856								4	18
uncharred	4					40																44	0	1	1							1.8		0
M-c-60 charred	2																				1	3	3,875		3,875			1						26
uncharred						64																64	0	0	0									0
M-b-63 charred	5												1					1			2	9		1,840	1,840									12
uncharred						24																24	0	0	0									0
M-a-65 charred													1					5			3	9		1,165	1,165									12
uncharred						52															1	53	0	0	0									0
N-a-48 charred	9																					9	4,100	1,700	5,800									16
uncharred	34		16			140						13	128									331	90	210	300									8
N-d-66 charred																						0	330		330									13
uncharred	6					3																9	0	0	0									0
TOTAL	3,301	7	349	2	1	4,796	1	2	110	7	1	29	270	2	5	2	2	14	1	1	57	8,959	119,446	48,973	316,360	1,770	9	62	14	11	1	9.2	36	61
TOTAL (c)	64	0	3	2	1	2	1	0	82	7	1	0	3	2	0	1	0	9	1	1	54	231	52,658	23,689	92,356	1,770	2	11	11	0	0	0.0	19	53
TOTAL (uc)	3,237	7	352	0	0	4,794	0	2	28	0	0	29	267	0	5	1	2	5	0	0	4	8,728	66,788	25,284	224,004	0	7	51	3	11	1	9.2	3	8
Ubiquity (%)	50	14	33	3	3	53	3	3	23	8	3	8	25	3	6	6	6	11	3	3	44	.	81	83	.	13	8	22	17	14	3	25.0	31	.
Ubiquity (%c)	39	0	17	6	6	11	6	0	44	17	6	0	17	6	0	6	0	17	6	6	61	.	100	100	.	27	11	33	33	6	0	0.0	44	.
Ubiquity (%uc)	61	28	50	0	0	94	0	6	22	0	0	17	33	0	11	6	11	6	0	0	28	.	61	67	.	0	6	11	11	22	6	50.0	17	.

* All rim samples are from an excavated trench.

** Needles were not counted separately. These counts are used in total needle count but not in total species count.

' = whole fruit with several joined seeds.

\# Neg = negligable

Table 3. HP 7 Floor – Plant Inventory

	SEEDS (N)																NEEDLES (N)			STEM	MISC. PLANT					CHAR^{t} (g)
Provenience (sq. - subsq.)	*A. alnifolia*	*A.uva-ursi*	?Boraginaceae	*Chenopodium*	*Cornus*	Ericaceae	Poaceae (lg.)	Poaceae (sm.)	*Opuntia*	*Phacelia*	*Prunus*	*Rosa*	*S. stellata*	*Scirpus*	Unidentified	TOTAL	*P. menziesii*	*P. ponderosa*	TOTAL	Poaceae (n)	Conifer buds (N)	Conifer cone parts (N)	Fruit pedicel (N)	Betula bark (g)	Unidentified Tissue (N)	
A - 1															1	1	10**		10							0
A - 7						3										3	8	0	8							1
A - 9															1	1	1		1							1
B - 1															1	1	17		17						1	1
B - 7															1	1	30		30							2
B - 9															1	1	6		6							1
B - 15	1					1									2	4	31		31							8
C - 1															2	2	81		81							1
C - 13																0	271		271							3
C - 15	1														1	2	15		15							0
E -1										1						1	220	50	270							4
E - 7																0	23		23							1
E - 9																0	70	15	85							1
F - 7																0	36		36							1
F - 9				6											1	7	146	156	302						2	4
F - 15																0	50		50							1
F - 16															1	1	0		0							0
G - 7	1			5		2	1									9	144	27	171			2				5
G - 15						1									3	4	3	34	37							3
H - 1															3	3	20	160	180							4
H - 2		1			1	1			1			5	1		4	14	92	10	102							5
I - 9																0	120	13	133							1
I - 16*							1									1	111	466	577							6
J - 1	6															6	839	5,800	6,639			5				20
J - 9						3	1									4	617	250	667							8
P - 7															1	1	68		68							8
Q - 7*	1					3									5	9	17		17							20
Q - 15						1									10	11	44		44							4
R - 15						2									6	8	41		41						1	22
U - 9	1	1?				2	2								1	7	604	54	658	2		1	1			5
U - 15	12	1?		5		6	12	1				3			7	47	1,184	112	1,296	2		8			11	6
W - 11															1	1	160	160							5	
X - 8																0	2	0	2							1
X - 9						1			1						2	4	124		124						2	5
X - 16																0	80	21	101						1	3

	SEEDS (N)																NEEDLES (N)			STEM	MISC. PLANT					CHAR' (g)
Provenience (sq. - subsq.)	*A. alnifolia*	*A.uva-ursi*	?Boraginaceae	*Chenopodium*	*Cornus*	Ericaceae	Poaceae (lg.)	Poaceae (sm.)	*Opuntia*	*Phacelia*	*Prunus*	*Rosa*	*S. stellata*	*Scirpus*	Unidentified	TOTAL	*P. menziesii*	*P. ponderosa*	TOTAL	Poaceae (n)	Conifer buds (N)	Conifer cone parts (N)	Fruit pedicel (N)	Betula bark (g)	Unidentified Tissue (N)	
Y - 7	1														3	4	179		179						3	6
Y - 15		2		16	2		1								1	22	269	91	360	3	1			2	1	4
Z - 6															2	2	40		40						1	7
BB - 1	2														5	7	6	39	45						4	12
BB - 7						3					2					5	40	8	48							8
BB - 15						1										1	27	8	35							1
JJ - 7	2			5		2	2	1		11					3	26	124	59	183	5	1					6
JJ -8*						7				5					6	18	not counted		.	3						9
JJ - 9						1	2			1						4	183	51	234					2		4
JJ - 15						1									1	2	37	7	42							1
KK - 9				3		2	1	2								8	339	88	427	2						8
LL - 1	1					1					1					3	44	12	56			1				4
LL - 15							1									1	310	15	325			2				3
MM - 1	1			1		1										3	83	41	124							4
MM - 9																0	98	24	122							2
NN - 7																0	115	23	138						1	3
NN - 10														1		1	94	10	104						1	2
NN - 13*	1															1	36	17	53		1				1	5
OO - 1	1			2		1	1	1								6	282	102	384	1					1	5
OO - 9																0	342	158	500	2					2	3
PP - 7	2			3		2										7	357	180	527	1						3
PP - 7.2	1			26		2	2	1							2	34	1,446	208	1,654	32					2	6
QQ - 1				20												20	1,186	488	1,574	6						4
QQ - 7.2				8												8	2,000	98	2,098	6						4
RR - 1											1				1	2	140	17	157							4
RR - 7	1			3		1	1	1								7	280	56	336	4						6
RR - 15	1	1		1		1	1								1	6	160	32	192	2		1				5
SS - 15	1	1		5		1	1						1		1	11	197	43	231	5	1			1		4
SS - 2				1			1	2							7	11	374	25	399						2	2
SS - 9		1				1	13					1			1	17	304	69	373	3	1					6
TT - 7							20									20	1,350	393	1,743	25	1					6
UU - 14	2		1	16		2									3	24	2,870	402	3,272	41	1					8
VV - 7																9	524	46	970	5					2	3
VV - 15		1		18		4		1		2					2	28	252	109	361	6	2				5	4
TOTAL	40	9	1	148	3	62	64	13	2	20	4	9	2	1	94	472	18,129	10,078	29,549	79	9	20	1	7	44	323
Ubiquity (%)	29	11	1	26	3	45	25	13	3	7	4	4	3	1	52	.	99	97	.	28	11	10	1	6	28	.

* feature

** Needles not separated by species. These counts used in total needle count but not in total species count.

Table 4. HP 3 Floor – Plant Inventory

	SEEDS (N)															NEEDLES (N)					STEM	MISC. PLANT				CHAR[t] (g)
Provenience (sq. - subsq.)	*A. alnifolia*	*A. uva - ursi*	*Carex Sp.*	*Chenopodium sp.*	Ericaceae	Poaceae (lg)	Lilliaceae	*Opuntia sp.*	*Phacelia*	*P. menziesii*	*Rosa cf.* [illegible]	*Scirpus*	*Silene sp.*	unidentified	TOTAL	*P. menziesii*	*P. ponderosa*	*A. tridentata*	Deciduous	TOTAL	Poaceae (N)	Coniferbuds (N)	Fruitpedicel (N)	Betula bark (g	Unidentified Tissue (N)	
A - 7								1							1	0	1			1						Neg
A - 9	1														1	3	1			4						2
B - 6					1	1				2					4	45	20			65						4
E - 7														1	1	2	1			3					1	1
E - 15									1				1		2	4	3			7			1		2	1
F - 3*					1										1	66	48			114						1
F - 9										1				1	2	7	1			8						4
F - 15					4				1	1				6	12	11	6		1	18						3
G - 6			1					1						1	3	1,180	35			1,215		1			2	9
G - 9	2	1			6										9	383	67			450						5
G - 16*	4								1						5	53	4			57						20
I - 1	1														1	20	11		1	32	1				1	4
I - 15	1				1										2	18	3			21						1
J - 1	1														1	276	70			356						5
J - 15					3										3	3	1			4						1
M - 1					2										2	132	18			150			1			2
M - 15				1											1	13	4			17						3
N - 1	1	1													2	42	1			43	1					2
N - 9	1	1			6										8	22	1			23						2
O - 10	1	1		5	2	1									10	1,564	254			1,818	24			2	1	6
O - 15	2			4		2									8	1,766	194			1,910	54	1			1	5
Q - 7						1									1	276	44			320		1			2	3
U - 1				4	1	1									6	87	9			96						3
U - 7	3			14			2?		2		1			1	23	600	6			606	13				5	3
V - 6					1			2							3	306	4			310	5				6	1
V - 9					1										1	73	2			75	2				1	Neg
W - 9	2	1?		1?											4	22	5			27					1	Neg
X - 13				2	1	1								2	6	51	6	1		50	3				3	3
AA - 1	1									1					2	4				4						3
EE - 1	1														1	6				6						1
EE - 15															0	28	1			29						2
II - I		1							2					2	5	36		1		37	2			1	1	1
II - 15		1		4	1										6	100	1	5		106	3	7			1	3
MM - 1															0	95	6			101					2	2
MM - 9	1			4	8			8							18	48	19			67	2				6	4
UU - 1	4	2				2						1			9	247	18			265	4					7
VV - 3	1				5									1	7	163	12			175	1					1
WW - 1		2												1	3	45	9			54						4
TOTAL	27	11	1	36	44	9	2	12	7	5	1	1	1	16	172	7,521	835	7	2	8,644	115	11	2	3	36	122
Ubiquity(%)	45	24	3	24	42	18	3	11	13	11	3	3	3	24	.	97	92	11	5	.	34	11	5	5	42	.

* feature

Table 5. HP 12 Floor – Plant Inventory

	SEEDS (N)					NEEDLES (N)			STEM	MISC. PLANT (N)			CHAR[†] (g)
Provenience (sq. - subsq.)	*A. alnifolia*	*Chenopodium sp.*	Ericaceae	unidentified	TOTAL	*P. menziesii*	*P. ponderosa*	TOTAL	Poaceae (N)	Coniferbuds	Deciduous buds	Unidentified Tissue	
A – 2					9	142	3	145				2	8
A – 11		2			2	326	1	327					2
B – 10		1			1	105	3	108					3
B – 15					0	60	5	65	1			1	Neg [**]
C – 15	1				1	101	2	103					1
D – 7					0	5	1	6					1
D – 15			1		1	3	1	4					1
E – 7		1	1		2	189	7	196				1	4
E – 11		1			1	912	2	914	1				7
G – 1		2			2	61	3	64	2	1			1
G – 10	1				1	60	3	63					1
I – 1		2		1	3	1	0	1					1
I – 9				1	1	2,041	72	2,113			3		8
I – 15		1			1	210	4	214				8	4
J – 1					0	34	1	35					Neg
J – 15					0	89	3	92					5
TOTAL	2	10	2	2	16	4,339	111	4,450	4	1	3	12	46
Ubiquity (%)	13	44	13	13	.	100	94	.	35	6	6	25	.

[†] CHAR = grams of charcoal [**] Neg = negligable

Table 6. HP 7. Percent Wood and Charcoal Taxa from Select Rim Samples*

	Percent													
Sq.- samp #	**Pin**	**Pmen**	**Sam**	**Pop**	**Sal**	**Aln**	**Acr**	**Atri**	**?brk**	**?con**	**?dec**	**unid**	**tot dec****	**tot con****
Charcoal														
D-24	15	25	-	55	-	-	-	-	5	-	-	-	42	58
K-22	30	45	-	-	-	25	-	-	-	-	-	-	75	25
K-28	35	25	-	30	-	5	-	-	-	-	5	-	60	40
K-26	45	50	-	-	-	-	5	-	-	-	-	-	5	95
L-30	40	45	-	15	-	-	-	-	-	-	-	-	85	15
M-60	45	45	-	5	-	-	-	-	5	-	-	-	95	5
M-63	35	35	-	25	-	-	-	-	5	-	-	-	74	26
M-65	40	40	-	15	-	-	-	5	-	-	-	-	80	20
N-48	60	35	-	5	-	-	-	-	-	-	-	-	95	5
N-66	5	5	-	90	-	-	-	-	-	-	-	-	10	90
X ± sd	35 ± 16	35 ± 14	0	24 ± 29	0	3 ± 8	1 ± 2	0	2 ± 3	0	1 ± 2	0	62 ± 33	38 ± 33
Wood														
D-24	-	80	-	-	-	-	-	-	10	-	10	-	89	11
K-22	40	5	20	-	15	-	-	-	15	5	-	-	59	41
K-28***	35	20	-	-	-	-	-	-	-	5	30	10	61	39
K-26	65	10	-	10	-	-	-	-	5	5	-	5	89	11
N-48	65	5	-	-	-	15	-	-	5	-	5	5	78	22
X ± sd	41 ± 27	24 ± 32	4 ± 9	2 ± 5	3 ± 7	3 ± 7	0	0	7 ± 6	3 ± 3	9 ± 12	4 ± 4	75 ± 15	25 ± 15

* N=20 for all samples. Pin=Pinus sp.; Pmen=Psuedotsuga menziesii; Sam=Sambucus racemosa; Pop=Populus sp.; Sal=Salix sp.; Aln=Alnus sp.; Acr=Acer glabrum; Atri-Artemesia tridentata; ? brk=unidentified bark; ? dec=unidentified deciduous; ? con=unidentified conifer; ??=unidentifiable. Samples from Square M and N-66 contained charcoal, but no uncharred wood.

** Calculated using all specimens that could be placed in either the deciduous or coniferous categories.

*** Wood badly degraded and difficult to identify.

Table 7. HP 7. Percent Charcoal Species from Floor Flotation Samples

	Percent										
Sq.-subsq.	N	Pin	Pmen	Jun	Pop	Aln	Bet	?brk	?dec	tot con*	tot dec*
A-7	20	30	50	-	5	-	-	15	-	94	6
E-1	20	10	70	-	20	-	-	-	-	80	20
E-9	20	15	60	-	10	-	-	-	15	75	25
F-9	15	20	27	-	53	-	-	-	-	47	53
G-15	15	60	33	-	7	-	-	-	-	93	7
G-7	20	20	75	-	5	-	-	-	-	95	5
H-1	15	7	73	-	7	13	-	-	-	80	20
H-2	20	25	75	-	-	-	-	-	-	100	0
I-9	20	15	60	-	15	-	-	10	-	83	17
J-1	10	10	50	-	20	10	10	-	-	60	40
J-9	20	25	50	-	10	5	-	5	5	79	21
P-7	10	20	10	-	70	-	-	-	-	30	70
Q-15	10	10	80	-	-	-	-	-	10	90	10
R-15	10	-	80	-	20	-	-	-	-	80	20
V-7	10	10	60	10	10	10	-	-	-	80	20
W-11	10	10	90	-	-	-	-	-	-	100	0
X-9	10	40	50	-	10	-	-	-	-	90	10
X-8	20	30	55	-	-	-	-	-	15	85	15
Y-7	10	10	90	-	-	-	-	-	-	100	0
Z-6	10	-	40	-	60	-	-	-	-	40	60
BB-1	15	7	86	-	7	-	-	-	-	93	7
BB-15	20	30	70	-	-	-	-	-	-	100	0
BB-7	20	10	85	-	5	-	-	-	-	95	5
X ± sd	23	18 ± 14	63 ± 20	0.4 ± 2	15 ± 20	2 ± 4	0.4 ± 2	1 ± 4	2 ± 4	81 ± 19	19 ± 19

Ppon=Pinus ponderosa; Pmen=Psuedotsuga menziesii; Jun=Juniperus sp.; Pop=Populus sp.; Aln=Alnus sp.; ?brk=unidentified bark; ?dec=unidentified deciduous.

* Calculated using all specimens that could be placed in either the deciduous or coniferous categories.

as being the most important plant in the traditional culture of both groups; the Keatley Creek remains suggest that this was the case prehistorically as well.

Douglas-fir is found in a variety of contexts at Keatley Creek. It seems to have been the preferred wood for roof construction in HP 7 (Table 10), and was also a preferred construction wood in ethnographic times. Douglas-fir is an excellent fuel source for the same reasons as ponderosa pine, and is reported to be a preferred wood for pit-cooking, as well as puberty, illness, and death rituals. At Keatley Creek, it equals *Pinus* in abundance in hearth and rim samples in HP 7 (Tables 6 and 9), and exceeds pine in the floor contexts (Tables 7 and 8). The ethnographic literature documents the use of Douglas-fir boughs for bedding and floor coverings as well as in pit-cooking by the Interior Salish people. The distribution of Douglas-fir needles at Keatley Creek suggests that Douglas-fir boughs, like ponderosa pine, were placed on the floor on mats or on raised benches above floors of the pithouses.

Douglas-fir grows in the vicinity of Keatley Creek today as well as throughout the general study area. Indeed, it is the dominant tree species in the variety of biogeoclimatic zones in which in grows. Douglas-fir wood and boughs could be harvested year-round as needed.

Coniferous Buds. Several fragments of axillary buds (probably Douglas-fir) were recovered. Douglas-fir produce axillary buds in the fall; these remain on the branches all winter and then open in the spring (Allen and Owens 1972; USDA 1989). The buds in the samples are not opened, suggesting they may have been picked sometime in the fall or winter.

Monocotyledons

Cyperaceae (Sedge Family)

***Carex* sp. (Sedges).** This genus is represented by two seeds, one each from HP 7 and HP 3. Sedges grow in wet sites as well as dry, open forests within the study area. Ethnographically, only the Okanagan are reported to have used the leaves of a single *Carex* species (*C. concinnoides*) to layer between food in pit-cooking, as well as lining or covering berry baskets. The mature stems of *Carex* were harvested ethnographically in the late summer; the presence of *Carex* seeds in the archaeobotanical assemblage supports the notion of late summer or fall harvesting.

***Scirpus* sp. (Tule).** This genus is represented by one seed from the floor of HP 7, and one from HP 3. Two species of Scirpus, *S. lacustris* and *S. microcarpus* grow in the

Table 8. HP 3. Percent Charcoal Species from Selected Floor Flotation Samples

	Percent							
Sq.-subsq.	N	Pin	Pmen	Pop	Decid	Unid. bark	Unid. Conif*	Decid*
A-9	15		80	14	-	6	86	14
B-6	15	28	66	6	-	-	94	6
E-7	15	66	14	14	6	-	80	20
F-9	15	14	80	6	-	-	94	6
G-6	20	10	75	10	-	5	89	11
I-15	15	-	74	20	6	-	73	27
J-1	15	30	46	28	-	6	71	29
AA-1	15	6	74	14	-	-	80	20
EE-15	15	20	54	20	6	-	73	27
X ± sd	9	19 ± 21	63 ± 22	15 ± 7	3 ± 3	2 ± 3	82 ± 9	18 ± 9

Pin=*Pinus* sp.; Pmen=*Psuedotsuga menziesii*; Pop=*Populus*; Unid Dec=Unidentified deciduous; Unid Con=Unidentified conifer; Tot Conif = Total % Conifer; Tot Decid=Total % Deciduous

*Calculated using all specimens which could be placed in either the deciduous or coniferous category.

Table 9. Percent Charcoal Species from Hearth Flotation Samples from Three Housepits

	Percent							
Sq.-subsq.	N	Size	Pin	Pmen	Pop	Bet	Tot Con	Tot Dec
HP 7								
B-?	15	93	7	-	-	-	100	0
F-9	15	14	46	33	-	7	65	35
G-15	15	33	60	7	-	-	93	7
P-14	15	14	33	53	-	-	47	53
Q-7	10	100	-	-	-	-	100	0
Q-7	15	7	60	20	13	-	67	33
Z-9	15	20	46	34	-	-	66	34
BB-13	15	33	60	7	-	-	93	7
X ± sd	8	39 ± 36	39 ± 24	19 ± 19	2 ± 5	1 ± 3	79 ± 20	21 ± 20
HP 3								
G-16	20	10	85	5	-	-	5	95
HP 12								
I-9	15	40	60	-	-	-	0	100

Interior Plateau. Both are common in wet lands. Tule leaves were used for structural and technological purposes, particularly making mats. Like *Carex*, tule was likely harvested in the late summer.

Miscellaneous Unidentified. One seed tentatively assigned to this family was recovered from the roof deposits of HP 7.

Lillaeace (Lily Family)

***Smilacina stellata* (Star-flowered Solomon's-seal).** Two charred star-flowered Solomon's-seal seeds were recovered from the floor of HP 7. This species grows in the more mesic portion of the Interior Douglas-fir Zone. According to ethnographic information, ripe Solomon's-seal berries were eaten raw by several Interior groups, but not by the Fraser River Lillooet. Their presence in the Keatley Creek archaeobotanical assemblage may indicate a shift in food habits from prehistoric to ethnographic times. The berries ripen in late summer.

Miscellaneous Unidentified. A few miscellaneous seeds which may belong to this family were recovered from HP's 7 and 3.

Poaceae (Grass Family)

Miscellaneous Unidentified. Charred grass seeds from two species were recovered from several samples in both pithouses. I have thus far been unable to identify them to species (both are festucoids; Reeder 1957). One is large (3.5 mm × 1.0 mm) and likely originates from one of the larger grasses, perhaps *Elymus cinereus* (rye grass). The second is much smaller (1.0–1.5 × 0.5 mm). The large seeded species is both more abundant and more ubiquitous than the small species.

Charred fragments of grass stems are abundant in several samples from a variety of deposits in HP's 7 and 3. Because of the absence of diagnostic characteristics, the grass stems cannot be identified further. Grass stems were used by Interior Indians for a variety of technological purposes, such as basketry and weaving, lining of caches and steaming pits, and as bedding. Teit (1909:688) notes that meat was wrapped in grass before storing in the winter house.

The abundance of grass seeds and stems in the deposits corroborates the findings of the microfabric analysis, which revealed many grass phytoliths (Vol. I, Chap. 7). Most grasses go to seed in late summer.

Dicotyledons

Aceraceae (Maple Family)

***Acer* sp. (Maple).** This taxon (probably *Acer glabrum*) is represented by one charcoal specimen from the rim of HP 7. Maples are relatively common in the wetter areas of the interior Douglas-fir zone, usually in open areas, and are found at Keatley Creek today. Ethnographically, the tree was considered both an excellent source of wood for fuel and for various technological purposes, but it does not seem to have been preferred at Keatley Creek. The fibrous bark of Rocky Mountain maple was used to make soapberry whippers. The wood could be collected year-round; the bark was probably collected in the spring months.

Asteraceae (Aster Family)

***Artemisia tridentata* (Big Sagebrush).** One charred leaf and one charcoal fragment represents this taxon. Ethnographically, the shredded inner bark of sagebrush served many technological purposes (e.g., weaving clothing, tinder), and the wood was used as a fuel for cooking (Turner 1979:182) and smoking hides.

Today, sagebrush is a common plant throughout the dry Interior, as it is at Keatley Creek. Its relative absence in the Keatley assemblage is striking. The distribution of this shrub may have been somewhat more restricted prior to heavy grazing by cattle in historic times (see "Paleoenvironmental Reconstruction," below; also compare Turner 1992). Its relative absence in the Keatley Creek assemblages compared to pine, Douglas-fir, and *Populus* suggests that either it was less common around the habitation area than today, and/or it was not a preferred fuel wood. Sagebrush could be collected all year.

Miscellaneous Unidentified. One charred seed from this family was recovered from the roof deposit of HP 7. It may come from *Balsamorhiza sagittata*, the seeds of which were eaten ethnographically by the Nlaka'pmx and Okanagan.

Betulaceae (Birch Family)

***Alnus* sp. (Alder).** Alder (probably *A. sinuata*) is represented by occasional specimens of charcoal and uncharred wood from HP 7. Alders are found throughout the Plateau in cool, moist areas. Although they are not present in the gully at Keatley Creek today, this is the type of habitat in which they grow. As a hardwood, it provides relatively high heat when burned. Ethnographically, alder bark was used for dyeing and tanning.

***Betula papyrifera* (Paper Birch).** Paper birch is represented in the assemblage by two pieces of charcoal and numerous pieces of uncharred and charred bark "rolls." Paper birch was highly valued by the Interior Salish for its bark which was peeled off the tree. The bark was used for a variety of technological purposes, primarily for making containers of many types and for lining caches. Its wood was considered a general fuel by Interior groups, and was also used to construct various implements. The ability of birch bark to preserve uncharred is likely to due its high resin content.

Birch grows throughout the Interior in moist, open areas, and is found at Keatley Creek today. The relative absence of paper birch wood at the site, compared to the bark, suggests that the tree may not have grown in the immediate vicinity prehistorically, and only the easier to transport bark was regularly brought back to the site from elsewhere. Of course, the wood of birch may just not have been used. Birch bark could be collected throughout the year, but was primarily gathered in the late spring and early summer months. One uncharred (probably modern) seed from *Betula* was recovered from the rim of HP 7.

Boraginaceae (Borage Family)

***Amsinckia menziesii* (Small-flowered Fiddleneck).** Several uncharred seeds of this species were recovered from the rim of HP 7. *Amsinckia* grows infrequently at low to mid elevations in moist to dry disturbed sites; it was likely part of the flora growing in the vicinity of the Keatley village. No ethnobotanical uses have been recorded for this plant.

***Lithospermum* sp. (Stoneseed).** Several uncharred specimens from three rim samples represent this species; stoneseeds are never found charred at Keatley Creek. The archaeological context of these seeds is questionable. *Lithospermum ruderale* grows in abundance on the dry open areas surrounding the site today.

Its seed (actually a nutlet) is very hard and durable, and it is possible that it would be preserved uncharred in an archaeological context. In fact, *Lithospermum* seeds have been found in hearths and burials excavated in other Interior sites (Smith 1899; Stryd 1973). However, during the Keatley Creek excavations I noted that they are often found in rodent dens. Only the roots of this taxon are reported to have had ethnobotanical significance as both a food and dye. Until charred specimens of these seeds are found, or they are recovered in a context with no rodent disturbance, their prehistoric significance will remain in question.

Cactaceae (Cactus Family)

***Opuntia* sp. (Prickly Pear).** Several uncharred and a few charred seeds of the prickly pear cactus were recovered from both pithouses. Prickly pear cacti grow throughout the Interior in dry, open areas. *Opuntia fragilis* and *O. polyacantha* grow at Keatley Creek today. Prickly pear fruits were only occasionally eaten by the Interior Salish, the stem segments being much preferred. The fruits are small, whereas the stems were easier to harvest, and a more abundant resource. The seeds of the fruit may have been incorporated into the archaeological record attached to the stems, or the presence of the charred seeds may indicate that the fruits were eaten more frequently in the past. The fruits would have been available for harvesting in the summer and into the winter. All the uncharred *Opuntia* seeds which were recovered in the flotation samples had been partially eaten by rodents. Had some not been found charred, and in several secure contexts (i.e., non rim deposits), their prehistoric use would remain in question. Whether the uncharred seeds in the rims are in their primary context remains unclear (see discussion of rims, below).

Caprifoliaceae (Honeysuckle Family)

***Sambucus* cf. *cerulea* (Elderberry).** One charred seed belonging to this taxon was recovered from the rim of HP 7. The Interior Salish collected elderberries in the late summer and ate them fresh or dried them for winter use. *S. cerulea* grows throughout the Interior in valley bottoms and on open, dry slopes.

Miscellaneous Unidentified. Two charred seeds tentatively assigned to this family were recovered from the rim deposits of HP 7.

Caryophyllaceae (Pink Family)

***Silene* sp.** One charred, partially complete seed from this herbaceous taxon was recovered. At least one species (*S. noctiflora*) of this genus may have been used as a charm in ethnographic times. That particular species is a widespread weed in disturbed habitats. To what species this particular seed belongs cannot be determined with such a small sample.

Chenopodiaceae (Goosefoot Family)

***Chenopodium album* and *Chenopodium* sp. (Lamb's Quarters).** This weedy, herbaceous genus is represented by many uncharred seeds from almost every analysed sample. I have identified the uncharred specimens as *C. album*, an introduced species. The *C. album* seeds generally measure to approximately 1.0 mm^2, (they can be as small as 0.5 mm^2). An intact endosperm inside several of the seeds indicates that those specimens are modern.

Far fewer charred specimens were recovered. The charred specimens have not been identified to species because the charring has somewhat altered their morphology. The seeds are usually smaller than the uncharred *C. album* (approximately 0.5 mm^2), although the size of the charred seeds does fall within the range of *C. album*. The smaller, charred seeds likely belong to one of the several native varieties of *Chenopodium* which grow in the Interior.

How the native chenopod seeds became introduced into the archaeological record remains a bit of a mystery. The young leaves of *C. album* were boiled and eaten in historic times, and it is possible that the native varieties were used similarly prehistorically. In this scenario, the seeds would have been introduced attached to the stems with the edible leaves. However, *C. album* leaves are most palatable in the spring, before going to seed, and thus would be invisible archaeobotanically. A more likely scenario is that the chenopod plants were harvested accidentally in the fall along with other deliberately collected resources, such as grasses. Finally, given the ubiquitous nature of this weedy species, and the ability of each individual plant to produce abundant seeds, it is also possible that the seeds were accidentally introduced into the deposits (see discussion of rim and floor formation processes, below).

Cornaceae (Dogwood Family)

***Cornus stolonifera* (Red-Osier Dogwood).** A few uncharred and charred seeds from this taxon were recovered from HP 7. Ethnographically, the berries of *C. sericea* were gathered by the Interior Salish in mid-summer. The berries were eaten fresh, and the pits may have also been a snack; the berries were also sometimes dried for later use. Red-osier dogwoods grow throughout the Interior in the moister areas of the Douglas-fir zone, as well as other biogeoclimatic zones in the study area.

Ericaceae (Heather Family)

Arctostaphylos uva-ursi **(Kinnikinnick).** Kinnikinnick seeds were recovered from several samples in both HP's 7 and 3, and are especially ubiquitous in HP 7. They are mostly found uncharred, but charred specimens were recovered as well. This low, trailing shrub is a common plant throughout the dry slopes of the Plateau, although it does not presently grow at Keatley Creek. The berries were eaten raw or fried by many Interior people and could be harvested from late summer to well into the winter if the snow cover was not too extensive. Kinnikinnick seeds have been recovered from burial sites in the Interior (Smith 1900), and were important in rituals of death and bereavement (Teit 1900). The leaves were also smoked, and the berries may have entered the pithouse attached to the branches. The leaves could have been gathered year-round.

Unidentified Miscellaneous. Uncharred and charred seeds from an unidentified taxon from the Ericaceae family are among the most abundant and ubiquitous of the seeds recovered at the three housepits. They are small seeds (roughly 1.0 mm × 0.5 mm × 0.5 mm). A single specimen which was found with all the seeds still in their original position suggests that they come from a small fruit (approx. 1.0 mm^3). These seeds are often found when no other botanical remains (i.e., except needles and charcoal) were recovered. Its ubiquitous presence in several contexts at this site and other Interior sites (Lepofsky 1987) suggests that it was probably both used extensively in the past, and was a common enough plant to be introduced accidentally into archaeological contexts. The ethnographic literature offers no definite leads; it may be a plant for which there is no recorded ethnobotanical information.

Grossulariaceae (Gooseberry Family)

Ribes **sp. (Gooseberry).** Charred seeds of a small seeded gooseberry were recovered from the roof of HP 7. Several species of gooseberry grow throughout the more open areas of the Douglas-fir Zone. Gooseberry fruits ripen in mid summer; all species of gooseberry were eaten by the Interior Indians, though some were preferred more than others. The fruits of the preferred species were dried for later use.

Hydrophyllaceae (Waterleaf Family)

Phacelia **sp.** A few charred seeds from this taxon were recovered from HP's 3 and 7. This may be *P. linearis*, but positive identification has not yet been made. Both *P. linearis* and *P. hastata* are found throughout the Interior Plateau, in dry open sites. Steadman (1930, cited in Turner et al. 1990) reports that *Phacelia* had medicinal value in historic times.

Polygonaceae (Buckwheat Family)

Miscellaneous Unidentified. One uncharred fragment of a seed belonging to this family, and one charred fragment tentatively assigned to this family, was recovered from the rim of HP 7.

Rosaceae (Rose Family)

Amelanchier alnifolia **(Saskatoon).** Seeds of the saskatoon are among the most common and ubiquitous of the paleoethnobotanical remains at Keatley Creek. They are found charred and uncharred in a variety of contexts. They range in size considerably (from ca. 0.5 mm to 2.5 mm), and probably represent different varieties. Saskatoons were among the most highly valued fruit of the Fraser River people (Turner 1992). Saskatoons were gathered from mid to late summer depending on the locality and variety, and were eaten fresh or dried for later use. A mixture of dried saskatoons and dried salmon was a prefered winter food (Sam Mitchell in Romanoff 1992:237). Saskatoons are the most consistently abundant, from year to year, of all the berries eaten. The shrub is common in the Interior, growing on dry open hillsides and woods, especially in old burn sites. In fact, it is possible that areas were regularly burned to maintain its abundance (Turner 1992:413). It does not grow in the immediate vicinity of the Keatley Site today.

Prunus **sp. (Cherry).** A few charred and uncharred seeds from this taxon were recovered from the rim and floor of HP 7. Three cherry species grow in the southern Interior today: *P. virginiana*, *P. emarginata*, and *P. pensylvanica*. The fruits of all three species were eaten by Interior Plateau peoples, but only *P. virginiana* was gathered in abundance and either eaten fresh or dried for later use.

Rosa **cf. *woodsii*** **(Wood Rose).** This taxon is represented by charred and uncharred seeds from HP's 3 and 7. The fruits of all the rose species were eaten sparingly by the Interior Salish. They ripen in the late summer, but can be harvested through the winter because they remain on the bushes. They were sometimes dried. *Rosa* grow in the moister areas of the Interior Douglas-fir forests, as well as the Interior Subalpine and Ponderosa Pine Biogeoclimatic Zones.

Salicaeae (Willow Family)

Populus **sp. (Aspens/Cottonwoods).** Aspen/cottonwoods are represented at Keatley Creek by an abundance of charcoal from all pithouses. After Douglas-fir and pine charcoal, it is the most commonly represented charcoal category at the site. It was used

Table 10. Identified Beams, Planks, and Posts from Three Housepits

Sq.-subsq.	Total N	Pin	Pmen	Pop
HP 7				
Roof beams	12	1	8	3
Floor posts	4	2	2	0
HP 3				
Floor planks	6	1	0	5
Floor posts	2	0	0	2
HP 12				
Roof beams	4	3	1	0

in roof construction at HP 7, and for posts and a bench plank in HP 3 (Table 10). *Populus* sp. are generally found along watercourses or moist areas throughout the Interior. Today both *P. balsamifera* and *tremuloides* are common around Keatley Creek itself. *Populus* is a good self-pruner. *P. balsamifera* is reported to have been valued in historic times by the Lil'wet'ul both to smoke fish and for fuel. *P. balsamifera* was also used for making dugout canoes and rafts, and the bark and branches served a variety of technological purposes.

***Salix* sp. (Willows).** Willows are rare in the assemblage, and are only represented by uncharred wood fragments from the rim. It is never found as charcoal. It may not have been highly valued for fuel, as it is a poor self-pruner, and is difficult to collect. Ethnographically, the willow branches were used for various technological purposes such as making fishing weirs and basket traps. It could have been collected year-round.

Scropulariaceae (Figwort Family)

***Collinsia parviflora* (Small-flowered Blue-eyed Mary).** One charred seed of this species was recovered from the rim of HP 7. *Collinsia* grows throughout the Plateau in ponderosa pine and Douglas-fir forests and in grasslands. No ethnobotanical uses have been recorded for this species.

Other Unidentified Plant Remains

Outer Tissues. This miscellaneous category includes both woody and soft outer tissues. Many different taxa are represented in these general groupings, probably from several different plant parts (i.e., fruit "skins," root/bulb outer skins, bark). No doubt there is much information on prehistoric plant use to be learned from these specimens. However, their identification to taxa is dependent on acquiring a larger sample size, assembling a more complete comparative collection, and examination with special microscopy techniques (i.e., SEM; cf. Hather 1991).

Unidentified Fruit, Bud, and Fruit Pedicel. These are other miscellaneous categories into which several unidentified taxa have been placed.

Unidentified Plant Material. This category includes botanical specimens which could not be identified taxonomically or anatomically. Usually the specimen is too small or decayed for identification.

Formation Processes

Source and Preservation

Determining the source of remains is a basic consideration in any discussion of formation processes. For botanical remains, of interest is both how remains entered the site as well as how they came to be preserved in the archaeobotanical record (Pearsall 1988). The following section outlines the source and context of preservation of the plant remains recovered in the Keatley deposits. This information is a critical component of the subsequent discussion of the formation history of the roof, rim, and floor deposits.

Source of Archaeobotanical Remains

The plant remains recovered from the three housepits can be grouped into four categories: charcoal and wood (including bark), needles and grass, seeds, and birch bark. The first three categories are composed of taxa which potentially originate from several different sources. Below, I outline the potential sources of each of these categories; the possible sources of individual identified seed taxa are presented in Table 11. The following analyses of the formation histories of the roof, rim, and floor focus only on charcoal, needles, and seeds. Birch bark remains were not recovered in sufficient quantities from flotation samples to include in the analyses.

Charcoal and Wood

1) Collected for fuel or as fire starter.
2) Collected for tools.
3) Used in pithouse construction.

Needles and Grass stems

1) Collected for mats, bedding, pit liners, or roofing material.
2) Collected for fire starter.
3) Accidentally introduced by humans.
4) Introduced by rodents.

Seeds

1) Gathered for the edible fruit.
2) Gathered as non-food item (medicinal, ritual).

3) Gathered incidentally with plant parts deliberately gathered for food.
4) Gathered incidentally with plant parts deliberately gathered for non-food purposes (e.g., roofing material).
5) Accidentally introduced by humans.
6) Introduced by rodents.

Birch Bark

1) Collected with birch wood for fuel.
2) Collected as fire starter.
3) Collected for artifact construction, pit liner, or for roof construction.

Preservation of Plant Remains

There are several processes through which the archaeobotanical remains came to be preserved in the pithouses. Given the preservation conditions in the floor and roof, only charred remains are considered to be prehistoric in these deposits. The exception to this is birch bark "rolls" which are found uncharred throughout the deposits (see Plant Inventory). The high resin content in the birch bark probably makes it more resistant to decay than other plant materials.

Charred plant remains may have entered the record in one of several ways. Some remains became charred during the occupation of the pithouses via accidental or purposeful charring in one the floor hearths. In addition, plants were charred after abandonment, when the entire structure burned. The burning of the structure likely preserved plants which were introduced to the record both during and after pithouse occupation. An important question about site formation processes involves distinguishing between these two scenarios.

Unusually dry conditions in the rim deposits promotes the preservation of uncharred as well as charred plant remains. Distinguishing the source of uncharred remains in the dry rim deposits is somewhat problematical since these remains may have been introduced to the rims during pithouse occupation (purposefully or accidentally), or they may be considerably more recent introductions (via rodents). Identifying the source of the uncharred specimens is an important component in understanding the formation history of the rim deposits.

How the Roof Deposits were Formed

Despite the small number of flotation samples from HP 7 roof deposit (N=10; Table 1), the archaeobotanical analysis does offer some insights into roof formation processes. A non-random distribution of remains across the roof is suggested in Figure 1. There appears to be a trend towards a concentration of remains along the periphery of the structure, but confirmation of this requires more extensive sampling. More certain is the fact that there is a general correlation in density of remains across the three categories.

An examination of the range of taxa comprising the roof assemblage suggests the remains originate from plants collected for food (Table 11) and for roof construction. There are three possible sources of the plant food remains on the roof: 1) they are the remains of food processing on the roof itself; 2) they are the remains which originated from processing which took place inside the house or elsewhere, and then were later dumped onto the roof in a cleaning event; or 3) they are the remains of food that was originally stored in the rafters of the house and became incorporated in the roof deposit when the roof collapsed.

Table 11. Potential Sources of Seed Taxa Recovered from the Keatley Creek Housepits[1]

1. Collected for edible fruit
Amelanchier alnifolia
Arctostaphylos uva-ursi
Cornus stolonifera
Ericaceae
Prunus sp.
Ribes sp.
Rosa cf. woodsii
Sambucus cerulea
Smilacina stellata

2. Collected as non-food item
Silene sp.

3. Collected incidentally with food
Chenopodium sp.?[2]
Opuntia sp.

4. Collected incidentally with non-food item
Pinus sp.
Psuedotsuga menziesii
Poaceae
Carex/Scirpus sp.
Chenopodium sp.
Silene sp.
Arctostaphylos uva-ursi
Phacelia sp.

5. Unknown source
Amsinckia menziesii
Collinsia parviflora
Lithospermum ruderale

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1. Categories of potential sources correspond to those outlined in Table 3 for sources of seeds. Since any taxon can be introduced accidentally by humans or by rodents, these potential sources have been excluded from the table. Taxa identified to family level which contain a wide variety of species (e.g., Caprifoliaceae, Compositae, Polygonaceae) are not included in the table.
2. The leaves of chenopods were eaten by Europeans in the early contact era, and it possible that they were eaten in prehistoric times as well. Chenopod seeds may have entered the archaeological record attached to plants collected for their edible leaves. However, the leaves were eaten in the spring when they were tender; seeds are not produced until mid to late summer.

Though the archaeobotanical data do not allow further evaluation of the three alternative scenarios, other independent data provide some insights into the formation of the roof deposits. Concerning the first scenario, the absence of features on the roof of HP 7 argues against food plants being processed on the roof itself. The second scenario, that the remains originate from elsewhere and then were dumped on the roof, is supported by the fact that the eastern side of the roof was used as a discard area for fauna and FCR. We have no way of independently evaluating the third scenario.

If, in fact, the plant food remains originate from elsewhere, the floor is a likely source of those remains. To explore this possibility, I compared the density and diversity of remains on the roof to that of the floor. If the floor is indeed the orginal source of the plant remains, the density and diversity of remains in the roof should be higher than on the floor. The reasoning for this is that if the debris from multiple activities was regularly cleaned from the floor and then deposited on the roof, over time the roof should display a greater density and diversity of remains than the floor. However, when the density of remains on the roof and the floor are compared, they can not be distinguished statistically (Table 12). In terms of diversity, more taxa are recovered from the floor deposit than the roof (Tables 1 and 3), but this may be a factor of sample size. Taken together, these analyses lend no support for the hypothesis that the floor was a source of the roof remains.[1]

Of the non-food plants, the abundance of chenopods and grasses recovered from the roof requires explanation (Table 1). Two possible explanations emerge. In the first scenario, the seeds were introduced accidentally when the roof was being constructed. The grass seeds may have been collected incidentally with grass stems that were collected for roofing material, and the chenopods may have also been gathered accidentally with the grasses (Table 11). In fact, the editor of this volume has observed hundreds of chenopod seeds among the grasses he has collected from his own garden.

An alternative explanation for the presence of the chenopods and grasses is that they were not collected, but were growing naturally on the roof and perimeter of the structure. Pollen analysis from the Keatley and Bridge River sites does indicate that both grasses and chenopods grew in abundance at the site (see Vol. I, Chap. 4). At this time, we have no way of evaluating further these two alternate scenarios.

Post-occupation formation processes, specifically the burning of the structure after abandonment, was clearly a major factor influencing the patterning of plant remains on the roof. In the case of the chenopods and grasses, regardless of how they were introduced into the roof deposit, they became preserved in the archaeobotanical record when the roof burned. The charring of remains during the burning of the structure also accounts for the preservation of the wood (as charcoal) and the needles recovered in the roof deposit.

The post-occupation burning of HP 7 may also explain the relatively low abundance of remains overall across the roof. Given that pithouse roofs were constructed of a superstructure of wooden beams with a covering of needles, boughs, and possibly grasses, a considerable amount of charred wood, needles, and grasses should be distributed throughout the roof deposit. Yet the abundance of these remains on the roof is quite low (Table 1). In fact, a statistical comparison of abundance of charcoal and needles in the roof relative to the floor and rim deposits indicates that the roof and floor have a similar abundance of remains, while the rim has a far greater abundance of both charcoal and needles (Table 12).

Again, I can think of two alternate scenarios which may explain the low overall abundance of plant remains recovered from the roof deposit. A possible explanation for the low abundance of structural remains is that wood was salvaged from the roof prior to the burning of the structure. However, this does not explain the relatively low abundance of other roofing materials, such as needles and grasses. An alternative explanation for the low abundance of all roof material is that the house fire was of sufficient intensity to burn much of the remains completely to ash.

How the Rim Deposits were Formed

The rims are by far the most complex of the pithouse deposits. Unlike the more internally homogenous roof and floor deposits, portions of the rims are composed of layers and lenses, which are in turn comprised of both charred and uncharred plant remains. Determining the source of these sediments is fundamental to an understanding of the formation history of the rim.

The complexity of the rim deposits is reflected in the multiple components of the analysis of rim formation processes. The following questions are explored in turn, below: 1) what are the effects of

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[1] In the first field season I analyzed 27 samples from secure roof and floor deposits from four pithouses (HP's 1, 3, 4, 7) in an attempt to identify criteria for distinguishing between roof and the floor deposits. I examined number and kind of floral remains and degree of rounding of charcoal fragments, but found no statistical differences between the deposits (Lepofsky 1986). With a larger sample from the roof, differences between the taxa represented in the two deposits may have emerged.

Table 12. Comparisons of Average Density of Remains in Roof, Floor, and Rim Deposits in HP 7*

		N	*X*	sd
Roof vs Floor				
charred wood (g)	$p = 0.11$			
	roof	10	7.9	6.5
	floor	65	4.7	4.3
charred needles (N)	$p = 0.87$			
	roof	10	307.2	461.5
	floor	65	444.7	971.8
charred seeds (N)	$p = 0.772$			
	roof	10	11.3	19.6
	floor	65	6.8	9.1
Roof vs Rim				
charred wood (g)	$p = 0.001$			
	roof	10	7.9	6.5
	rim	19	21.8	10.1
charred needles (N)	$p < 0.0001$			
	roof	10	307.2	461.5
	rim	19	4915.8	4460.0
charred seeds (N)	$p = 0.128$			
	roof	10	11.3	19.6
	rim	19	21.8	10.1
Rim vs Floor				
charred wood (N)	$p < 0.0001$			
	rim	19	13.8	13.1
	floor	65	4.7	4.3
charred needles (N)	$p < 0.0001$			
	rim	19	4915.8	4460.0
	floor	65	444.7	971.8
charred seeds (N)	$p = 0.04$			
	rim	19	13.8	13.1
	floor	65	6.8	9.1

* Comparisons of roof vs. floor and roof vs rim are Mann Whitney U tests; rim vs floor comparisions are t-tests. All tests are calculated on abundance per 1 liter flotation sample.

bioturbation; 2) is the uppermost layer of the rim (layer XIIIA) redeposited sediment derived from the roof; 3) are there differences in composition of the layers within the rim; and 4) is the rim a disposal area for refuse from the pithouse.

Bioturbation in the Rims

There are several indications that the rim deposits have been disturbed to some degree by rodents or other biological agents. Although internal stratigraphy was observed in some portions of the rim, other portions of the deposit are internally homogenous. The rarity of discrete lens of either burned or unburned remains suggests that some of the deposit has experienced some mixing. Bioturbation, possibly combined with trampling of deposits by walking on the rim surface, may in part be responsible for the mixed matrix.

More definitive evidence of rodent activity in the rims is provided by the many uncharred seeds which have been gnawed (e.g., all the uncharred *Opuntia* seeds have been partially eaten), and the higher concentration of rodent coprolites in the rims relative to other contexts. Given that uncharred plant remains are potential food sources for rodents, it is important to distinguish those remains which may have been introduced to the deposits by rodents (either during or after occupation) and those which were deposited as part of a cultural event.

To examine the relationship between rodent disturbance and the uncharred remains, I compared the abundance of coprolites and uncharred seeds. Assuming that the rodent coprolites are a measure of rodent activity, we would expect a positive relationship to exist between the coprolites and the uncharred seeds if the uncharred seeds were introduced by rodents. The absence of such a relationship would suggest that the source of the uncharred remains cannot be attributed solely to rodents.

A comparison between the two categories of remains indicates that the relationship between uncharred remains and rodent coprolites is not straightforward. There is no statistical relationship between the number of rodent coprolites and all uncharred seeds in the rim samples (r^2=0.004), nor are there significant relationships between coprolites and the most abundant uncharred seed taxa (*Amelanchier* r^2=0.16; *Arctostaphylos* r^2=0.001; *Opuntia* r^2=0.000; *Chenopodium album*; r^2=0.004).

It may be that coprolites are not a sufficient measure of rodent disturbance in the rim deposits. However, until a better measure is devised, I will assume that the uncharred remains which are not obviously modern (i.e., have an intact embryo or are an introduced species [e.g., *C. album*]) are part of the initial cultural depositional event.

Relationship of Upper Rim Layers to Roof Deposits

A working hypothesis during excavation of the Keatley Creek pithouses was that the uppermost level of the rims (level XIIIA in HP 7, see Vol. III, Chap. 6) is redeposited roof material from prior rebuilding events (Hayden 1987). This hypothesis resulted from the field observations that level XIIIA had a similar appearance to the roof deposits, and contrasted with the other rim deposits both in color and apparent composition.

To test the notion that level XIIIA of the rim originates from the roof, I compared the density and diversity of botanical remains in the two deposits. Since there is no evidence to suggest that the two deposits underwent different post-depostional processes, I assumed that any differences observed reflected the original composition of the deposit. Thus, similar density and diversity of floral remains in the roof and upper rim deposits would support the hypothesis that rim XIIIA sediments originated in the roof. Furthermore, differences in density and diversity between the upper rim stratum and the other rim strata are expected if rim XIIIA has a unique history from that of the rest of the rim deposit.

A comparison of remains indicates that XIIIA rim and the roof generally differ in density, but not diversity of charred botanical remains. Statistically, more charcoal and charred needles were recovered from the rim XIIIA samples than from the roof, but the abundance of seeds in the two samples are similar (Table 13). The two deposits cannot be distinguished in terms of diversity of taxa, based on the average number of taxa per flotation sample (Mann Whitney U test, $p=0.27$, roof $X=3.8 \pm 3.9$, N=10; XIIIA $X=6.7 \pm 7.7$, N=6).

Rim XIIIA also differs from the rest of the rim deposit in density of remains. With the exception of seeds, the rim XIIIC samples have more remains on average than the uppermost rim level (Table 13). However, the two rim deposits cannot be distinguished based on average diversity of seed taxa (Mann Whitney U test, $p=0.772$, XIIIC $X=4.3 \pm 2.2$, N=7).

The results of the analyses do not clearly support or negate the hypothesis about the origin of the upper rim material. That rim XIIIA and the roof differ in density or remains suggests that Stratum XIIIA did not originate solely from the roof. However, a more complex formation history of XIIIA which involved a mixing of sediments both from the roof and other sources (such as organic rich lenses from the rim) still remains a possibility. The differences in density of charred remains between the upper rim and the rest of the rim deposit do suggest that rim XIIIA may have a unique depositional history, but what that is cannot be determined with the given sample.

The greatest deterrent to deciphering the origin of the rim deposits is the small sample size available. The large standard deviations in abundances within the levels of the rim (Table 13) reflect a great amount of internal diversity within the strata. It is likely that we have not adequately sampled the internal variation of this complex strata, and our comparison may be premature. Larger samples composed either of sediment originating from only one lens, or several large pinch samples from throughout the entire stratum would be more representative of the internal variation. A detailed study of the formation processes involved in rim formation would be an undertaking of major proportions.

Table 13. Comparisons of Average Density of Remains in Rim and Roof Deposits in HP 7*

		N	X	sd
Roof XIIIA vs Roof V				
charred wood (g)	$p = 0.04$			
	rim a	7	17.3	4.8
	roof	9	9.2	6.1
charred needles (N)	$p = 0.04$			
	rim a	7	3141.0	1992.0
	roof	9	518.0	804.0
charred seeds (N)	$p = 0.75$			
	rim a	7	17.0	16.0
	roof	9	17.0	21.0
Rim XIIIA vs Rim XIIIC				
charred wood (g)	$p = 0.07$			
	rim a	7	17.3	4.8
	rim c	7	28.9	12.8
uncharred wood (g)	$p = 0.03$			
	rim a	7	1.4	2.8
	rim c	7	13.8	15.2
charred needles (N)	$p = 0.02$			
	rim a	7	3212.7	2088.8
	rim c	7	8716.9	5109.2
uncharred needles (N)	$p = 0.05$			
	rim a	7	509.6	952.9
	rim c	7	11187.0	11845.0
charred seeds (N)	$p = 0.95$			
	rim a	7	17	16
	rim c	7	15	14
uncharred seeds (N)	$p = 0.04$			
	rim a	7	142	182
	rim c	7	864	850

* All tests are Mann Whitney U tests, calculated on abundance of remains per 1 liter flotation sample.

Variation within the Rim Deposit

As discussed above, inadequate sampling prohibits a detailed statistical comparison of the variation in rim layers. However, qualitative differences between the strata can reveal some aspects of interest about the formation history of the rim deposits. For instance, in contrast to other rim contexts, uncharred wood is completely absent from samples from Square M, from Strata XIIID, and is largely absent from samples from Strata XIIIA (see Vol. III, Chap. 6). Uncharred needles are also rare or absent in these strata.

The relative absence of uncharred material in these deposits is likely due to differential preservation across the rim. Uncharred remains are less likely to survive in the bottom of the rim (XIIID) where water can collect at the interface between the rim and the more compact sterile layer underneath. Furthermore, when the initial rim deposits were laid down, the surrounding matrix may not have been suitable for preservation of uncharred remains (i.e., the soil may have been too basic or too moist). In essence, the buildup of the first strata of remains (XIIID) was probably needed to gradually change the conditions of the matrix to encourage preservation of other uncharred remains. This is analogous to the formation of shell middens in coastal sites where shells have deteriorated in the initial deposits but are better preserved as the midden accumulates.

Similarly, uncharred remains are less likely to be preserved in the uppermost stratum of the rim (XIIIA) because the deposit was apparently churned repeatedly and is subject to more moisture than the lower deposits. A similar reason may apply to the sample at the northern periphery of the rim (Square M). The rim deposits are thinner along the structure's edge, and more of the remains are subject to degradation either from surface moisture or moisture collected at the bottom of the rim.

The nature of the matrix provides another difference between rim samples. In most rim samples the matrix is composed of an extremely fine, loose sediment. By contrast, sediment is more consolidated in samples K/b-22 from Stratum XIII and K/c-26 from Stratum XIII. In addition, horizontal bands of decayed plant material were noted during excavation (Vol. III, Chap. 6). The plant material is too decayed for identification, but appears to be composed of several species with both woody and non-woody materials.

The Rims as a Disposal Area for Refuse from the Pithouse

The presence of discrete lenses in some parts of the rims, as well as the overall thickness of the deposit, suggests that the rims were formed by multiple dumping events. One possible source of the sediments may be refuse from activities which were conducted on the pithouse floor and then later redeposited on the rims when the floor was cleaned. If the floor was the source of the rim sediments, there should be a higher density of remains in the rims than on the floor of the housepit. Diversity in the rims may also be higher, but since density and diversity are correlated in the pithouse floor deposits (Vol. II, Chap. 4, Fig. 5), diversity would not be a useful measure of the source of the material.

A comparison of density of charred remains in the two deposits indicate a higher density of all categories of plant remains in the rim than the floor (Table 12). The rims are also more diverse than the floor, as indicated by the average number of seed taxa per flotation sample (t-test, p=0.06; rim X=4.9 ± 5.0, N=18; floor X=3.1 ± 3.1, N=65), but this may simply be a reflection of density. These data support the hypothesis that the floor as a whole may be a source of the rim sediments. The wide array of potential sources of seed taxa in the rim (Table 11) suggests the seeds originated from several, discrete dumping events.

Thus far, the analyses of rim formation has focused on charred remains, since only charred remains can be used in comparisons between the three deposits. What remains now is to examine the potential source(s) of the uncharred remains within the rim and to examine whether they differ from that of the charred remains from the same deposit. The uncharred and charred remains clearly differ in that only one set was burned prior to deposition, but what is not immediately obvious is whether the two groups of remains also initially originate from different activities.

To examine the source of the uncharred remains in the rim, I compared the relative abundance of uncharred and charred taxa within the rim itself. I limited the analysis only to wood remains, since the distribution of uncharred wood is less likely to be affected by rodent disturbance than uncharred food remains. If the charred and uncharred wood originate from a different source, on average the same taxa should be represented in different relative abundances of both the charred and uncharred material.

A comparison of the three most abundant wood and charcoal taxa (Table 6) suggests the charred and uncharred wood within the rim were subject to different formation processes. Charred *Populus* wood from the rim was recovered in greater abundance than uncharred *Populus* taxa (Mann Whitney U test, p=0.031), which suggests that charred and uncharred *Populus* fragments resulted from different activities. The charred and uncharred pine and Douglas-fir, however, were recovered in similar abundances. This suggests that the uncharred and charred remains of these taxa may have originated from the same source, and only differ in that some portion of the remains were charred before dumping.

A more qualitative examination of the source of the uncharred wood involves examining the presence/absence of the taxa represented. Comparisons of the uncharred and charred taxa demonstrate that whereas only the charred specimens produced maple and sagebrush, only the uncharred specimens produced willow and elderberry (Table 6). Though these differences may be due to small sample size, the fact that both the uncharred and charred populations produced the same number of identifiable taxa (six), even though the sample size for charcoal identifications is double that of uncharred wood, suggests there may be real differences in the sources of the uncharred versus the charred wood. Clearly, a considerably larger sample size is needed to refine the analyses of the source of the uncharred remains in the rim.

Taken together, the analyses support the notion that the rims were used as disposal areas for waste from the pithouse floor. The uncharred wood may have also originated from different activities than the charcoal (debris from woodworking?), but the small sample size prohibits further investigation of this.

How the Floor Deposits were Formed

Unlike the roof and rim deposits, flotation samples were analysed from the floors of HP 3 and HP 12, as well as HP 7. However, the overall density of archaeobotanical remains on the floor of HP 12 is too low to discern patterning. Thus, the following discussion focuses on the formation history of the floors from the larger houses.

Several lines of evidence suggest that the floors of the housepits are relatively intact and undisturbed. The discrete patterning of small archaeobotanical remains on the floors of the two larger housepits (Vol. II, Chap. 4, Figs. 1–2) likely reflects intact activity areas on the floor. The clearly in situ location of roof beams HP's 7, 3, and 12 also suggest that post-depositional movements of plant remains is slight. Modern plant intrusions (uncharred and/or Eurasian introduced species) are found sporadically throughout the floor deposits, but their density is typical of minor soil movement via roots and insects, and do not seem to have played a major role in the floor's formation history.

In all three housepits, the concentration of plant remains across the floors is generally quite low (Tables 3–5; Vol. II, Chap. 4, Figs. 1–3). This is especially apparent in HP 12, but even in the high density areas in the large structures, overall recovery was minimal. This is surprising given the diversity of taxa represented in the larger structures and the number of potential sources of those taxa (Table 11). The clusters of these diverse taxa suggests a variety of plant processing activities took place in discrete areas throughout the use-life of the floors of HP's 7 and 3. However, the low density of remains even in these clusters indicates that the floors must have been regularly cleaned at frequent intervals or that fires were used relatively infrequently (Vol. I, Chap. 17) resulting in low incidences of seeds carbonized by chance. Large quantities of plant materials were evidently being processed and used by pithouse residents as indicated by the abundant botanical remains in the rim middens of the houses. Even in areas that are regularly cleaned, small seeds are likely to remain in situ (Miksicek 1987:227).

Although post-depositional disturbance of the floor appears to have been minimal, we cannot entirely discount all post-occupation formation processes. There is a high density of grass and chenopod or just chenopod seeds along the periphery of the floors of HP's 7 and 3, respectively. As in the roof deposits, these concentrations may be the result of cultural activities during the pithouse occupation, or may have been introduced after pithouse abandonment.

As in the roof deposits, a possible explanation for the chenopod and grass seeds on the floor is that they were accidentally introduced into the deposits. In this case, the chenopod and grass seeds on the floor may have been collected incidentally with grass stems that were deliberately collected for bedding material. In fact, the distribution of these seeds closely parallels the distribution of needles, which are likely the remains of boughs collected for bedding or sitting. In both HP's 3 and 7 grass stems are abundant along the periphery of the floor (Tables 3 and 4; Vol. II, Chap. 4).

A major event effecting the floor deposits was the burning of the structure after abandonment. Although many of the plant remains associated with the hearths may have been charred during processing, the concentrations of remains away from the hearths must have been charred when the structure burned. This particularly applies to the concentrations of remains on the periphery. If the structure had not burned, there would have been quite a different distribution of archaeobotanical remains on the floor (cf. Hally 1981).

Summary of Formation Processes

The formation history of the Keatley Creek deposits is complex. Each deposit has it own unique history (Table 14), being formed by a variety of events which took place during occupation and after the house was abandoned. The formation history of each of the deposits is summarised briefly below.

Roof Formation Processes

In hindsight, the analysis of roof formation processes is severely limited by the small sample size. A larger sample would not only have resulted in a better understanding of the spatial patterning across the deposit, but also the relationship of the roof formation history to the rim and floor (cf. Lennstrom and Hastorf 1996). Despite the limited sample, we can draw some conclusions about the formation history of the roof of HP 7.

The distribution of plant remains across the roof can be best explained as a combination of primary and secondary deposition during pithouse occupation and post-occupation formation processes. The remains of primary deposition are the roofing material, including the charred roof beams and possibly the needles and grasses, and also possibly the remains of the plant food stored in the rafters. The redeposited food remains, either processed inside the pithouse or elsewhere, are the remains of the secondarily deposited material. Finally, the post-occupation formation processes involve the preservation of the roofing material through charring, the differential burning of parts of the roof, and the incorporation of the grasses and chenopods growing on the roof when the structure burned.

Table 14. Summary of Formation Processes of Roof, Rim, and Floor in HP 7

	Primary Deposition During Occupation	Secondary Deposition During Occupation	Post-Occupation
Roof	• roof construction	• dumping of food plants	• removal of larger beams • charring of roofing material when structure burned • differential burning of roofing • material when structure burned
Rim		• dumping from floor • biotubation?	• bioturbation? • differential preservation of uncharred remains
Floor	• food and non-food processing • bedding		• charring of remains on periphery when structure burned

The distribution of plant remains in the HP 7 roof deposit also provides insight into the roof's original structure. The archaeobotanical analysis revealed that Douglas-fir and pine wood were used to construct the roof (Table 10), and field observations indicate that *Populus* bark was also used in roof construction. Conifer boughs, as suggested by the concentrations of conifer needles associated with twigs and small branches, were used as roofing material. Both pine and Douglas-fir boughs were used for roof construction, with no clear preference for either species.

Observations from roof deposits in other structures augment the paleoethnobotanical analysis of HP 7's roof deposit. Excavators observed concentrations of conifer boughs in the roof of HP 12 (Vol. III, Chap. 8), and thick pieces of bark from pine and other species were recovered from the roofs of HP's 12, 58, and 47 (Vol. III, Chap. 10). Bark was used as a component of the roofing material in ethnographic pithouses as well (Laforet and York 1981; Teit 1900).

Rim Formation Processes

The paleoethnobotanical analysis of the HP 7 rim deposits suggest that the rims were formed by a combination of secondary deposition during pithouse occupation and post-occupational formation processes. The diverse source of material composing the rims, the presence of both charred and uncharred remains, some internal stratigraphy, large standard deviations in abundance of remains within rim layers, and the differences in diversity and abundance between rim layers, indicate that the rims are composed of material from several discrete events. The relatively more dense botanical remains in the rim than the floor suggest that the floor may be the source of the rim deposits. The analyses do not indicate that the roof deposits played a major role in the formation of the rims.

Some bioturbation of the rims is apparently extensive, and likely occurred both during and after pithouse occupation. However, at present, we cannot discriminate the effects of bioturbation in the rims from cultural deposition. Bioturbation is indicated by the presence of rodent coprolites, rodent-gnawed seeds, and the lack of internal stratigraphy in parts of the rims. Unfortunately, the analysis of the relationship of uncharred seeds and rodent coprolites is inconclusive and suggests that the relationship between uncharred remains and rodent activity is not a direct one.

Differential preservation of remains appears to be the primary post-depositional formation process of the rim. In the uppermost, lowermost, and peripheral portions of the rim, conditions were not conducive to the preservation of uncharred remains. In the bulk of the deposit, however, charred and uncharred remains seem to have had an equally likely chance of being preserved. Unlike the roof and the floor, the post-occupation burning of the structure did not play a significant role in the formation history of the rim deposit.

Finally, it is important to note that the results of the analysis of site formation history of the rims of HP 7 may not apply to some other housepits. The rim deposit of HP 7 is similar to many other large housepits in that it is quite thick. However, it contrasts with the rims of smaller housepits which lack any clear accumulation of botanical or artifactual remains. This is likely due to the shorter occupation periods of smaller housepits. Since less waste was discarded on those rims insufficient organic matter was deposited to create an extraordinary preservation environment similar to that of the rim of HP 7.

Floor Formation Processes

The floor deposits were formed by a combination of primary deposition during pithouse occupation and post-occupation formation processes. Primary deposition resulted from the processing of food and non-food plants and the use of various plant materials as bedding. The discrete patterning of remains from these activities indicates that the floor deposit is relatively undisturbed. The diversity of taxa within and between activity areas indicates that the deposits likely reflect the accumulation of material from multiple activities. Use of lithic and faunal materials on the floor of HP 7 seems to have followed a similar pattern (Vol. I, Chap. 13; Vol. II, Chaps. 7 and 11).

The botanical analysis illustrates that the pithouse floors were kept relatively clean and free of garbage. This is particularly apparent in the center of the structures, where we recovered almost no floral remains. This pattern parallels that found for the faunal remains (Vol. II, Chap. 7) and to some degree for lithics (Vol. II, Chap. 11). The density and diversity of remains on the floor indicates that the floors were regularly cleaned. The analysis of the rims suggests that the debris cleaned from the floors may have been dumped into the rims.

Post-occupational formation processes play a significant role in the formation of the floor deposits. We cannot know to what extent plants would have been preserved through accidental charring while the pithouse was occupied, but the burning of the structure certainly increased the number of charred remains incorporated into the deposit. This was especially important for the preservation of the remains on the periphery, whenever they were introduced into the pithouse.

Prehistoric Plant Use at Keatley Creek

Paleoenvironmental Reconstruction

The paleoethnobotanical analysis, in combination with already completed pollen analyses (Vol. I, Chap. 4), provides some insights into the environmental setting of Keatley Creek. In general, these data suggest the environment at the time of occupation was similar to that of today. Most of the archaeobotanical remains grow today in the vicinity of the site. The exception to this is the unidentified Ericaceae seeds and possibly the birch bark rolls. The relative absence of birch *wood* in the assemblage, and the abundance of birch *bark* may indicate that the tree did not grow nearby in abundance, and only the bark was transported back to the site. That birch was not common around the site is further suggested by the low frequency of birch pollen recovered from a sediment sample from HP 7 (Vol. I, Chap. 4).

There are inconsistencies in the archaeobotanical and pollen data about the abundance of sagebrush in the prehistoric environment. Today, the shrub is the single most common plant around the site and along most of the Fraser River terraces. Yet it was absent from the pollen record from the nearby Lillooet site of EeRl 4 (Vol. I, Chap. 4), and is almost absent from the assemblage of identified wood from Keatley Creek. The Lillooet data conflicts with the preliminary pollen analysis from the HP 7 floor where sagebrush made up 31% of the identified taxa (Vol. I, Chap. 4). Thus, although it is difficult to interpret the conflicting data, both the Lillooet pollen study and the archaeobotanical remains suggest the massive invasion of sagebrush onto the river terraces may have been a historic phenomenon.

A combination of events may have interacted to change the frequency of sage on the Keatley Creek landscape. Prior to European arrival in the Lillooet area, natural fires would have played a major role in maintaining the structure of the natural landscape. Low-intensity ground fires, ignited by lightning or by people and fuelled by the high grass cover that was characteristic of the area, were a frequent phenomenon. Fire histories from the Kamloops region, in the same biogeoclimatic zones as Keatley Creek, revealed evidence of such fires on an average of every 12.1 years, with none occurring since 1902 (Low 1988). Such fires would have maintained the open parkland-like structure of this forest by keeping the growth of shrubs, such as sagebrush, in check (Barry Booth, School of Forestry, UBC, personal communication).

The European presence in the Lillooet region effected the natural regeneration cycle in two significant ways. The first was the supression of the natural and culturally-induced fire cycle. In the Kamloops region, for instance, this seems to have begun in 1902. By controlling fire frequency, the main source of disturbance and subsequent vegetation regeneration would have been altered.

In addition, the European introduction of cattle into the region likely played an important part in creating the current habitat surrounding Keatley Creek. Cattle were brought into the region by the early settlers of the late 1800's, and there is no doubt that over-grazing has changed the local vegetation by denuding the grass and tree seedling population. This, combined with fire restrictions, could have dramatically altered the vegetation communities.

Site Seasonality

Determining site seasonality with archaeobotanical material from the Pacific Northwest is difficult since clear seasonal indicators are rare. This is true, despite the fact that many plants, or specific plant parts, are only seasonally available. For instance, spring plant resources were eaten fresh as they became available, and thus rarely entered the archaeobotanical record. Even when processed, most spring plant foods are unlikely to be preserved archaeologically (e.g., fresh greens, processed tree cambium). Summer and early fall plant foods have better potential to be represented because berries and seeds are more likely to leave lasting archaeobotanical remains. However, it is these species that were often preserved for later consumption, and thus may not be accurate indicators of season of use. Finally, inferring winter seasonality based on floral remains is hampered by the fact that although some plants were available for harvesting during the winter months, most are species which would have been available in the fall and spring as well (e.g., cacti, rose hips).

The archaeobotanical seasonal indicators from Keatley Creek are summarised in Table 15. In this table, I have tabulated the seasonally available species by the seasons in which they were available for harvesting. I have divided summer into mid (corresponding to June and July) and late (corresponding to August), because this level of specificity of information was available for those resources. Species in brackets are those known ethnographically to have been processed and stored for later use as well as eaten fresh. As these species are not necessarily reliable seasonal indicators, I do not include them in my evaluation of site seasonality.

The compilation of seasonal indicators suggests that the Keatley Creek village was occupied at least in the late summer (possibly in connection with transporting and storing fish at the site) and likely throughout the winter. There is nothing in the archaeobotanical assemblage to indicate spring use of the village. Mid-summer occupation is also questionable since all the plants recovered are processes for winter use. Thus, with the given data, we can neither demonstrate nor dismiss spring and mid-summer occupation. Late summer and winter occupation is also suggested by the fauna at Keatley Creek (Vol. I, Chap. 10), and is consistant with the ethnographic descriptions of permanent villages (e.g., Teit 1900; Alexander 1992).

A Model of Prehistoric Plant Use at Keatley Creek

In this section, I construct a model of prehistoric plant use at Keatley Creek based on the ethnobotanical information for the Interior Salish and the archaeobotanical remains at the site. The review of ethnographic plant use by the Interior Salish (based primarily on Alexander 1992, Turner 1997, Turner 1992) is organized into general categories of plants that are likely to be involved in similar site formation processes. These categries are food, technology, and medicinal and ritual plants. Based on the ethnographic record, I then make predictions about how these major categories of plants may have been introduced into the archaeological record at Keatley Creek. Finally, a comparison of the actual archaeobotanical data with the ethnographic predictions allows a detailed reconstruction of plant use at the Keatley Creek village.

Table 15. Archaeobotanical Seasonal Indicators at Keatley Creek[1]

Winter	Spring	Mid Summer	Late Summer	Fall
conifer buds				conifer buds
				Pinus
			Carex	
			Scirpus	
			Poaceae	
			Smilacina	→
Opuntia			Opuntia	
			[Sambucus]	
		Chenopodium[2]		
		[Cornus]		
Arctostaphylos			Arctostaphylos	→
		[Ribes]		
		Phacelia[2]		
		[Amelanchier]		
			[Prunus]	
Rosa			Rosa	→

1. All remains are seeds unless otherwise noted. Species in brackets [ ] are those which are reported ethnographically to have been dried for later use as well as eaten fresh. I have listed these under the season in which they would have been harvested. Such species are not reliable seasonal indicators.
2. These species are questionable as seasonal indicators as I cannot confirm their actual seeding time for the Keatley area. Whether the chenopod seeds are contemporaneous with the archaeological deposits is another confounding problem (see text).

Ethnographic Plant Use by the Interior Salish

The ethnographic sources are clear that a range of plant taxa for food, technology, medicine, and ritual, were collected by the Interior Salish from a variety of ecosystems throughout the year. Among the Fraser River Lillooet, at least three plant harvesting expeditions may have been made to the upland zones in the course of a year: in spring, mid-summer, and fall (Turner 1992). These trips would have been interspersed with plant collecting trips in the lower elevations. Many of the low elevation trips likely occurred near the winter village site. During the warmer months villagers likely made regular visits back to Keatley Creek to store supplies (Alexander 1992).

Among the plant foods, geophytes (root foods or plants with other underground parts such as balsam root, lilies, mountain potatoes, onion) are considered in some ethnographic models to be the most important plant food group. In fact, after salmon, they are considered the most important food group for some Plateau groups (e.g., Ames and Marshall 1981; Pokotylo and Froese 1985; Thoms 1989; Peacock 1998). This view differs from recent analyses of Fraser River Lillooet plant use, specifically those which suggest that geophytes were not extensively used because they were too heavy and cumbersome to be transported to the winter village from the relatively distant harvesting sites (Hayden 1992:528; Turner 1992) and were never exremely common in the area (Turner 1992; Alexander 1992; Tyhurst 1992).

Geophytes were gathered from low to high elevation areas from spring to the end of summer. After harvesting they were roasted in large pits and eaten immediately or dried for winter consumption. Small quantities could also be dried without roasting if they were to be eaten later. To facilitate transport, it is likely that all processing occurred near the harvesting site. Several of the early spring bulbs could have been harvested in small quantities and processed at Keatley Creek itself, and then stored for later use. Dried bulbs could be reconstituted by boiling or steaming.

Berries and fruits were another major component of the diet. Berries and fruits offered a variety of essential vitamins and nutrients not available in other foods. They were harvested in the summer and fall, depending on location and species, and then eaten immediately, or dried and stored for later use. Berries and other upland plants were probably processed at the collection site, and then transported to the winter village in a lighter and more portable state, whereas berries collected close to the village site may have been processed at the village site. Berries were processed either by cooking and then drying, or by drying immediately after harvesting. They were eaten during the winter months either dried or reconstituted by adding water. Among the Fraser River Lillooet, saskatoons were among the most preferred of the berries (Turner 1992; Romanoff 1992:237).

Relative to the other food groups, seeds were a minor component of the traditional diet. Conifer seeds are the major component of this category, with whitebark pine seeds (*Pinus albicaulis*) being the most important species. These seeds were gathered in the uplands in the fall. All conifer seeds were often roasted before being eaten, probably at the harvesting site. Other seeds (for example *Cornus sericea*) were incidental components of the diet and were eaten fresh at the time of harvest. Conifer seeds would have stored well throughout the winter months in cool, dry places.

Various types of mushrooms and lichens were also consumed by the Interior Salish. These foods could be eaten immediately or dried for later consumption. Mushrooms and lichens were predominantly gathered in the fall.

Fresh greens (leaves, shoots) and tree cambium comprise the remaining major category of plant food utilized by the Interior Salish. Both were harvested predominantly during the spring, the former at the beginning of the season, the latter towards the end. Greens were only eaten fresh at the time of harvest. Lodgepole pine cambium was eaten fresh and sometimes dried for later use, whereas cottonwood cambium was only eaten fresh.

The plants collected for technological purposes were many and varied. They include wood from trees and shrubs for construction, fuel, and tool making; conifer boughs for bedding; inner barks, leaves, and fibrous roots and stems for cordage and mats; outer barks for construction, fuel, and containers; and pitch for various construction purposes. Most of the necessary technological resources were available year-round from a variety of habitats, or as the habitat became seasonally accessible. Major exceptions to this are Indian hemp (*Apocynum cannabinum*), the most valued of the fibres, and paper birch bark. Hemp was only suitable for harvesting in the late fall, and birch bark was collected in the late spring. The initial processing of most technological plants likely occurred at the harvest site, but much of the final processing was probably conducted in the winter village.

Even in a brief summary such as this, the role of plants in medicine and rituals cannot be ignored. Although probably constituting a smaller total bulk than most of the other categories, these plants were highly culturally signficant. Unfortunately, this diverse category is perhaps the least well known of the ethnographically used plant groups. It is known that medicinal and ritual plants were harvested from a variety of habitats throughout the year. Some plants were likely used fresh, while others that could be preserved were probably stored for later use.

Processed food plants collected throughout the year were stored at or near the winter home for easy access throughout the cold months. Teit recorded that the most common method of food storage was in underground caches. Berries or roots stored in these cache pits were first placed in baskets and then wrapped in birch bark (Teit 1900:199). Presumably, some plant foods were also stored in the rafters of the pithouse in various types of containers or in above ground elevated caches. There is little information on how technological, medicinal, or ritual plant resources were stored at the winter village.

Archaeological Predictions from the Ethnographic Record

The ethnographic record indicates that a wide range of plants were brought to the winter village throughout the year. However, not all of these plants had an equal chance of survival in the archaeobotanical record. In general, the likelihood that a plant will survive is directly proportional to how likely it is to come in contact with fire and thus be charred. At Keatley Creek, for instance, the only plants that would survive in the roof and floor deposits were those that were deliberatey or accidentally charred in a hearth or charred when the structure burned. In the rims, where both uncharred and charred remains preserve, all plants had a roughly equal chance of survival.

Among the food plants, those that were completely or partially processed at the village site had the greatest chance of being preserved through charring. According to the ethnographic model, the remains of primary processing activities should have included roasting pits for early spring roots, and drying sites for berries. The reconstituting of roots and berries in the winter home by boiling or steaming should have also resulted in the accidental introduction of charred remains into the deposits. Several roasting pits have been recorded at the Keatley Creek village, but their contents have not been analyzed and their function is unknown. Berry drying sites have yet to be recorded at a winter village site, but they should appear similar to limited activity processing sites found on the coast (e.g., Mack 1992).

Furthermore, dried plants (berries, roots, mushrooms, cambium, and lichens) are more likely to survive archaeobotanically than those deposited in a fresh state. The removal of water in the drying process associated with preserving for winter consumption should have also enhanced the chances that they would be preserved in the archaeological record. This particularly applies to the rim deposits, where uncharred remains are preserved, but completely dried uncharred specimens may also be preserved in other deposits if the conditions are right. Indeed, uncharred, dried mushrooms have been recovered from the floor of a pithouse at the nearby Mitchell site (Compton et al. 1995).

Of all the plant food categories, fresh greens are the most unlikely to be preserved in the archaeobotanical record. According to the ethnographies, these plants were likely an important spring food source to the village inhabitants. However, the greens are unlikely to show up in the archaeological record because they were consumed fresh without processing. Even if some accidentally fell in a fire, due to their high water and low fiber content they are not likely to survive the charring process.

The method of storage also effects the likelihood of recovering archaeobotanical remains. For instance, roots and berries (and possibly seeds) that were contained within baskets within storage pits would be less likely to leave remains than if they were stored without a container. The remains of spilled contents of the basket, or forgotten or partially used caches, however, would be retrievable from the archaeological record only if uncharred remains were preserved in that context, or if the entire contents burned when the structure burned. Remains of the baskets themselves, either in the pit, or the refuse pile, could be recovered from the archaeological record. In fact, the remains of one birch bark container found at a pithouse village in the Lillooet area contained a saskatoon berry cake (Mathewes 1980). The high oil content of birch seems to encourage the preservation of uncharred bark in archaeological sites throughout the Plateau. Finally, in addition to pit storage, plants stored in rafters could be incorporated into the roof deposit as the structure burned and collapsed.

Although initial preparation of plants used in technology probably occurred at the harvest site, the remains of fine finishing should be archaeologically visible at the village. Woodworking must have produced copious debris, and such debris is likely to end up in the hearths or in the discard area. However, it would be difficult to distinguish wood which was intended for some technological purpose and fell accidentally or was discarded into the hearth, from wood which was intended to be used to fuel a hearth fire. Shavings, bark, and other debris produced from making other artifacts of plant material are likely to have been thrown in the hearth to be burned, or thrown directly into the discard area. Again, it would not be possible to distinguish these hearth contents from any other burn event, but the uncharred material, if preserved, might be distinctive. Obviously, any tools, construction material, mats, baskets, etc., left in the abandoned pithouse are likely to preserve through charring when the structure burned, (e.g., HP 104; Vol. III, Chap. 10).

The recovery of medicinal and ritual plants in the archaeobotanical record of the winter village is largely hampered by our ability to identify their ethnobotanical use. In general, it would be difficult to differentiate these plants from those used for more mundane purposes, or even from weeds which were accidentally introduced into the deposit. Those plant remains which are found in extraordinary contexts (special structures, containers, etc.), and/or are an extraordinary species (e.g., Compton et al. 1995), may be recognizable as medicinal or ritual.

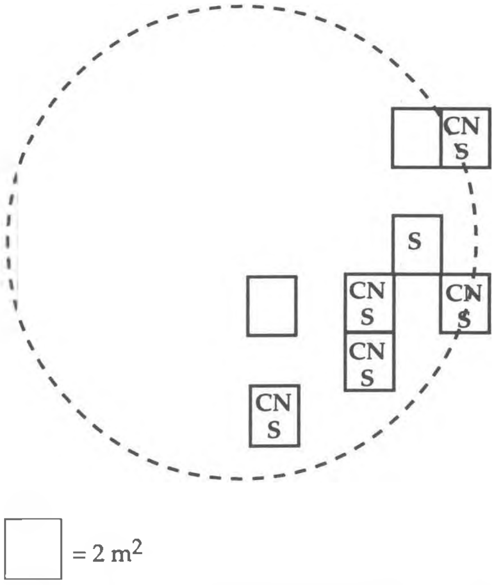
Comparison of Ethnographic Data with Keatley Creek Archaeobotanical Record

In general, the botanical record from Keatley Creek is consistent with the ethnographic model for winter village life. In this model, the inhabitants were dependent on readily accessible storable foods which were gathered from diverse ecosystems, sometimes at a distance from the village. At Keatley Creek, the diversity of remains does indicate gathering from varied environments, but most of these resources could have been collected in some quantity locally. Thus, the need for diverse winter foods appears to have been met by gathering in a relatively small catchment area. Even if birch bark and the Ericaceae were the only resources that did not occur in the immediate vicinity of the site, it is difficult to imagine that the modest stands of cottonwood, saskatoon, and other resources in the Keatley Creek drainage would have been adequate for a seasonally returning community of over a thousand people.

The archaeobotanical record offers little insight into how plants were stored for winter use. There is no evidence to suggest that plant foods were stored in containers in caches as the ethnographies suggest. However, the relative absence of floral remains in all pit features more likely indicates that at the time the structures were burned they had already been cleared of stored plants. Placement in birch containers or wrappers would account for the fact that no remains were left behind at the bottom of pits. At Keatley Creek, storage pits have been found both with and without a layer of birch bark on the bottom. The abundance of birch bark fragments found in the rims may be the remains of containers used to store plants and other foods.

The paleoethnobotanical analysis suggests that fruits and berries were the primary plant foods used by the inhabitants of Keatley Creek. If the village was indeed occupied only during the late summer and through the winter, many of the berries and fruits entered the pithouse in some preserved form. To date, no evidence has been recovered at Keatley Creek to suggest that locally gathered berries were processed at the site. As in ethnographic times, saskatoons were among the most important of the berry foods for the Keatley Creek inhabitants. Contrary to ethnographic observations, some foods, such as star-flowered Solomon's-seal and prickly pear fruits may have been important prehistorically, but were used only infrequently in ethnographic times.

The absence of geophytes in the Keatley Creek archaeobotanical record contrasts with the ethnographic model for intensive "root" use among Plateau peoples, (e.g., Peacock 1998; Thoms 1989) but is consistent with the specific ethnobotany of the Fraser River Lillooet people. The unidentified epithelial tissue recovered from some of the samples may prove to be the remains of such roots. However, even if all the fragments in this catch-all category are from roots, their relative scarcity in the archaeobotanical record does not argue for an abundance of root processing or consumption at Keatley Creek. Further, even if the unanalyzed roasting pits at the site were primarily for root processing, there are few enough such features to argue against root consumption being a daily activity. The relative absence of geophyte remains and roasting features at the site supports Turner's (1992) assessment of the quantities and main consumption locations of geophytes in the Keatley Creek band range.



C: ≥ 5 g charcoal/1 liter flotation sample
N: ≥ 200 needles/1 liter flotation sample
S: ≥ 5 seeds/1 liter flotation sample

Figure 1. Distribution of plant remains on the roof of HP 7.

The archaeobotanical analysis suggests that a wide range of technologically important plants were used at the winter village. The rush and tule seeds may have come from leaves and stems collected for weaving, and conifer boughs appear to have been used as bedding. Birch bark obviously served a variety of technological purposes, and various woods were used both structurally and for fuel. The dominant woods used seem to be those which were the most common in the environment. The uncharred wood remains in the rim may have been used for a different purpose than the charred wood, but the statistical analyses at this point can not adequately assess this.

Among the wood taxa used, there is evidence that some species were selected preferentially for certain purposes. For instance, the relative abundance of the three most common wood taxa on the floors of HP's 7 and 3 are strikingly similar to each other (Tables 7 and 8) suggesting the same selection process of woods by both sets of pithouse inhabitants. In both structures Douglas-fir is clearly the preferred wood, followed by *Pinus* and *Populus*. By contrast, Douglas-fir and *Pinus* co-dominate in the hearth and rim samples from HP 7 (Tables 6 and 9), suggesting that a different selection process was going on for wood used in these contexts. The sample size of identified structural elements from the three houses is too small to make definitive statements about wood preferences for these purposes (Table 10).

Finally, as expected, we are on weak ground when making interpretations about medicinal and ritual use of plants. No plants were recovered at Keatley Creek in a distinct enough context to *de facto* indicate such special uses. Several of the plants recovered at Keatley Creek are known ethnographically to have been used medicinally or ritually, but this alone cannot be used to indicate special use. *Phacelia* stands out as the only species in the archaeobotanical record for which only medicinal uses have been identified. However, *Phacelia* is a weedy species which likely grew on the terraces surrounding the site, and thus could have been introduced into the record accidentally as well.

Summary

The foregoing analysis demonstrates the complexity of the formation history at Keatley Creek. At the most fundamental level, the many potential sources of the individual plant taxa and even parts of those taxa, contribute to the complex history. This is compounded by the variety of potential contexts for preservation (i.e., charred accidentally or deliberately in a hearth, charred when the pithouse burned, or uncharred in the rims). The combination of possible sources and preservation conditions result in a range of potential formation histories.

To decipher the individual formation histories of the Keatley Creek deposits required examining the distribution, density, and diversity of plant remains both within and between deposits. The results clearly indicate a unique depositional history for the roof, rim, and floor deposits at Keatley Creek. Unfortunately, small sample sizes especially from the rim and roof, have ultimately limited our understanding of the formation histories.

At a more general level, we can draw several conclusions about specific prehistoric plant use, and life in general, at Keatley Creek. A comparison of the ethnographic model with the archaeobotanical record indicates that ethnographic plant use was both similar to and different than prehistoric plant use. The most striking discrepancy between the two is the paucity of evidence for prehistoric root food consumption. Although this agrees with recent ethnographies of the Fraser River Lillooet, it differs from other models of Plateau plant use. This should serve as cautionary note about how widely general models of prehistoric adaptation on the Plateau can be applied to specific areas.

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Chapter 10

Animal Resource Utilization and Assemblage Formation Processes at Keatley Creek

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Introduction

The goals of this chapter are, first, to describe animal resource utilization and, second, to discuss faunal assemblage formation processes at the Keatley Creek site. Analysis of the faunal assemblage from the Keatley Creek site has provided extensive information concerning the subsistence strategies of the inhabitants of Keatley Creek and adds to our knowledge of subsistence practices and resource use at winter village sites in the region. Until recently, faunal studies in the southern British Columbia Interior Plateau have been limited to cursory comments which note that salmon and deer form the largest components of the assemblages (Sanger 1963, 1970; Stryd 1972; Rittenberg 1976). More recent analyses have begun to provide information concerning prehistoric subsistence practices (Stryd 1981; Lepofsky et al. 1987; Kusmer 1987, 1990) but, prior to the present work, there has been only one detailed faunal study of sites in the Lillooet region (Langemann 1987). Langemann (1987) analyzed the faunal assemblages from seven housepits at five sites near Lillooet. Although detailed provenience information was not available for these assemblages, her study yielded the first good archaeological information concerning subsistence of winter village inhabitants in the Lillooet area. The Fraser River Investigations of Corporate Group Archaeology research project at Keatley Creek provides the good provenience control and collection techniques for faunal remains lacking of earlier excavations at Lillooet and allows an opportunity to test previous and current ideas concerning Lillooet winter village subsistence practices and economic organization within villages and housepits. Faunal data from Keatley Creek were obtained from total excavation of four housepit floors, partial excavation of 19 other housepits, and excavation of 23 small cultural depressions, including cache pits. Based on these data, the utilization of animal resources at the Keatley Creek site is discussed below.

The Fraser River Investigations of Corporate Group Archaeology research project also examined taphonomic processes involved in pithouse construction, occupation, and abandonment. It was recognized that a major problem confronting Interior British Columbia archaeology is the difficulty of interpreting housepit excavations because of the extremely complex site formation processes underlying pithouse sites (Wilmeth 1977; Fladmark 1982). A taphonomic approach was also needed to evaluate the potential for obtaining a reasonably secure faunal database from housepits before the broader research goals of the project (concerning regional cultural history and socioeconomic inequalities among complex hunter/gatherers) could be addressed (Vol. II, Chap. 7). Thus, a large part of the zooarchaeological research at Keatley Creek was directed towards describing and explaining the attributes and distributions of faunal remains at the site within a taphonomic framework. Within this framework, the faunal data were used to aid in the definition of intact living floors, to develop criteria to help distinguish floor from roof deposits, and to attempt to explain the patterning of remains within floor deposits. In addition, the presence and condition of faunal remains in all other major deposits (roof, rim, pits, potential pit or midden areas outside of housepits) were investigated. Results of this analysis are described below.

Environmental Setting

The location of the Keatley Creek site on benchlands above the Fraser River gorge allows access to a variety of animal and plant resources because of the range of biotic zones available within a short distance of the site. The vertical zonation provides close access to stream, grassland, and forest habitats. During the Kamloops occupation of the site anadromous salmon (*Oncorhynchus* sp.) were abundant in the Fraser River and the Lillooet area contained exceptional fishing spots and salmon drying conditions. The more extensive grasslands present at that time would have provided better habitat for deer and, possibly, elk than occurs today. Deer (*Odocoileus* sp.) were available on the benches in open forests and thickets near grassy meadows and bighorn sheep (*Ovis canadensis*) grazed on the grassy benches in the winter. Grasslands and parklands in the higher elevations would have offered summer grazing and browsing for deer, bighorn sheep, and elk (*Cervus elaphus*). A variety of small fur-bearers and game birds, such as snowshoe hare (*Lepus americanus*), red squirrel (*Tamiasciurus hudsonicus*), weasels (Mustelidae), fox (*Vulpes vulpes*), lynx (*Lynx* sp), and grouse (Tetraonidae), were available in the open forests and aquatic animals, such as beaver (*Castor canadensis*) and muskrat (*Ondatra zibethica*), and freshwater shellfish were available in some streams and ponds, particularly Seton Lake. See Alexander (1992a) for a more detailed discussion of fauna available in the various biogeoclimatic zones around the site.

Account of Taxa Present at Site EeRl 7

A summary of the taxa recovered from the Keatley Creek site follows. See Table 1 for the locations and deposits in which each taxon was found.

Freshwater shellfish remains (only *Margaritifera falcata* was identified) were found in low amounts at the site. The evidence of limited use of freshwater shellfish is similar to information available from other pithouse sites in the Lillooet Region (Langemann 1987). In this area, freshwater molluscs appear to have been utilized in small numbers throughout prehistory. Shellfish were more heavily exploited in the South Thompson area (Mohs 1981) and in the Columbia Plateau (Lyman 1980; 1984). Evidence from the Columbia Plateau suggests shellfish were largely exploited during early spring (Lyman 1984). Thus, it is possible that shellfish were collected and discarded away from winter villages in Lillooet. However, the greater abundance and quality of salmon in the Fraser River near Lillooet and superior conditions for drying salmon (Romanoff 1992a) seems to have led to less reliance on alternate dietary sources. It is likely that the few remains found at Keatley Creek are fragments of artifacts such as shell spoons and pendants (a number of valves have holes cut in them).

Eight dentalium shells (*Dentalium* sp.) were found at the site. *Dentalium* are found along much of the Pacific Coast, usually in deep water with sand or mud bottoms although they can occur in the intertidal zone (Barton 1991). Ethnographically, they were obtained on coastal British Columbia islands by picking them up where they washed up on beaches and by using special dentalium fishing rakes and spears (Barton 1991). They were highly prized and a valuable trade item.

One dogwinkle (*Nucella* sp.) shell and one purple-hinged rock scallop (*Hinnites giganteus*) artifact, possibly a bracelet, were found at the site. Dogwinkles are marine molluscs common along rocky, intertidal foreshores along southern British Columbia coasts. Rock scallops are large, marine bivalves found in low densities in intertidal, rocky areas. Dentalium, dogwinkle, and rock scallop are rarely recovered from Interior sites.

Fish (*Oncorhynchus* sp.) bones were the most common faunal remains found at Keatley Creek. Radiography was used to speciate some of the *Oncorhynchus* vertebrae and they have all been identified as species of Pacific salmon (Vol. II, Chap. 8). Thus, all the fish remains are assumed to be salmon. The distribution of species of *Oncorhynchus* present in the housepits and fish bone distribution are discussed in Volume II, Chapters 7 and 8.

Bird remains are very limited at the site. Grouse (Tetraonidae) were probably obtained for food, as most body parts have been recovered. The other bird bones probably are the remains of birds obtained for ritual or decorative purposes. Long-tailed hawk (*Accipiter* sp.) and short-tailed hawk (*Buteo* sp.) are represented by wing bones only. These are probably the remains of animals collected primarily for their feathers. One crow (*Corvus* sp.) wing bone was found. One bald eagle (*Haliaeetus leucocephalus*) mandible fragment and four common loon (*Gavia immer*) bones (3 ulnae and 1 fibula) were found in one housepit. Common loons are found in freshwater lakes and large open rivers during spring,

Table 1. The Location and Type of Deposit from Which Taxa were Recovered

The first number in each line is the number of specimens (NISP) for that taxon. Bone/antler artifacts are included. See Volume II, Chapters 7 and 10 for deer, fish, and dog locations.

Freshwater shellfish
(some identified as Margaritifera falcata)
2 - EHP 8 (cache pit, level 2)
3 - EHP 11 (occupation level)
2 - HP 1 (rim)
11 - HP 3 (floor, roof, pit)
63 - HP 7 (floor, roof, rim, pit)
18 - HP 9 (all floors, roof, pit)
2 - HP 47 (floor and refuse dump)
2 - HP 58 (floor)
2 - HP 101 (most recent floor)

Dentalium sp. (dentalium shells)
3 - HP 7 (rim, pit)
4 - HP 9 (second and last floors)
1 - HP 109 (stratum VI)

Nucella sp. (dogwinkle)
1 - HP 7 (pit)

Hinnites giganteus (purple-hinged rock scallop)
1 - HP 7 (floor)

Gavia immer (common loon)
4 - HP 9 (second floor, pit associatied with second floor)

Accipiter sp. (long-tailed hawk)
2 - HP 7 (pit)
1 - HP 3 (pit)

Buteo sp. (short-tailed hawk)
1 - HP 3 (roof)

Haliaeetus leucocephalus (bald eagle)
1 - HP 9 (basal roof)

Tetraonidae (grouse)
7 - HP 7 (floor, roof, pit)
1 - HP 101 (most recent floor)
3 - HP 105 (pit)
1 - HP 110 (most recent floor)

Corvus sp. (crow)
1 - HP 8 (pit)

Lepus americanus (snowshoe hare)
1 - EHP 7 (rim)
1 - HP 3 (pit)
26 - HP 7 (floor, roof, rim, pit)
3 - HP 9 (basal floor, second floor, pit)
1 - HP 105 (refuse dump)
4 - HP 110 (earliest floor, pit)

Tamiasciurus hudsonicus (red squirrel)
2 - HP 7 (roof)
1 - HP 3 (roof)
1 - HP 58 (roof)
2 - HP 107 (floor)
1 - HP 110 (most recent floor)

Castor canadensis (beaver)
2 - EHP 6 (buried paleosol)
4 - HP 1 (floor, rim)
6 - HP 4 (floor, pit)
8 - HP 3 (floor, roof)
1 - HP 8 (pit)
58 - HP 7 (floor, roof, rim, pit)
21 - HP 9 (all floors, roof, rim, pit)
6 - HP 12 (floor, roof)
1 - HP 47 (refuse dump)
1 - HP 101 (most recent floor)
2 - HP 105 (pit)
2 - HP 108 (floor)
14 - HP 110 (earliest floor)

Ondatra zibethica (muskrat)
1 - HP 7 (rim)
1 - HP 58 (floor)

Vulpes vulpes (red fox)
2 - HP 7 (floor, roof)

Ursus arctos (grizzly bear)
1 - HP 7 (floor)

Martes pennanti (fisher)
2 - HP 7 (roof, rim)

Lynx sp. (lynx or bobcat)
1- HP 7 (roof)

Cervus elaphus (elk)
2 - HP 7 (floor, pit)
3 - HP 9 (second floor, pit)*chck lg antler from other floors*
2 - HP 12 (floor, roof)
1 - HP 90 (roof)
1 - HP 101 (dump assoc. with 1st occupation)
1 - HP 105 (pit)

Alces alces (moose)
1 - HP 7 (rim)

Ovis canadensis (bighorn sheep)
1 - EHP 7 (storage deposits of pit)
2 - EHP 10 (infill and refuse)
3 - HP 4 (pit)
11 - HP 7 (floor, roof, rim, pit)
18 - HP 9 (second and last floors, basal roof, pit)
5 - HP 58 (roof, refuse dump, pit)
4 - HP 101 (earliest floor, pit, most recent floor)
6 - HP 105 (pit)
3 - HP 110 (earliest floor)

cf. Oreamnos americanus (mountain goat)
1 - HP 58 (refuse dump)

summer, and fall. They migrate to coastal areas in B.C. for the winter. Usually only one breeding pair inhabits a lake, although large lakes may have two or more breeding pairs (Godfrey 1976). The loon bones (primarily wing bones) are probably the remains of loons obtained for some purpose other than food, such as for ornamental uses.

Small mammal remains other than beaver (*Castor canadensis*) and snowshoe hare (*Lepus americanus*) are uncommon at the site. Beaver are represented primarily by incisors (Table 2), which were commonly used as woodworking chisels ethnographically. These tools were probably curated and may represent remains from beavers caught during the summer or fall. Few post-cranial remains were found suggesting beaver were rarely hunted for food or pelts during the winter when they would have been relatively inaccessible. The beaver inhabits slow-moving streams, usually in forested areas, and spends most of the winter beneath the ice and in lodges (Banfield 1981). Based on body part representation (Table 2), the snowshoe hare, on the other hand, appears to have been hunted (probably for both its meat and skin) during the winter and brought back to the pithouses for processing. The snowshoe hare inhabits forests and thickets and is active year-round (Banfield 1981).

Table 2. Beaver and Hare Element Distribution at EeRl 7

Skeletal Element	Beaver	Hare
Tooth fragment	68	0
Mandible	1	1
Premaxilla	0	1
Vertebra	8	0
Rib	8	0
Scapula	1	2
Humerus	1	4
Radius	0	2
Ulna	0	2
Femur	2	4
Tibia	0	5
Carpal/Tarsal	1	0
Metapodial	2	6
Phalanx	6	4

Muskrat (*Ondatra zibethica*) was found in two housepits. Muskrats are large, aquatic, rat-like animals which inhabit marshy edges of lakes and rivers. They sometimes occupy beaver-lodges (Cowan and Guiget 1975) and could be acquired along with beavers. Ethnograpically, they were trapped for their skins (Teit 1906). The remains are too few to determine why they are present in the site.

Small rodent remains, vole (*Microtus* sp.), deer mouse (*Peromyscus* sp.) and pack rat (*Neotoma* sp.), were found in some of the deposits in small numbers. These animals occur naturally in the area and their body part representations (often virtually complete skeletons of one animal) and low occurrences indicate they are the remains of animals that died naturally on the site.

Two red fox (*Vulpes vulpes*) molars, representing two individuals, were recovered. Two fisher (*Martes pennanti*) molars and one lynx (*Lynx* sp.) proximal phalanx were also found. Teit (1906) states that foxes, fishers, and lynx were trapped for their skins. The remains are too few to determine why they are present in the site.

Dog (*Canis familiaris*) remains are discussed in a separate analysis (Vol. II, Chap. 10).

A large grizzly bear (*Ursus arctos*) distal phalanx was the only bear bone found at the site. Bears are not true hibernators and would have been available to winter hunters. However, they appear to have been seldom utilized, and perhaps were used more for ritual purposes or for their skins rather than for subsistence. Ethnographically, bears were important in Lillooet mythology and some of the Lillooet clans were Bear Clans, the members of which wore black and grizzly bear skins during ceremonies (Teit 1906). The grizzly was a powerful guardian spirit for hunters and, according to Teit (1906), grizzly bears were hunted for their skins and claws. Bear prints figure prominently in the rock art of the area.

Few elk (*Cervus elaphus*) remains were found at the site. The remains are almost exclusively tool/ornamental materials (antler fragments; canines, some with perforations; a metacarpal; and a phalanx) which were probably curated, suggesting that elk were butchered elsewhere. Elk prefer open, parkland habitats and low valleys in the winter, and the Fraser Valley near Lillooet is apparently not good elk habitat (Teit 1906; Langemann 1987; Alexander 1992a, 1992b). They do not occur in the study area today. Ethnographically, elk bones and antlers provided material for tools and canine teeth were used as ornaments. The elk remains may have been trade items. Teit (1906) notes that the Lillooet obtained elk teeth and skins from the Thompson and Shuswap and elk were common in these areas in the past (Alexander 1992b).

Deer (*Odocoileus* sp.) was the most common mammal, other than dog, identified at the site. The distribution of deer remains is discussed in Volume II, Chapter 7 and in Appendix I. The species of deer occurring in the Lillooet area today is the mule deer (*Odocoileus hemionus*). White-tailed deer (*Odocoileus virginianus*) presently occur primarily in southeastern British Columbia. However, archaeological evidence from the Columbia Plateau indicates white-tailed deer were probably more common prehistorically than they are now (Livingston 1987). Based on morphological criteria, the bones of these two species can be identified only to genus. Deer browse in forest edges, open coniferous forests, subclimax brush, and river valleys. In the Interior Plateau, they move to lower elevations and prefer south facing slopes with shelter from deep snow and cold winds in the winter (Banfield 1981). Ethnographically, in the Lillooet area they were usually hunted in the fall after the salmon runs (Romanoff 1992b).

A worked moose (*Alces alces*) antler piece was found in the rim of one housepit. This is most likely a trade item. According to biogeographical evidence moose were not present south of Prince George, British Columbia, prior to about 1920 (Cowan and Guiget 1975; Banfield 1981). Moose remains have not been found in other archaeological sites in the Lillooet region to date. Teit (1906) states that moose were never known in the habitat of the Lillooet Indians. Ethnographically, Upper Lillooet often traded with Shuswap Indians and Teit (1906) notes moose skins were occasionally given to the Lillooet by the Shuswap.

Bighorn sheep (*Ovis canadensis*) remains were found in small amounts in seven housepits and two exterior cache pits. Sheep remains are found in the earliest to the latest occupations but are much less common than deer remains in all contexts. The majority of identified remains are horn fragments, phalanges, and teeth. The body part representation is similiar to that of deer in most areas of the site and reflects survivability and ease of identification of the elements, making assessments of butchering practices difficult. Since no evidence for on-site butchery was found for sheep, although there was for deer, the element representation may indicate that sheep butchering took place off the site and that primarily bones attached to skins or needed for tools were brought back to the site. Bighorn sheep are grazers and usually move seasonally between summer alpine meadows and grassy winter valleys close to rugged cliffs. On winter ranges they may be found in close proximity to deer (Banfield 1981).

One possible mountain goat (*Oreamnos americanus*) phalanx was found. Goats inhabit rugged mountainous areas with deeper winter snow than bighorn sheep (Banfield 1981). They occur some distance from Keatley Creek in the higher mountains to the west but were hunted ethnographically for both their meat and skins (Teit 1906).

Animal Resource Utilization At Keatley Creek

As has been noted at other Late Prehistoric sites in the Interior Plateau, the faunal assemblage indicates that the subsistence of winter village inhabitants at Keatley Creek was predominantly based on dried salmon and deer, along with specific plants as discussed in the preceding chapter. Salmon and deer remains (most unidentifiable artiodactyl and large mammal bones are assumed to be deer) form by far the greatest part of the faunal assemblage at the site. The importance of the salmon fishery in the Lillooet area is exemplified by the preponderance of salmonid bones in the Keatley Creek faunal assemblage. A number of other taxa were found in the site but, based on the paucity of their remains, animal resources other than salmon and deer were of limited importance during the winter occupations of the site (Table 1). Bighorn sheep, beaver, snowshoe hare, red squirrel, and grouse were apparently utilized in small amounts. The small animals could have been obtained opportunistically during deer hunting or plant gathering expeditions and bighorn sheep would have been available in the winter near deer habitats. Some of these taxa were probably obtained primarily for their meat, while others, such as the beaver, also yielded pelts and materials for tools and rituals (these materials were probably curated).

The fish remains found on housepit floors are most likely remains from fish that were uncooked since bones of fish boiled or stewed for any length of time are highly susceptable to destruction (Wheeler and Jones 1989; Lubinski 1996). Thus, the remains are probably from fish that had been air-dried or smoked (and which are often not cooked before eating) and stored for winter and early spring consumption. The fish bones found in the bottoms of the pits within housepits are primarily articulated backbones, with few cranial remains. Although today most fillets are dried without bones, ethnographically salmon fillets were air-dried or smoked either with or without backbones attached, depending on the species and fat content of the fish (which varies with species and part of the run), and were stored in both underground and above-ground caches (Kennedy and Bouchard 1992; Romanoff 1992a). Historically, the best of the coho, those which were not too fatty, and sockeye were often smoked, or especially air-dried, with the backbone attached (Kennedy and Bouchard 1992; Romanoff 1992a). Teit (1900) notes that salmon caught late in the fall were dried without removing the backbone. The Lillooet also dried backbones separately. These "neckties" were used for making soup in the winter (Romanoff 1992a; Kennedy and Bouchard 1992) and also had considerable meat attached (Hayden, personal communication). The fattest, tastiest salmon seem to have been stored in above-ground caches near the river and consumed first, while underground caches were reserved for later consumption and contained the leaner fish caught later in the year (Kennedy and Bouchard 1975). The species of salmon present in the interior pits at Keatley Creek (primarily pink and possibly sockeye or spring) supports the idea that the underground interior pits at Keatley Creek contained fish from a fall fishery (Vol. II, Chap. 8). Archaeological data from the eastern Interior Plateau indicate that salmon from late fall runs were used for long-term underground storage in that area also (Kusmer 1990), probably due to lower fat content and lesser chance of spoilage (Romanoff 1992a). Fatter fish taste better but do not preserve as well as lean fish. Therefore, both kinds would have been desired to make it through the winter.

The subsistence pattern seen at Keatley Creek (intensive exploitation of deer and stored salmon with limited opportunistic exploitation of other varied resources) is also supported by Langemann's data (1987) and by stable-carbon isotope analyses which indicate that a marine source (salmon) contributed 70% of the protein in prehistoric diets in this area (Chisholm 1986; Chishom et al. 1982; Lovell et al. 1986). Ethnographic accounts (Teit 1906) imply that a greater variety and abundance of animals (greater diversity) were used during terminal prehistoric and early historic times. This apparent change in subsistence strategy parallels a change in settlement pattern discussed by Hayden and Ryder (1991).

Unusually large and complex winter villages, such as the Keatley Creek site, developed in the Lillooet region during the last 3,000 years and were abandoned about 1000 years ago. Hayden and Ryder (1991) believe that this collapse was caused by a catastrophic landslide that dammed the Fraser River, blocking salmon runs. The heavy reliance on salmon and deer documented in the assemblage from Keatley Creek supports this hypothesis. Salmon stores were apparently so abundant during occupation of the site that few animals other than deer were needed to supplement them. The river upstream from Lillooet is ideal for procuring high quality salmon and conditions in the area are better than most for drying and preservation. If a slide reduced access to salmon, a greater range and number of animals would be needed to take the place of salmon, since no one other animal is as abundant and accessible. This could explain the greater diversity of animals noted in the ethnographic record. It is also likely that smaller animals such as beaver were easier to obtain during seasons other than winter and that most of their bones may have been left at seasonal hunting camps.

Bone Distribution at the Site

Animal procurement, butchery, consumption, and disposal practices at Keatley Creek have been examined both through the analysis of several housepits and through the analysis of faunal remains from other areas of the site. Areas where refuse was disposed of, exterior hearths and cooking pits, exterior storage pits, and a butchering area have been identified. These data allow us to make some preliminary assessments concerning utilization of animals during winter occupation of the village pithouse site.

Mammal bones are found in relatively low amounts at the site compared to fish bones (see Vol. II, Chap. 7 for discussions of fish bone distribution at the site). This probably reflects primarily the importance of the salmon fishery and relatively low artiodactyl carrying capacity in the Lillooet area (Alexander 1992a, 1992b), although some off-site disposal of artiodactyl bones cannot be ruled out. Ethnographically, a large portion of the meat stored for winter use was stored without bones (Teit 1906). Dried deer meat was also a potlatch item (Romanoff 1992b). Bones of some animals, particularly deer and beaver, were sometimes thrown into the water so that dogs would not gnaw on them and offend the animals (Teit 1906). Ray (1942:128–129) lists cultural practices among the Lillooet which would result in deer bones not being found in housepits: meat may be given away en route (on the hunt), may be deposited outdoors, cooked meat may be taken out (of the pithouse), meat may be divided evenly between hunters, deer bones may be buried or thrown in the water, and dogs may get some of the bones. It is likely that most bones of animals hunted during the winter more than a few kilometers away were not always brought back to the pithouse and Ray's (1942) trait list of ethnographic bone disposal and meat dispersal supports this. Although these types of practices may have had an effect on large mammal bone distribution prehistorically as well, it is difficult, if not impossible to test for these in the archaeological record. Also, the bone element distribution in most areas of the site reflects the ability of the bones to survive destructive processes obscuring butchering information (Vol. II, Chap. 7). The only thing that is certain is that some proportion of the animals that were hunted in the winter were brought back to winter villages with bones and that these were generally extensively broken up presumably for the extraction of lipids. Langemann (1987) also found that bones from Lillooet sites were exceptionally heavily fragmented. This may explain why few bones have traces of dog consumption since bones boiled for marrow appear to be unappealing to carnivores (Yellen 1991). Environmental evidence presented by Alexander (1992a, 1992b) suggests that absolute abundance of deer was never great in the area (ranging from about 25 to 600, depending on the severity of the winter) and that 2 to 42 deer could be taken by hunters (mostly in Alpine areas) per year on a sustained basis. Winter deer kills by residents of any one pithouse may have been on the order of 1 to 2 per winter at the most. This is probably the most important reason why mammal bones are relatively rare compared to salmon at the site.

Test excavations indicate that areas around the pithouses were sometimes used as hearths or roasting pits to cook deer and salmon, and may also have been used as refuse dumps (Appendix I). Ethnographic studies (e.g., Teit 1906) and archaeological work at other sites in the Canadian Plateau suggest that small, circular or oval pit features are often associated with housepits. The small amount of evidence we have to date suggests these pits were primarily used for food storage and earth ovens (Teit 1906; Lepofsky et al. 1987; Richards and Rousseau 1987; Kusmer 1987) and this is supported by the excavations at Keatley Creek.

At least four of the excavations near housepits revealed cache pits (EHPE 7, 8, 9, and 10) (Appendix I). These features appear to have been originally used for storage and then to contain refuse or dirt from the immediate vicinity. In general, the recovered faunal remains appear to be refuse material. The bones are comparable in size to bones from interior pits, being larger than bones from floor and roof deposits but still relatively heavily fragmented, and many of them are burned. These characteristics, the amount of identifiable deer and artiodactyl bones, and element representation is consistent with the idea that the bones are refuse from butchering activities conducted elsewhere (Appendix I). The presence of salmon bones with the artiodactyl remains also suggests the pits were filled with garbage from butchering and food preparation activities that occurred elsewhere.

The exterior cache pits differ from interior pits with respect to the distribution of salmon bones. Large interior pits are sometimes found to contain a large amount of salmon at the bottom of the pits. These remains probably represent stored salmon left at the bottom of the pits. None of the sampled exterior pits contain large amounts of salmon near their bottoms. (EHPE 10 contained a few salmon bones at the bottom but these are associated with charcoal and may have been dumped in from a hearth.) The exterior pits were either not used to store salmon, or all the salmon in these features was utilized. At this point we do not understand why there are external and internal storage pits or what differences between external versus internal storage mean. Perhaps salmon stores from exterior pits were utilized first, and as winter progressed, interior pits were used. Thus, salmon at the bottom of the interior pits may have had more time to spoil. The salmon species identified from the interior pits indicates the fish were caught during the fall (Vol. II, Chap. 8). These are generally the less desirable, less fatty fish, which may have been stored for consumption during the last phase of winter and early spring when the stores in the exterior pits were depleted. On the other hand, exterior pits near the pithouses may have been used to store food other than fish such as dried deer meat or berries. Ethnographically, three kinds of caches were used to store food (Teit 1906). Both underground cache pits and elevated box caches were apparently constructed near where resources were obtained and ethnographically, riverside caches were used first in the winter (Kennedy and Bouchard 1978). Salmon storage pits have been found near the town of Lillooet on a terrace about 28 m above present day river

Table 3. Deer (Odocoileus sp.) Remains Recovered from HP 58, Stratum V

Square A

1 left mandible, teeth not fully erupted
1 left mandible, mature
1 right maxilla, teeth not fully erupted
1 left maxilla, mature
1 left distal metacarpal, epiphyses fused
2 left distal humeri, epiphyses fused
1 right proximal humerus, unfused
1 left tibia, epiphsyses fused
1 left proximal metacarpal, epiphysis fused
1 distal metapodial, epiphysis unfused
1 right distal tibia, epiphysis unfused
1 left distal femur, epiphysis unfused
5 incisors
11 skull fragments
10 vertebral fragments
7 rib fragments
3 costal cartilage fragments
1 distal phalanx, epiphysis fused
5 sesamoids
1 second phalanx, epiphses unfused

Square B

1 left distal humerus, epiphysis fused
1 left distal radius, epiphysis fused
1 left distal tibia, epiphysis fused
1 left tibia, epiphyses unfused
1 right radius, epiphyses unfused
1 right proximal tibia, epiphysis fused
1 left scapula (in 5 fragments), fused
1 right fibular tarsal
1 left fibular tarsal
3 phalanges, epiphyses fused
2 sesamoids
12 vertebrae, 6 with unfused epiphyses
10 rib fragments
5 pelvic fragments
NISP = 101 MNI = 4[1]

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[1] Based on 3 mature left distal humeri (= 3 mature individuals) plus 1 immature individual which would not have had a fused distal humerus.

level (Lepofsky et al. 1987). Underground caches near pithouses were also used for storing food for the winter (Teit 1906; Romanoff 1992a). Fish and meat were often stored in the elevated caches, while the underground caches near pithouses were used for roots and berries (Kennedy and Bouchard 1978). Whether the same pattern of use characterized the Keatley Creek storage practices remains to be demonstrated.

Relatively large amounts of faunal remains were recovered from deposits overlaying occupation floors in three of the small housepits which were test excavated (Appendix I). The assemblages from two of the housepits (47 and 105) have been interpreted to be refuse dumps (Appendix I) and this suggests that sometimes vacated pithouses and/or pithouse depressions were used as garbage dumps by inhabitants of other pithouses. The lack of such remains in the large housepits excavated to date (other than in interior pits) suggests these structures were utilized late in time, perhaps up until the time of site abandonment. The assemblage from the third housepit, HP 58, is different from other assemblages found at the site (Table 3; Appendix I) and attributes of the assemblage suggest the pithouse/depression was used at least once for primary butchery of artiodactyls after the pithouse was abandoned. Little further butchering for marrow extraction or grease production seems to have occurred here although all other mammal bones recovered from Keatley Creek indicate bones were heavily fragmented for marrow and grease extraction.

Housepit Deposit Formation Processes

This section describes the faunal assemblages present within housepit deposits at Keatley Creek and examines and attempts to distinguish processes involved in their formation. The aims of this part of the faunal study were as follows:

1) To identify and attempt to explain the differences and similarities of animal remains between floor and roof deposits tentatively identified through geological techniques. Criteria to be investigated were bone fragment size, frequency, condition, breakage, and taxa represented. It was hoped that this analysis would serve as a supplementary line of evidence and aid in the interpretation of the different deposits.
2) To examine the frequency and distribution of different size fractions of bone in the living floor deposits. Along with a similar study of lithic debitage, this analysis would provide information concerning the degree of contamination of the floor deposits. Evidence from ethnoarchaeological studies (Hayden 1982; Hayden and Cannon 1983) suggests that refuse collects along the walls and little used areas of a structure, that central areas are clear with small debris around hearths, and that the largest refuse is located along the walls. The presence of this type of patterning would indicate relatively uncontaminated floors, while a random distribution of debris would suggest contamination of the floor deposits.
3) If intact living floors were satisfactorily identified, a third aim was to identify activity, storage, and disposal areas and gain some insight into animal utilization and disposal practices within a pithouse. Roof deposits would be similarly examined for patterning that might be expected from disposal of waste on the roof or butchering activities conducted at the base of the roof. This would be accomplished by examining the frequencies and distributions of various size categories of remains, taxa represented, and butchery and breakage patterns.

This third aim is discussed in Volume II, Chapter 7.

Methods

A large housepit (HP 7) and a medium-sized housepit (HP 3) were chosen for detailed analyses of underlying taphonomic processes responsible for housepit formation, and in particular to examine differences between major types of housepit deposits (floor, roof, and rim).

All faunal remains recovered from HP 7 and HP 3 were examined. The following information was recorded for each bone fragment recovered from the 6.35 mm mesh: element, portion of element, taxon, type of break, weathering state, surface modification (e.g., burning, cutmarks, gnaw marks), and maximum dimension. For the faunal remains from the flotation samples, taxa represented and the frequency of bones (all in the 0.15–1.00 cm size range) were recorded.

Faunal Assemblage Formation

Most of the faunal remains recovered from HP 7 and HP 3 can be placed in two categories: small fragments of unidentifiable mammal bones or fish bones. The data indicate that the frequencies of these bone types vary with the type of deposit and that attributes of the mammal bones also vary with deposit type (Table 4). The following discussion attempts to explain the processes responsible for this faunal assemblage formation.

Mammal bones from all deposits in HP 7 and HP 3 are generally small fragments, unidentifiable to skeletal element, although bones from the rim and interior pits in HP 7 tend to be slightly larger. This indicates natural and/or cultural processes were extensively reducing bones at Keatley Creek. Artiodactyl bones are highly fragmented at the site suggesting extensive bone breakage for marrow and grease production. The frequency of artiodactyl skeletal parts is correlated with the density of the individual skeletal parts. The most common skeletal parts are those that survive well because they have the densest bone (and also are easily identifiable as small fragments) (Table 5). This indicates the patterns of artiodactyl skeletal parts observed has more to do with the ability of individual bones to survive fragmentation processes rather than being a reflection of primary butchering patterns (Lyman 1991; 1992). The frequency distributions of artiodactyl remains as a whole (not distinguished by element) may, however, suggest processing and/or consumption areas within the pithouses (Vol. II, Chap. 7).

In addition to human fragmentation for grease procurement, post-depositional weathering and carnivores can cause extensive bone fragmentation, leaving only the most durable elements. Surface condition of the bones suggests weathering is not a major problem, especially for bones from floor and pit deposits (Table 4). Dog remains are relatively common in the assemblage suggesting dogs may have fragmented some of the bones. However, there is little direct evidence for this. Carnivore damage is rare on bones from any deposit. The most frequent break type occuring on bone fragments is the spiral fracture. Spiral fractures may be produced by a number of processes, including both carnivore chewing and human bone reduction activities. However, most of the long bone fragments appear to have originated from mid-shaft breaks, rather than breaks occuring at the bone ends which are usually associated with carnivore damage (Lyman 1987). Dog coprolites have been recovered from the site and frequently contain salmon bones. There is no indication of canid gastric etching and few gnaw marks on bones. The extensiveness of artiodactyl bone fragmentation in all deposits, the abundance of small, mammal bone fragments in all types of deposits, the lack of carnivore damage or gnawing on bones, and the presence of salmon bones in dog coprolites, suggests most bones were reduced during bone processing for marrow and grease. This is not unexpected in a site occupied during the winter when sources of meat may have been limited. Dogs may have primarily been fed poorer quality salmon (salmon is ethnographically of lower status than deer [Romanoff 1992b]) and have had little access to artiodactyl bones. In any case, whether human or natural processes were fragmenting the artiodactyl bones, the result is the same: transport and butchering information has been greatly diminished.

Table 4. Condition of Faunal Remains Recovered from Deposits in HP 7 and HP 3, Keatley Creek

	HP 7		HP 3	
	#	%	#	%
Floor				
Total bones	2401	—	561	—
Fish bones	1344	.56	314	.56
Non-fish bones	1057	.44	247	.44
Burned bones[1]	349	.33	124	.50
Weathered bones[2]	28	.04	0	0.00
0–2 cm	797	.75	160	.65
2.1–8 cm	254	.24	86	.35
>8 cm	6	.01	1	<.01
Roof				
Total bones	3,046	—	293	—
Fish bones	319	.10	14	.05
Non-fish bones	2,727	.90	279	.95
Burned bones	1,595	.59	143	.51
Weathered bones	339	.30	27	.20
0–2 cm	1,917	.70	189	.68
2.1–8 cm	787	.29	89	.32
>8 cm	23	.01	1	<.01
Rim				
Total bones	636	—		
Fish bones	177	.28		
Non-fish bones	459	.72		
Burned bones	123	.27		
Weathered bones	168	.50		
0–2 cm	206	.45		
2.1–8 cm	248	.54		
>8 cm	5	.01		
Filtered Collapse				
Total bones			153	—
Fish bones			2	.01
Non-fish bones			151	.99
Burned bones			105	.70
Weathered bones			12	.08
0–2 cm			102	.68
2.1–8 cm			44	.29
>8 cm			5	.03
Roof/Rim				
Total bones	312	—		
Fish bones	70	.22		
Non-fish bones	242	.78		
Burned bones	46	.19		
Weathered bones	42	.21		
0–2 cm	148	.61		
2.1–8 cm	94	.39		
Medium/Large Pits				
Total bones	4,955	—		
Fish bones	3,161	.64		
Canid bones	1,265	.25		
Other bones[3]	529	.11		
Burned bones	61	.11		
Weathered bones	38	.07		
0–2 cm	268	.51		
2.1–8 cm	252	.48		
>8 cm	9	.01		

1. The number and percent of non-fish bones that are burned.
2. The number and percent of non-fish and unburned bones that are weathered.
3. The numbers and percentages of burned, weathered, and sizes of bones in pits pertains only to these non-fish, non-canid bones.

Floor assemblage formation: Data from HP 3 and HP 7 indicate two major differences between bones from floor and roof deposits (Table 4). First, fish remains are found primarily in floor deposits (and in interior pits). Few fish bones are found in roof deposits. This indicates that there has been little intermixing of roof and floor deposits. This pattern is also strongly developed in the HP 9 assemblage (Table 6 and Appendix II), excavated after the detailed analysis of HPs 3 and 7 was completed. Secondly, few bones from the floor, pits, or filtered collapse are weathered, while 20–30% of the roof bones and 50% of the rim bones are weathered. Bone fragment size is similar in floor and roof deposits. The differences in fish bone frequency and weathering frequency appear to be good distinguishing characterisics of floor versus roof bone assemblages, and can be used to help distinguish the two types of deposits. The paucity of weathered bones in floor deposits, along with the small relative amount of mammal bones (compared to that in roof deposits) and the small size of the bones, suggests the floors are largely uncontaminated with roof bones and that the fish bones and highly fragmented mammal bones on the floor are the product of cultural activities that took place within the housepit. Non-random distributions of bones on the floors also corroborate this assessment (Vol. II, Chap. 7). The floors were kept clean of large debris. Bone preservation in floor deposits is good and therefore apparently had little influence in creating spatial patterning of bones observed in floor deposits, although housecleaning activities (especially of larger bones) and trampling likely affected some distributions (Vol. II, Chap. 7).

Roof assemblage formation: The presence of relatively large frequencies of mammal remains in roof deposits as compared to floor deposits can be due to a number of factors such as butchering activities on or near roofs, bone artifact manufacture, and refuse dumping. The bones are generally small fragments (Table 4), similar in size to floor deposit bones indicating extensive bone reduction processes occurred. The greater exposure to subaerial weathering of roof bones could have caused some bone breakage. However, many of the small fragments appear to be in good condition and are not broken in a way typical of weathering-related breakage. Rim bones have a higher frequency of weathering, yet they are larger than roof bones, suggesting factors in addition to weathering probably fragmented the roof bones. Analyses of the patterning of bones from roof deposits (Vol. II, Chap. 7) suggests the large amounts of small fragments of mammal bones on the roofs are probably the result of butchering and bone reduction activities (occurring either on the roof or inside with subsequent discard on the roof), in addition to some weathering-related breakage (and loss).

Due to the presumed longer existence of roof deposits than floor deposits plus the possible continuous discard of bone material on the roof throughout the use-life of the house, we might expect many times more faunal remains in roof than in floor deposits. This is clearly not the case, suggesting either considerable attrition of faunal remains in roof deposits (which we have no evidence for) or that the dirt roofs were used for relatively short periods of time and were periodically replaced.

The similarity in the frequency of burned mammal bones from floor and roof deposits in HP 3 suggests that there was a similar processing origin for mammal bones in both (Table 4). Possibly burned and unburned refuse bone on floors were periodically gathered up

Table 5. Distribution of Artiodactyl Elements

	HP 7			HP 3		HP 12	
Skeletal Element	Floor	Roof	Pits	Floor	Roof	Floor	Roof
Tooth fragment	10	32	5	1	8	0	0
Skull	0	6	0	0	0	0	0
Mandible	4	0	0	0	0	0	0
Vertebra	0	9	2	1	0	0	0
Rib	1	4	1	0	2	0	0
Sternum	2	0	3	1	0	0	0
Scapula	2	8	5	1	0	0	0
Humerus	4	2	0	1	0	0	0
Radius	0	3	0	1	0	0	0
Ulna	0	2	1	0	0	0	0
Pelvis	0	2	1	0	0	0	0
Femur	1	0	0	0	0	0	0
Tibia	0	2	0	0	0	0	0
Carpal/Tarsal	12	14	8	3	1	0	1
Metapodial	11	29	5	3	4	5	9
Phalanx	21	35	13	2	2	0	6
Total[1]	68	148	44	14	17	5	16

[1] Does not include antler fragments.

and discarded on the roof. The relatively small number of burned fish bones in floor and roof deposits suggests that many of the bones were not burned during burning of the structure, perhaps because they were insulated by the soil. In HP 7, the higher frequency of burned roof bones is due to concentrations of burned bones in post-occupational hearths and hunting camps in the center area of the housepit depression. Areas of refuse dumping and possibly butchering activities relating to the housepit occupation are found around the periphery of the roof in HP 7, as in HP 3 (Vol. II, Chap. 7).

Filtered collapse assemblage formation: These deposits were observed in HP 3. Bones from filtered collapse deposits are the same size as other roof bones, but are more burned and less weathered (Table 4). Fish bones are rare, as in roof deposits. This is to be expected of bones from bottom roof deposits that first filtered down onto the floor as the structure burned. The lower incidence of weathered bones than in standard roof deposits may be due to the position of filtered collapse at the base of roof sediments which would have protected the bones from subaerial weathering.

Roof/Rim (Stratum V) assemblage formation: In HP 7, the relatively larger bones from roof-like deposits in the upper rim in the east (Stratum V) have characteristics similar to mammal bones from interior storage/refuse pits (Table 4), suggesting either that garbage bones were dumped on the roof in this area or that butchering activities occurred here. This deposit consists of collapsed roof material, not typical rim deposits. This is because a hill slope forms the rim on the east side. These roof deposits are different from deposits elsewhere on the roof because of their location on the house rim and because the extreme slope sometimes caused slumpage. The bones in this deposit occur at a higher frequency than other rim deposits, and are less burned, less weathered, and larger than bones from typical roof deposits. Possibly the natural hill slope abutting the roof here created favorable conditions for butchering or other activities. No similar occurrences were found in the east or other roof sections of housepits that did not abutt hillsides.

Medium and large interior pit assemblage formation: Interior pits in HP 3 and HP 7 are major repositories of faunal remains. The presence of large quantities of articulated salmon remains in the bottoms of some of the pits suggests the primary function of the pits was to store salmon (see Appendix III). In HP 7, mammal bones from these features are similar in size to rim bones, being larger than floor or roof bones (Table 4). These bones are less weathered than roof or rim bones (similar to floor bones) and less burned than floor, roof, or rim bones. The relatively large size and unburned and unweathered condition of mammal bones and bone artifacts from the pits in HP 7 indicate that after the pits were emptied of stored fish, the pits were filled in with debris from the floor, including unwanted bone tools and larger bones. Thus, the bones in the pits are probably collections of bones, especially larger bones, from animal processing actvities that occurred on the floors. The artiodactyl bones in the pits have a similar element distribution to bones from the floor and roof deposits, suggesting that most bone refuse was put in the pits after secondary butchering and consumption activities. The pits could have been used as garbage receptacles during occupation once the salmon was depleted, and the bones may be the remains either from tossing in individual bones during meals and/or from housecleaning (Bartram et al. 1991). Alternatively, unused salmon storage pits may have been filled in with larger debris, left on the floor at the time of seasonal abandonment, during fall cleanup prior to reoccupation. The relative frequency of fish in the pits, above the bottom layers of fish bones, is similar to the frequency of fish on the floor (about 60%). Also, bone refitting in one of the pits indicates the pit was filled in fairly rapidly, supporting the second scenario, although different pits may have different depositional histories.

Two of the large pits in HP 7 also contained domesticated dog skeletons at the bottom of the pits, indicating some sort of special treatment of dog remains (see Vol. II, Chap. 10). The faunal remains in the fill above the dogs are similar to those in the other pits. The large pits in HP 3 were also apparently used to store salmon, but the fill above the salmon bones contained few mammal remains compared to the pits in HP 7. There are fewer medium/large pits in HP 3, suggesting they were all needed for salmon storage, and actively being used for this purpose, rather than some being filled with garbage during occupation of the house. According to field notes, one pit was apparently partially filled in with hearth cleanings during the last occupation.

Rim assemblage formation: Rim deposits were excavated primarily in HP 7. The highly localized concentrations of relatively large, unburned, and weathered bones in rim deposits in HP 7 (Table 4) could be primary refuse from butchering activities, secondary refuse from activities that took place in the house, or both. The remains mostly concentrate in the north, with another concentration in the east. The percentage of identifiable artiodactyl remains in rim deposits is similar to that in floor and roof deposits and they are primarily axial and lower leg and foot parts, although more fragments of large mammal limb bones were found than in the floor or roof deposits. Thus, all parts of the artiodactyl skeleton occur on the rim, and the long bones were apparently smashed for marrow extraction (although not necessarily on the rim). It is difficult to tell from the attributes of the bones whether they are primary or secondary refuse, or both. Ethnoarchaeological research highlights this problem, but suggests that occupational length and proportion of secondary to primary refuse are related (Bartram et al. 1991). The permanence of the pithouse structures and evidence of repeated seasonal reoccupation of many of the structures leads one to expect that many of the bones at the site have been moved from their original contexts through various activities such as trampling, scuffing, and housecleaning. The location of the bones in the rim, around the periphery of the living area, suggests they are the result of dumps of debris from housecleaning; perhaps from cleaning out interior pits and/or from housecleaning of large debris left on the floor during seasonal abandonment. Dumps of fire-cracked rock also concentrate in the north indicating that area was used as a garbage dump (Vol. I, Chap. 14).

The presence of all parts of the artiodactyl skeleton, including axial parts such as mandibles, in localized areas of the rim supports the idea that they are garbage dumps. Axial parts, including mandibles, are also found on the floor in contexts that suggest consumption areas, indicating these parts of the skeleton were utilized and not left at butchering sites. Ethnoarchaeological research also suggests that axial parts and phalanges in primary contexts (on the floors in this case) indicate post-butchering consumption areas (Bartram et al. 1991). Their presence in rim deposits points to post-consumption cleaning and dumping of floor deposits on the rims.

Summary

The winter village inhabitants at Keatley Creek during the Kamloops phase appear to have been relying primarily on stores of food acquired during hunting, gathering, and fishing expeditions at other times of the year. Their animal subsistence strategy during the winter involved concentrating heavily on dried salmon (and perhaps dried artiodactyl meat), with limited opportunistic hunting of deer and bighorn sheep, and little exploitation of smaller animals. Useful parts of other animals hunted during earlier seasons were also introduced into the housepits as curated tools or decorations (e.g., beaver teeth, bird wings, bear paws, tooth pendants, pelts). Still other elements were introduced as trade items (e.g., moose and elk antler, marine shells). The pattern of resource use revealed at Keatley Creek substantiates previous research suggesting that the combination of availability of vast quantities of a predictable resource (salmon), storage and processing technology, and optimal drying conditions had a major influence on the development of the Late Prehistoric subsistence strategy and growth of large pithouse villages in the Lillooet Region.

It appears food was stored for winter in both interior and exterior underground cache pits. Dried salmon seems to have been stored primarily in the interior pits, and the exterior pits may have been used for other dried foods and/or for salmon consumed earliest in the season. The few artiodactyls procured during the winter were extensively butchered for marrow procurement and grease production suggesting that they were a highly valued supplement to the dried foods. Some primary butchering may have occurred on inhabited pithouse roofs and in nearby abandoned pithouses, while secondary butchering and preparation for cooking may have occurred both on roofs and in the pithouses (Vol. II, Chap. 7). Debris from butchering and consumption activities was dumped into unused interior and exterior pits, onto roofs and rims, and in uninhabited pithouse depressions.

Analysis of bones from within housepits indicate that intact living floors were present and that faunal remains from floor and roof deposits differ in two major attributes; the degree of bone weathering and the frequency of fish remains. These attributes can be used in conjunction with other types of information to identify floor and roof deposits.

Floors were kept clear of large faunal debris. The differential occurrence of fish bone in floor deposits plus the non-random distributions of fish, identified mammal, and unidentified mammal bones (Vol. II, Chap. 7) indicate that activity/living areas on the floor have been preserved with little post-occupational disturbance. The small size of fragmented mammal bones, and low frequency relative to the roof, indicate that most large debris was swept or picked up and dumped elsewhere. Some larger bones and discarded artifacts appear to have been dumped in large interior pits after they were emptied of salmon and in localized rim areas. Pits emptied of salmon were apparently filled in with debris fairly rapidly, perhaps at the beginning or end of yearly reoccupations. Some smaller bone refuse appears to have been cleaned up and dumped on the roofs. The lack of fish bones in roof deposits suggests these tiny bones were difficult to remove from the floors and/or did not survive in the roof soil environment after periodic roof replacement involving removal of floor sediments. Clusters of larger bones in roof/rim deposits in HP 7 suggests larger debris from food production/consumption was dumped in specific areas or that animals were butchered there, which field observations indicate did occur at hunters' camps made in the housepit depressions long after the abandonment of the pithouses and the collapse of their roofs. There is evidence for extreme bone reduction for marrow procurement and grease production along with some weathering fragmentation. Little carnivore/dog damage is apparent. It is not possible to obtain much information concerning butchering practices because artiodactyl bones have been so fragmented and the remaining elements reflect survivablity and identifiablity rather than, or in addition to, butchering patterns.

Garbage bones from butchering, food preparation, and/or consumption appear to have been dumped in localized areas of the rim in HP 7. This may have occurred primarily at the beginning of yearly reoccupations when floors were cleaned up and swept. Smashing of long bones for marrow extraction may have occurred on the rim also, especially in the north. It is difficult to tell from the attributes of the bones in roof and rim deposits whether they are primary or secondary refuse, or both. However, the permanence of the pithouse structures and evidence of repeated seasonal reoccupation of many of the structures leads one to expect that many of the bones at the site have been moved from their original contexts.

Appendix I:

List of Faunal Remains from Areas Outside of Housepits and from Tested Housepits

Interpretations of feature and stratum identity/function are based on excavation reports in Volume III.

Extra Housepit Excavation (EHPE) 1, a roasting pit north of HP 7, contained the following bone fragments: 2 deer (*Odocoileus* sp.), 3 artiodactyl, 97 unidentifiable mammal, and 1 salmon. Twenty-four percent of the bone fragments were burned.

EHPE 2, a hearth north of HP 7, contained the following bone fragments: 1 *Canis* sp., 1 artiodactyl, 27 mammal, and 11 salmon. One mammal fragment was burned.

EHPE 4, a small circular cultural depression, may have been used as a storage pit and/or earth oven. However, the function of this area is not clear. Sixteen unidentifiable mammal framents (9 burned), 2 deer fragments, 4 large mammal fragments, and 5 salmon bones were recovered from this pit.

Eight areas between housepit depressions with apparent potential for cultural remains were excavated in 1988. The faunal remains from these areas are listed below.

EHPE 5 (HP 119): Extra-housepit excavation 5 took place in a roundish, flat area in the southwestern portion of the site. Excavations in the area in 1987, conducted to determine if cultural activity had created the feature, revealed cultural sediments under about a meter of naturally deposited sediments. These sediments were found in 1988 to be a buried Kamloops housepit (HP 119) covered initially by fluvial and then by aeolian deposits. Faunal remains were recovered from the following sediments: Five deer tarsal bones, 1 deer ulna fragment, 2 artiodactyl bones, 1 canid radius, and 54 unidentifiably mammal bones were recovered from Zone I. This zone is composed of recently deposited aeolian sediments and the faunal remains probably represent fairly recent bones left on the contemporary surface. One deer thoracic vertebra fragment, 1 deer pelvis fragment, 1 artiodactyl fragment, and 11 unidentifiable mammal fragments were recovered from Zone II. Zone II is composed of water-lain deposits which infilled the housepit. The bone fragments are small and probably washed in with the sediments. One deer pelvis fragment was recovered from Zone III, Stratum III. This stratum appears to be the roof deposits of the buried housepit.

EHPE 6: Extra-housepit excavation 6 consists of a 2 × 0.5 m unit dug into a small, mound-like feature about 35 m southeast of HP 1. A buried paleosol exists ca. 70–80 cm BS. Faunal remains were recovered from this stratum only and consist of 1 deer tarsal, 1 beaver (*Castor canadensis*) tooth, 1 beaver phalanx (burned), and 23 weathered large mammal fragments (all less than 3 cm in maximum dimension).

EHPE 7: Extra-housepit excavation 7 was dug into a small, oval, cultural depression located in the southeastern rim of HP 4. Three 1 × 0.75 m units, forming a N/S trench through the cultural depression were excavated in 10 cm arbitrary levels. The depression is thought to be a small cache pit dug into the rim spoil deposits of HP 4 and HP 73. It was apparently used during the Plateau horizon, which concurs with the main occupation of HP 4. The pit was apparently used as a refuse dump after its original use as a storage facility.

Seventeen salmon and 207 mammal bones were recovered from this depression. The bones were found in the following deposits: One slightly charred bighorn sheep (*Ovis canadensis*) tooth fragment, 1 left deer radius, 1 right deer radius, 1 right deer ulna, and 19 unidentifiable mammal fragments were recovered from deposits near the bottom of the pit. These deposits may represent the original storage function of the pit. One deer phalanx, 2 burned artiodactyl long bone fragments and 32 unidentifiable mammal fragments were recovered from infill deposits probably representing refuse dumping in the pit. One artiodactyl fragment, 1 deer molar, 1 immature deer metapodial, 2 salmon vertebrae, and 54 unidentifiable mammal fragments were recovered from Stratum XIII. This stratum appears to be rim spoil deposits from HP 4 to the north and/or HP 73 to the south. Fifteen salmon bones, 1 hare (*Lepus* sp.) femur, 1 deer metapodial, 1 deer pelvis, 1 deer talus, and 88 unidentifiable mammal fragments were recovered from Stratum XIX. This stratum is part of a large pit feature excavated into a paleosol and may be part of a buried housepit. The deposits are typical of heavily disturbed rim spoil.

EHPE 8: Extra-housepit excavation 8 was dug into a small, circular depression on the edge of a terrace bordering the western edge of the site. Three 1 × 0.75 m units, forming a N-S trench through the depression, were excavated in 10 cm arbitrary levels. The feature is thought to be a shallow cache pit, probably used only once. Fourteen large mammal fragments were recovered from the pit at 10–30cm BS. One fragment was burned, 13 fragments were 2–3 cm and one was 3–4 cm in maximum dimension. These remains probably represent debris from natural or cultural infilling of the pit.

EHPE 9: Extra-housepit excavation 9 was conducted in a small, circular, cultural depression on the southern edge of the site about 5 m southeast of HP 9. Two 1 × 0.75 m conjoining units were excavated. The depression is thought to have functioned originally as a cache pit. It appears to have been intentionally filled in with rim deposits from HP 9 after use as a storage facility during the late Kamloops horizon. Sixty-five bones were recovered from the pit, all from Stratum IIa and Stratum IIb. These strata appear to represent cultural infilling events. One deer phalanx, one deer tibia, 2 artiodactyl metapodials, and 56 unidentifiable mammal bones were recovered from 10–20 cm BS; and 5 mammal bones were recovered from 20–30 cm BS. About 25% of the bone are >2cm. Five of the bones are weathered and 40 are burned.

EHPE 10: Extra-housepit excavation 10 was conducted in a small, oval, cultural depression located on the first terrace overlooking the main part of the site. Three 1 × 0.75 m units, forming a trench through the feature, were excavated. The depression is thought to have originally been used as a storage facility and then used as a refuse pit. Salmon and mammal bones were found throughout Stratum III from 50–90 cm BS. This stratum appears to be composed of infill and refuse deposits. Eighty-seven salmon bones were recovered, 5 associated with charcoal at the bottom of the pit, 1 from 45–50 cm BS, and the rest from 60–90 cm BS. One *Canis* sp. metapodial was recovered from 72–76 cm BS. Eight intrusive vole (*Microtus* sp.) and 2 intrusive deer mouse (*Peromyscus* sp.) bones were found. Two bighorn sheep cervical vertebrae, 2 deer scapulae (1 highly weathered), 1 deer metacarpal, 3 deer tarsals, 1 deer phalanx, 1 deer humerus, 1 artiodactyl metatarsal, 3 artiodactyl ribs, and 7 unidentifiable mammal fragments were recovered from these deposits. Most of the large mammal bones were recovered from 73–80 cm BS. About 80% of the mammal bones are >3 cm in maximum dimension and about 50% are >8 cm.

EHPE 11: Extra-housepit excavation 11 was conducted in a small, circular, cultural depression immediately southwest of HP 26. Three 1 × 0.75 m units, forming a trench through the feature, were dug in 10 cm arbitrary levels. The feature is thought to represent a small dwelling, although it may also have been a storage pit. Faunal remains were recovered from the following strata: One mammal and 39 salmon bones were recovered from Stratum IIb. This stratum appears to represent natural infilling and cultural discard of items during the Kamloops horizon. Three salmon, 3 mammal, 3 freshwater shell fragments, and an artiodactyl metapodial wedge were recovered from Stratum IV. This stratum appears to relate to the occupation (or storage) function of the feature. Three salmon bones, 1 mammal bone, and 1 deer ulna exhibiting carnivore damage were found in Stratum VI. This stratum appears to consist of slopewash deposits. Eleven salmon bones, 12 mammal bones, and 1 artiodactyl metapodial were found in Stratum VII. This stratum also consists of slopewash deposits. Seventy-two salmon bones, 12 mammal bones, and 1 artiodactyl tooth fragment were recovered from Stratum VIII. This stratum represents the initial construction and use of the feature and appears to be the floor deposits of a small dwelling.

EHPE 12: Extra-housepit excavation 12 was conducted in a small, circular, cultural depression west of HP 105 on Terrace II. Three 1 × 0.75 m units, forming a trench intersecting the depression, were excavated in 10 cm arbitrary levels. Two individual episodes of hearth construction and use during the early Plateau horizon are evident in the deposits. These deposits contain a high frequency of small, burned, mammal bone fragments. The feature also appear to have been used as a refuse pit for lithic debris.

Faunal remains were found in the following strata: One salmon bone; 2 teeth, 4 phalanges, 2 metapodials, and 1 carpal from artiodactyl; and 199 unidentifiable mammal fragments (95% burned) were recovered from Stratum II. This stratum appears to be a mixture of natural and cultural fill associated with early Plateau use of the feature. One burned deer phalanx and 8 burned mammal fragments were recovered from Stratum III, an early Plateau hearth. One burned artiodactyl sesamoid and 26 burned mammal fragments were recovered from Strata IV and V, another Plateau hearth predating Stratum III. Six burned mammal fragments were recovered from Stratum VII. The origination of this stratum is not clear.

EHPE 15: One salmon vertebra and 1 burned mammal bone were recovered.

EHPE 18: Two artiodactyl long bones were recovered from Square A, Subsquare 3, Stratum I. Twenty-eight mammal bones, 2 salmon vertebrae, 2 salmon postcranial bones, 1 deer right first phalanx, and 1 deer left humerus fragment were found in Square A, Subsquare 7, Stratum III. Sixty-five mammal bones, 1 salmon cranial bone, 7 salmon vertebrae, 1 deer third phalanx, 1 artiodactyl metapodial fragment, 4 artiodactyl phalange fragments, and 1 artiodactyl tooth fragment were recovered from Square A, Subsquare 11, Stratum III. Two partial vole (*Microtis* sp.) skeletons were also recovered from Subsquare 11. The vole bones included 3 skull fragments, 4 mandibles, 4 femora, 1 ulna, 2 tibiae, 4 scapulae, and 1 radius.

Only 8 of the recovered bones are burned and none are weathered. Eighteen percent of the bones are over 3 cm in length and 20% are under 2 cm in length.

EHPE 19: In Stratum II, 122 mammal bones (1 burned), 14 salmon vertebrae, 36 salmon cranial bones (MNI=2), 17 fish rays and spines, 1 Canis phalange fragment, 10 artiodactyl long bone fragments, 5 deer humerus fragments, and 7 fetal/newborn artiodactyl long bone fragments were recovered.

In Stratum III, 7 mammal bones, 1 salmon vertebra, and 10 unidentifiable fish bones were recovered.

Only 1 of the recovered bones is burned and none are weathered. Forty-eight percent are less than 2 cm in length and 35% are greater than 3 cm in length.

Housepit 1

HP 1 is located on the western edge of the main site and averages 20 m in diameter. Test trench and unit excavations recovered Kamloops and Shuswap points. Fifteen fish bones, 76 mammal bones, 2 artiodactyl bones, and 1 deer phalange were recovered from roof deposits. Twelve fish and 58 mammal bones, 2 beaver incisors, and 1 deer scapula fragment were recovered from floor deposits. Fourteen fish, 62 mammal, and 2 artiodactyl bones; 1 ulna, 1 metapodial, and 1 phalange of deer; 2 shell fragments; and 2 beaver incisors were recovered from rim deposits. Seventy-five burned mammal bones were recovered from a hearth in Square B. About 650 fish bones; 33 mammal bones; and 3 phalanges, 1 carpal, 1 tarsal, and 1 metapodial of deer were found in pit feature #1. Six mammal bones were found in pit feature #2.

Housepit 2

HP 2 averages 18.5 m in diameter and is located in the central area of the site. Test trench excavations recovered Plataeu, Shuswap, and Kamloops points. One deer humerus and 35 burned mammal bones were recovered from roof deposits. One deer metapodial and 112 burned mammal bones were recovered from floor deposits. Ten mammal and 70 fish bones were recovered from rim deposits.

Housepit 4

HP 4 is located in the southwest main area of the site and averages 10.25 m in diameter. Test trench excavations recovered Plateau, Shuswap, and Kamloops points. Four fish and 24 mammal bones were recovered from roof deposits. Twenty-five fish and 34 mammal bones; 1 incisor, 1 humerus, and 1 radius of beaver; and 1 metapodial, 2 tarsals, and 1 tibia of deer were recovered from floor deposits. Four fish and 2 mammal bones were recovered from rim deposits. Eight fish and 30 mammal bones; 2 phalanges and 1 incisor of beaver; 1 deer phalange; and 3 bighorn sheep horn core fragments were recovered from pit feature #2.

Housepit 5

HP 5 averages 20 m in diameter. Test trench excavations recovered Kamloops, Shuswap, Plateau, and earlier points. One fish and 79 small, calcined mammal bones were found in rim deposits in Square F. Five fish and 15 mammal bones were found in a feature in Square A. One mammal bone was recovered from roof fill in Square B. Twenty-three fish and 4 mammal bones were found in a feature in Square C.

Housepit 8

HP 8 averages 17.5 m in diameter. Test trench excavations recovered only Plateau points. Five fish and 5 mammal bones were recovered from rim deposits. Eleven fish and 1 mammal bones, and 1 beaver incisor were recovered from a feature in Square BB. One fish and 25 burned mammal bones, and 1 crow carpometacarpus were recovered from a feature in Square AA. Thirteen mammal fragments were found in a feature in Square B.

Housepit 47

HP 47 is a cultural depression averaging 8.0 m in diameter. It is located on the southern edge of the site about 20 m east of HP 5. Test excavations revealed a complex stratigraphy which seems to be related to a series of cultural events that occurred at this feature. Initially a hearth appears to have been built and utilized, perhaps in the Late Shuswap—Early Plateau time period. A housepit was constructed some time later. After abandonment of the housepit, the depression was apparently used as a refuse dump during Late Plateau to Early Kamloops times, perhaps by nearby HP 5 inhabitants. A hearth, and possibly a small structure, were apparently built in the depression after its use as a refuse receptor. Faunal remains were recovered from the following deposits.

Stratum IV: One burned mammal fragment and 84 salmon bones were recovered from Stratum IV, the possible hearth feature built into the refuse dump.

Stratum VI: One salmon vertebra was recovered from Stratum VI, which is probably a refuse dump.

Stratum VII: One freshwater shell fragment, 159 salmon bones, 1 deer scapula, 3 deer phalanges, 1 deer tarsal, 1 intrusive vole (*Microtus* sp.) skull fragment, 1 beaver (*Castor canadensis*) tooth fragment, and 31 unidentifiable mammal fragments were recovered from Stratum VII, which was probably built up through a series of dumping events. The mammal bones are unburned, 40% are >2 cm and about 30% are >3 cm. These attributes are consistent with remains from either a refuse dump or butchering area, but element representation, associated faunal remains, and other contextual information indicate that the refuse explanation is more probable. A small (4 mm), calcined bone bead was also recovered from Stratum VII.

Stratum VIII: Fifty-four salmon bones, 1 deer metatarsal, 1 artiodactyl long bone fragment, and 1 unidentifiable mammal bone were recovered from Stratum VIII. This stratum is thought to consist of refuse deposits also, and may be combined with Stratum VII.

Stratum IX: One freshwater shell fragment, 37 salmon bones, 1 deer tarsal bone, and 14 unidentifiable mammal fragments were recovered from Stratum IX. The bones are unburned and about 75% are <2 cm. A wedge-shaped antler artifact and about 25 burned, broken fragments of a large mammal bone (probably a scapula) were also recovered. Some of the fragments show signs of cultural modification in the form of striations and ground edges. Stratum IX appears to consist of floor deposits from the housepit occupation.

Stratum XI: Fourteen salmon bones were recovered from Stratum XI. This stratum appears to represent the initial hearth deposits.

Housepit 58

HP 58, a small housepit, is located at the southwest edge of the main site area at the base of a terrace slope. Test excavations revealed a single occupation. After abandonment the depression was apparently used as a deer butchering area. Faunal remains were recovered from the following deposits.

Stratum II: This appears to be roof fill. Eleven salmon bones, 2 deer, 1 red squirrel (*Tamiasciurus hudsonicus*), and 81 unidentifiable mammal fragments were recovered. Four fragments of incised, flat mammal bone were also recovered.

Stratum IV: This appears to represent burned, bark covered roof deposits. It is overlain by Stratum II. Eight salmon, 4 deer, 1 bighorn sheep, 1 artiodactyl, and 110 unidentifiable mammal bones were recovered. Ninety-eight percent of the bones are burned. About 40% of the bones are >2 cm and about 15% are >3 cm.

Stratum V: This stratum contains one of the largest concentrations of bones recovered at Keatley Creek to date. Eighty-four salmon, 48 deer, 1 bighorn sheep, 1 possible mountain goat (*Oreamnos americanus*), 50 artiodactyl, and 463 unidentifiable mammal bones were recovered. The deer bones consist of the remains of at least 4 individuals and fragments from the entire skeleton are present (Table 3). (Ribs, vertebrae, sesamoids, and costal cartilage are identified as artiodactyl.) This element representation is different from what was found in other areas of the site (Table 5) and suggests this may have been a dumping area associated with a primary butchery location. This is further supported by the bone attributes: less than 5% of the bones are burned, about 30% are >3 cm, and about 10% are >8 cm.

Stratum VII: These deposits are difficult to interpret, but may be floor deposits which aggraded over time. Eleven salmon, 1 muskrat (*Ondatra zibethica*), and 16 unidentifiable mammal bones were recovered. Fifty percent of the mammal bones are burned and most are <2 cm.

Stratum III: This consists of rim deposits formed during construction of the initial housepit. Thirteen unidentifiable mammal bones were recovered. Two of the bones are burned and 9 are weathered. About 40% are >2 cm.

A pit feature partially exposed in the west wall of Square B contained 7 salmon bones, 3 immature bighorn sheep tarsals, 2 artiodactyl bones and 22 unidentifiable mammal bones. Thirty percent of the bones are >3 cm.

Although only a small amount of roof, floor, and rim deposits were excavated at HP 58, they appear to contain faunal remains with characteristics similar to remains from the same deposit types in housepits 3, 7, and 12.

Housepit 90

HP 90 is a small housepit located on the northwest periphery of the main area of the site. Most of the housepit was excavated and it was found to contain deposits from a single, late Plateau horizon, occupation. Faunal remains were recovered from the following deposits.

Stratum III: Five deer, 2 artiodactyl, 1 artiodactyl skull fragment, 4 large mammal, and 3 unidentifiable mammal bones were recovered from this stratum. This stratum represents post-occupational infilling.

Hearth feature 1: Seventy-nine burned mammal bones were found in this hearth associated with Stratum III. This appears to be the remains of an early historic temporary encampment.

Hearth feature 2: Thirty-six burned mammal bones were recovered in this hearth also associated with Stratum III. This appears to be a late prehistoric hunting campsite.

Stratum II: Two salmon and 5 mammal bones were recoverd from Stratum II, the floor deposits.

Pit feature 1: One deer ulna and 6 unidentifiable mammal bones were recovered from this pit feature associated with Stratum II.

Stratum V: Three salmon, 1 artiodactyl antler, 1 elk (*Cervus canadensis*) antler, 1 unidentifiable bird, and 14 unidentifiable mammal bones were recovered from Stratum V, which represents roof deposits.

Housepit 101

HP 101 is a small housepit located on the western edge of the main site area at the base of a terrace slope. Test excavations revealed at least three occupations. The initial occupation may have been during the Plateau horizon. The second occupation appears to have been brief and its age is uncertain. The final occupation occurred during the Kamloops horizon and its deposits were excavated in some detail. Faunal remains were recovered from the following deposits.

Stratum III: Ten salmon, 1 deer, 10 large mammal, and 17 unidentifiable mammal bones were recovered from Stratum III. This stratum appears to represent mixed roof and rim deposits from the southern edge of the house.

Stratum IV: Ten salmon, 2 large mammal, and 21 burned, unidentifiable mammal bones were recovered from Stratum IV. This stratum appears to represent roof deposits at the southern edge of the house from the most recent, Kamloops horizon, occupation.

Stratum V: Thirteen salmon, 2 deer, 8 large mammal, and 49 unidentifiable mammal bones were recovered from this stratum. This stratum also represents roof deposits associated with the Kamloops horizon occupation.

Stratum VI: Four hundred and eighty-three salmon bones (many partially articulated), 2 freshwater shell fragments, 1 grouse (Tetraonidae) bone, 1 beaver tooth, 4 deer bones, 2 bighorn sheep bones, 4 artiodactyl, 54 large mammal, and 46 unidentifiable mammal bones were recovered from this stratum. One of the shell valves has a perforation in it. Two deer antler artifacts were also found. Stratum VI represents floor deposits from the most recent Kamloops horizon occupation.

Stratum VII: Twenty-eight salmon and 2 large mammal bones were recovered from Stratum VII. This stratum may be a floor deposit lying directly underneath Stratum VI.

Feature 2: Fourteen salmon bones, 1 deer phalanx, 1 artiodactyl phalanx, and 3 unidentifiable mammal bones were recovered from this pit feature associated with Stratum VII.

Stratum IX: Eight salmon, 1 bighorn sheep phalanx, 1 large mammal, and 1 unidentifiable mammal bone were recovered from this stratum. Stratum IX represents floor deposits from the initial occupation of the house.

Feature 3: One artiodactyl metapodial and 1 burned, unidentifiable mammal bone were recovered from this pit feature associated with Stratum IX. A bighorn sheep horn core wedge was also found in this feature.

Feature 4: One burned deer phalanx, 1 burned elk canine, and 3 unidentifiable mammal bones were recovered from this possible hearth or refuse dump area associated with Stratum IX. An oval-shaped large mammal bone with a perforation in one end (probably a pendant) was also found here.

Stratum X: Eight salmon, 2 large mammal, and 9 unidentifiable mammal bones were recovered from this stratum. Stratum X represents rim deposits associated with the uppermost occupation of the house.

Housepit 104

Test excavation at this small housepit revealed a complex stratigraphy, difficult to interpret with available data. The deposits may represent dense collapsed house deposits overlying an ashy deposit with a high concentration of calcined bones. It is not possible to determine at this time if the ashy deposit is associated with the housepit occupation or was dumped in the house later. Faunal remains were recovered from the following deposits in the test trench.

Stratum I: Forty-seven unidentifiable mammal fragments wre recovered. About 96% of the bones are burned.

Stratum II: Three, unburned, unidentifiable mammal bones were recovered. This stratum may be associated with Feature I (Stratum III).

Stratum III: Forty salmon, 4 artiodactyl, and 196 unidentifiable mammal bones were recovered. About 97% are burned and over 90% are <3 cm. This stratum (Feature I) is a large circular accumulation of charcoal, ash, and calcined bones underlying Stratum I.

Stratum V: Two salmon, 4 artiodactyl, and 8 unidentifiable mammal bones were recovered. Four of the bones are burned and all are >3 cm.

Stratum VI: Five, unburned, unidentifiable mammal bones were recovered.

Stratum VII and Stratum IX: One deer tarsal, 1 artiodactyl phalanx, and 51 unidentifiable mammal bones were recovered. About 92% are burned and 94% are <3 cm. All the unburned bones are weathered. These strata may represent roof collapse deposits.

Stratum VIII: Seventeen salmon bones, 1 deer phalanx, 1 deer metatarsal, 1 artiodactyl phalanx, and 23 unidentifiable mammal bones were recovered. All of the bones are burned and 80% are <3 cm. Strata V, VI, and VIII may represent poorly understood cut and fill events.

The following remains were recovered during more extensive excavations of HP 104 in 1994–1996.

Square A. Five burned mammal bones were recovered from the surface. Nineteen mammal bones (15 burned) were recovered from the roof surface (Stratum II).

Stratum VII (roof): Six salmon vertebrae, 71 mammal bone fragments, 1 artiodactyl phalanx, 1 artiodactyl vertebra, 1 deer molar fragment, 3 deer phalanges, 2 deer astralagi, and 1 deer calcaneus were recovered from roof deposits. Ninety percent of the bones are burned and the unburned bones are weathered. Fifty-four percent of the bones are under 2 cm in length and 12% are over 3 cm in length. This area of the roof contains a higher percentage of burned bones, and smaller bones, than squares C, D, and F.

Stratum VIII (floor): Thirty-seven salmon vertebrae, 63 indeterminate fish bones, 1 hawk carpometacarpus fragment, 19 red squirrel (*Tamiasciurus hudsonicus*) bones (MNI=1), 124 mammal bone fragments, 20 mammal vertebrae fragments, 3 artiodactyl long bone fragments, 2 artiodactyl scapula fragments, 2 artiodactyla metacarpal fragments, 2 artiodactyl vertebrae fragments, 4 artiodactyl rib fragments, 1 artiodactyl metapodial, 1 artodactyl sesamoid, 1 deer mandible fragment, 1 deer femur, 1 deer humerus, 9 deer first phalanges, 3 deer second phalanges, 4 deer third phalanges, 1 deer carpal, 4 fragments of a burned deer metacarpal, 1 deer sesamoid, and 5 deer rib fragments were recovered from floor deposits. About 50% of the bones are burned (including most of the deer and artiodactyl bones) and 1 (<1%) is weathered. Thirty-one percent of the bones are <2 cm in length and 38% are >3 cm in length. This area of the floor contains more burned bones and the bones are slightly larger than the mammal bones found in Squares C, D, and F.

Two dog coprolites were found in floor deposits. Tiny fragments of mammal and fish bones were found in the coprolites.

The deer mandible, including incisors and molars, is a right mandible from a young deer, based on the unworn condition of the teeth. Some of the deer bones were found concentrated in one area. These are 5 rib fragments; 2 third phalanges; 1 second phalanx; 1 first phalanx; and articulated right first (unfused proximal epiphysis), second, and third phalanges.

Squares C, D, and F. *Stratum VII* (roof): Sixteen salmon bones, 212 mammal bone fragments, 2 vole mandibles, 9 artiodactyl fragments (2 metapodials, 1 phalange, 4 vertebrae, and 2 teeth fragments), 16 deer fragments (2 mandibles, 7 incisors, 2 metapodials, 3 phalanges, 1 astragalus and 1 sesamoid) were found in roof deposits. The 2 deer mandibles and 7 incisors are from the same individual. Twenty-two percent of the roof bones are burned and 6% are weathered. One mammal bone fragment shows evidence of carnivore chewing. About 30% of the bones are under 2 cm in length.

Stratum VIII (floor): One hundred and eleven salmon bones, 2 bird long bone fragments, 1 bird ulna fragment, 122 mammal bone fragments, 15 artodactyl fragments (1 long bone, 3 vertebrae, 1 metapodial, 10 phalanges), 6 deer phalanges, 1 hare (*Lepus americanus*) humerus, and 1 medium mammal femur were found in floor deposits.

In a dump on the floor, 2 salmon vertebrae, 18 mammal bones, 1 artiodactyl long bone, 1 artiodactyl rib, 1 deer left mandible, and 1 deer third phalanx were found.

About 25% of the floor bones are burned and about 70% of the bones are under 2 cm in length. The largest bones are found along the wall in the floor dump.

Square G. *Stratum VII* (roof): Two salmon vertebrae, 27 mammal bones, 1 artiodactyl metapodial fragment, 3 artiodactyl teeth fragments, 1 deer calcaneus, and 4 deer molars were found in roof deposits. Seventy-six percent of the roof bones are burned. Thirteen percent are under 2 cm in length and 24% are over 3 cm in length.

Stratum VIII (floor): Five salmon vertebrae, 2 salmon cranial bones, 22 indeterminate fish bones, 29 mammal bones, 6 deer first phalanges, 4 deer second phalanges, 3 deer third phalanges, 8 artiodactyl phalange fragments, 5 deer rib fragments, 7 deer sesamoids, 6 artiodactyl long bone fragments, and 3 artiodactyl sternum fragments were found in floor deposits. In a dump on the floor, 3 fish bones, 75 mammal bone fragments and the following artiodactyl and deer bone fragments were found: artiodactyl—2 long bone fragments, 2 vertebrae fragments, 2 metapodial fragments, 2 rib fragments; deer—6 teeth fragments, 2 rib fragments, 1 metapodial fragment, 1 skull fragment, 1 sesamoid, and 1 third phalanx.

Five percent of the floor bones are burned. One mammal bone shows evidence of carnivore chewing. Fourteen percent are under 2 cm in length and 56% are over 3 cm in length. The largest bones are found in the dump.

Feature 1: an ashy area in Square D. Two artiodactyl phalange fragments and 188 unidentifiable mammal fragments were recovered. All of the bones are burned and about 70% are less than 1 cm in length.

Stratum IIIA: organic loam associated with Feature 1. Two artiodactyl metapodial fragments and 73 unidentifiable mammal fragments were recovered. All of the bones are burned and 68% are less than 1 cm in length.

Feature 2: pit fill. One burned deer phalanx, 1 artiodacyl tooth fragment, 5 burned mammal bones, and 182 fish bones were recovered.

Feature 3: pit fill. One salmon vertebra, 59 mammal bones (4 burned), 1 artiodactyl long bone fragment, and 2 artiodactyl femur fragments were recovered.

Discussion

Housepit 104 appears to contain a much higher density of bones than most of the other housepits excavated at Keatley Creek. Although not all of the housepit has been excavated yet, and the bones have not been plotted across the floor or roof, some preliminary comparisons with other housepits can be made.

Floor and roof deposits differ with respect to the frequency of fish bones in the assemblages, with floor deposits having a higher frequency of fish. This bears out the results of the formation process study, in which floor deposits at the Keatley Creek site are hypothesized as being distinguishable from roof deposits on the basis of fish bone frequency.

Bones on the floor of HP 104 are particularly dense when compared to other housepits. The densities of bones per subsquare are higher by a factor of 10, than those in HPs 3 and 7. The density of bones in HP 104 appears similar to that in HP 58, Stratum V, which is apparently a dump associated with primary butchery of deer.

The identified bones in Housepit 104 are also primarily artiodactyl/deer. Based on number and state of fusion of phalanges, a minimum of 2 deer individuals occur in the floor dump; a fully mature adult and an immature individual. Bones from all parts of the artiodactyl/deer skeleton are found on the housepit floor.

In two areas of floor of HP 104, (Squares A and G), bones are larger than those generally found in excavated housepits at Keatley Creek. Only 14–31% of the floor bones are under 2 cm in length and 38–56% are over 3 cm, with the largest bones occurring in the dump on the floor. In contrast, 75% and 65% of the floor bones from HPs 7 and 3, respectively, are under 2 cm in length. The bones from these areas of HP 104 are more similar in size to those in Housepit 58, Stratum V, where 30% are over 3 cm and 10% are over 8 cm. On the other hand, Squares C, D, and F contain a large number of small bones (about 70%).

Although it may appear that a high frequency of artiodactyl lower leg and foot bones occur in HP 104, their number is not unusually high when compared to the frequency of such bones in other excavated areas of the site. About 60% of the artiodactyl/deer bones from HP 104 are lower leg/foot bones (metapodials, carpals, tarsals, and phalanges). This is similar to the percentages found in HPs 7 and 3. In HP 7, 64% of the artiodactyl/deer bones from floor deposits are foot bones and 53% from the roof are foot bones. In HP 3, 57% of the floor bones and 41% of the roof bones are foot bones. Bone reduction at the site is high, and these elements are found in relatively high frequencies because they survive destructive forces well, are relatively easy to identify as small fragments, and because of the relatively high number of foot bones found in one skeleton.

In summary, HP 104 contains an unusually high density of animal remains (mostly artiodactyl/deer) when compared to other housepits at Keatley Creek. These remains apparently occur over much of the floor and are also generally larger in size than we usually see at Keatley Creek. A concentration of large fragments of artiodactyl/deer bones near one of the main house posts may be a refuse discard area. Future mapping of the bones across the floor may help elucidate the processes and activities responsible for the distribution and attributes of the faunal remains in the housepit.

Housepit 105

HP 105 is a small housepit located on Terrace II near HP 104. Test excavations indicate the depression was used as a pithouse during the Kamloops horizon. A large number of artiodactyl and articulated fish bones were recovered from floor deposits. These remains were probably not deposited during occupation of the pithouse, or were deposited just prior to abandonment. Evidence from other housepits indicates floors were kept clear of large debris during occupation. Also, the condition of the remains, and the fact that fish and deer foot bones were articulated, precludes trampling after deposition. Thus, the remains may reflect use of the structure as a refuse dump after use as a habitation. Faunal remains were recovered from the following deposits.

Stratum II: One hundred and fifteen salmon, 7 deer, 1 artiodactyl, 3 vole (*Microtus* sp.), 1 *Canis* sp., and 117 unidentifiable mammal bones were recovered. About 40% are burned and 3% are weathered. About 75% are <3 cm. This stratum appears to be collapsed roof deposits.

Stratum III: This stratum represents floor deposits with a large number of bones lying horizontally on the surface. Three hundred and eighty salmon bones, many forming articulated skeletons, an articulated right rear deer ankle (consisting of 5 tarsals and 1 metatarsal), another right deer ankle (2 articulated tarsals), 1 left deer tarsal (burned), 1 left deer metatarsal, 1 hare premaxilla, and 73 unidentifiable mammal bones were recovered. Most of the bones are unburned (<50% of the unidentifiable mammal bones are burned) and none show signs of weathering. The deer bones and 10% of the unidentifiable bones are >3 cm.

Strata IV–VI: Bones recovered from levels 4–8 (15–40 cm BS) are lumped together for analysis because an unfused proximal epiphysis of a deer ulna recovered at 15–20 cm BS was found to fit on a right ulna recovered at 35–40 cm BS. The ulna has been culturally modified to form an awl at its distal end. Along with the ulna, 1 right deer radius, 4 deer phalanges, 2 deer metapodials, 7 artiodactyl bones, 524 salmon bones, and 253 unidentifiable mammal bones were recovered. These strata appear to represent deposits used to fill in a pit (Feature 1) to floor level. A fire-reddened area within these strata at 35–50 cm BS contained 2 salmon, 5 artiodactyl, and 167 unidentifiable mammal bones. All of these bones are calcined and about 98% are < 3 cm.

Feature 1: The strata from which bones were recovered from this large pit feature in Square A are difficult to discern from information on the level bags. Thus, I will list the remains recovered by level. Three bighorn sheep phalanges and 4 mammal bones were recovered from 50–60 cm BS (Strata VII and VIII?). One sheep phalanx and 8 mammal bones were recovered from 60–80 cm BS (Stratum VIII?). One bighorn sheep phalanx, 1 bighorn sheep astragalus, 1 artiodactyl astragalus, and 13 mammal bones were recovered from 80 cm BS to the pit bottom (Stata IX and X?).

In Square C, 92 salmon bones, 2 deer phalanges, 2 artiodactyl long bones, and 62 mammal bones were recovered from the first 20 cm of the pit. Forty-six salmon bones, 5 artiodactyl vertebrae (immature), 2 small bird humeri, and 71 mammal bones were recovered from 45–59 cm BS. Ten salmon bones, 1 right deer ulna, radius, and humerus; 1 *Canis* sp. phalanx, 1 beaver tooth fragment and 58 mammal bones were recovered from Stratum VI. One deer phalanx and 2 mammal bones were recovered from Stratum VIII. One large artiodactyl (probably elk) metacarpal (weathered), 1 grouse (Tetraonidae) scapula and coracoid, and 8 mammal bones were recovered from Stratum IX. One grouse humerus, 1 beaver tooth, and 3 mammal bones were recovered from Stratum X.

The deposits filling the pit feature appear to have been intact during the last occupation of the pithouse. Strata IV and V appear to represent infilling of the upper levels of the pit to floor level. These deposits contain refuse from consumption and/or butchering activities and are mostly deer and salmon remains. Strata VII to X appear to represent earlier pit filling events and Strata IX and X may be remnants of the earliest storage function of the pit.

Seventy-two flat, rectangular bone objects with a single hole drilled near their centers, were recovered from the pit near the bottom of Stratum X. The objects range in size from about 1 × 0.9 × 0.2 cm to about 2 × 1.5 × 0.2 cm. They were found mostly lying cortex-side up, suggesting they were some type of clothing ornament (Vol. III, Chap. 10).

A thin, round, polished bone needle was recoverd from Stratum VI in Square B. A sharp needle, flat on one side, and a small bone bead were recovered from Stratum V in Square C.

Housepit 107

HP 107 is a small housepit located on the south side of Keatley Creek about 15 m east of HP 9. Test excavations indicate the housepit was occupied for a single, relatively short period of time during the Plateau horizon (ca. 2,400 to 1,200 BP). The following faunal remains were recovered during test excavations.

Stratum II: One deer phalanx was recovered from these deposits which represent predominantly roof fill.

Stratum III: Twenty-five salmon bones, 2 red squirrel (*Tamiasciurus hudsonicus*) bones, and 3 unidentifiable mammal bones were recovered from this stratum, representing the floor deposits.

Housepit 108

HP 108 is a small housepit located on the south side of Keatley Creek on the uppermost terrace about 50 m southwest of HP 9. Test excavations revealed a single, short-term occupation. No temporally diagnostic artifacts were found. Faunal remains were recovered from the following stratum.

Stratum III: Fifteen salmon bones, 2 beaver incisor fragments, and 4 unidentifiable mammal bones were recovered from this stratum, which represents floor deposits.

Housepit 109

HP 109 is located in the northeast corner of Keatley Creek on a terrace above the main area of the site. It is slightly larger than the other small housepits tested and test excavations revealed complex stratigraphy. There appears to have been a late, or possibly Plateau, mat lodge occupation above an anomalous large pit feature. Faunal remains were found in the following deposits. Provenience information on the faunal bags was inadequate for this housepit and it was not possible to assign all the bones to strata.

Stratum II: Six salmon bones, 1 deer ulna, 1 artiodactyl long bone, and 9 unidentifiable mammal bones were recovered from this stratum, which represents roof deposits.

Stratum III: Sixty-nine salmon bones, 10 unidentifiable mammal bones, and 33 *Canis* sp. vertebrae fragments and 1 sacrum were recovered from this stratum. The sacrum and 4 lumbar vertebrae were apparently found articulated and covered with a birch bark/fir needle bundle. This stratum represents floor deposits.

Stratum IV: Fifty burned, unidentifiable mammal fragments were recovered from this stratum which probably represents a dump occurring before the housepit occupation.

Stratum V: Twenty-one salmon bones, 1 unidentifiable bird bone, 2 small mammal, 3 large mammal, and 7 unidentifiable mammal bones were recovered from this stratum, which represents a large pit under the floor deposits. One dentalium shell was recovered from this stratum also.

Housepit 110

HP 110 is a small housepit located on the south side of Keatley Creek on the lowest terrace overlooking the creekbed.

Test excavations have revealed at least three Plateau horizon occupations of the house and one post-abandonment open encampment. Faunal remains were recovered from the following strata.

Stratum II: Forty-nine large mammal and 30 mammal bones were recovered from this stratum. All the bones were burned. Stratum II apparently represents thin roof deposits associated with the most recent house occupation.

Stratum III: Three salmon, 1 grouse (Tetraonidae), 1 unidentifiable bird, 1 deer, 1 red squirrel, 22 large mammal, and 220 unidentifiable, burned mammal bones were recovered from Stratum III. This stratum appears to represent the floor deposits associated with the most recent house occupation.

Stratum IV: Seven salmon bones, 1 artiodactyl ulna, 11 large mammal, and 271 unidentifiable mammal bones were recovered from this stratum. Eighty-one percent of the bones were burned. This stratum represents floor deposits from the second occupation of the house.

Feature 1: Seventeen large mammal and 52 mammal bones, all calcined, were recovered from this hearth associated with Stratum IV.

Feature 2: Thirteen burned large mammal bones were recovered from this pit associated with Stratum IV.

Stratum V: Three salmon bones, 3 hare bones, 14 beaver bones (6 vertebrae, 6 ribs, 2 teeth), 1 scapula and 2 phalanges from bighorn sheep, 3 phalanges and 4 tarsals from deer, 125 burned large mammal bones, and 97 burned mammal bones were recovered from this stratum. This stratum represents floor deposits from the initial occupation of the house.

Feature 3: The remains of a partially burned dog (*Canis familiaris*) skeleton were recovered in one area of Stratum V deposits. The remains were partially articulated, although fragmented from burning, suggesting intentional cremation/burial. The remains included the left and right mandibles, fragmented skull, and fragments of most of the postcranial skeleton. A burned deer phalanx and burned hare humerus were also found in this area.

Housepit 119

See EHPE 5.

Appendix II:
Faunal Remains from Housepit 9

HP 9 is a small housepit located southeast from the main part of the site. Excavations in 1990 and 1992 exposed most of the housepit and revealed at least three occupations, the last one dating to the Kamloops phase. The faunal remains from the detailed 1990 and 1992 excavations and the earlier trench excavations are described here. Because it was probably occupied during the same period as HP 12, the late Plateau/early Kamloops occupation (Stratum VIII) is discussed further in (Vol. II, Chap. 7).

Faunal remains were recovered from the following strata excavated in 1990 and 1992.

Stratum IV: Final Occupation Roof

Two shell fragments, 25 salmon bones, 20 mammal bones, 5 large mammal bones, 3 incisors and 1 metatarsal of beaver, 1 canid metatarsal, 1 artiodactyl tooth, and 1 deer scapula fragment were recovered from this stratum (Table 6). A common loon ulna was recovered from this stratum during test trench excavations. A bird bone pendant was found near the bottom of this stratum and may be associated with stratum VIII (Vol. III, Chap. 7). The paucity of remains and the attributes of the remains suggests they are the result of limited refuse accumulation, perhaps from floor cleaning after food preparation. No regular refuse dumping or butchering activities apparently occurred on this roof. Fish remains are much more common on the associated floor (VI) than in these deposits.

Stratum VI: Final Floor Occupation

Three shell fragments; 897 salmon bones; 1 common loon fibula; 115 mammal bones; 27 large mammal bones; 1 hare tibia; 1 beaver incisor; 4 packrat bones; 1 canid phalanx, tarsal, and metatarsal; 32 skull, 8 teeth, and 2 metapodial fragments of artiodactyl; and 7 teeth and 1 phalanx of bighorn sheep were recovered from floor deposits (Table 6). From roof deposits associated with this floor, 67 salmon bones, 1 common loon ulna, 50 mammal bones, 18 large mammal bones, 1 beaver molar, 1 vole mandible, 3 artiodactyl teeth fragments, 1 deer phalanx, and 1 bighorn sheep tooth fragment were found (Table 6). A dentalium shell fragment, a shell bead, a large piece of worked antler, a bone point or awl, a polished bone fragment, and a piece of worked freshwater shell were also found in this stratum. A dump on the floor in Square J, Subsquare 13, contained 46 fish bones, 22 mammal bones, 1 deer molar, and 1 beaver cheek tooth.

The fish remains on this floor are relatively dense compared to other housepit floors and are often partially articulated with the abundant spines and ribs that are present. The fish remains and a concentration of artiodactyl cranial and appendicular fragments near the west wall suggests little trampling or cleaning of floor deposits and may reflect brief usage of the structure as a hunting/butchering base. Alexander (Vol. III, Chap. 7) discusses this distribution further and suggests this occupation may be a short-term camp used by a relatively wealthy family.

Fish remains are much more common in all three floor deposits than in roof deposits. Floor X deposits contain approximately 9 times as many fish bones as Roof XI and Floor VI deposits contain approximately 36 times as many fish bones as Roof IV and the percentage of fish bones in floors ranges from 81–93%, as opposed to 42–70% for roofs. This is consistent with other housepit excavations indicating that roof deposits have significantly fewer fish remains than floor deposits. As noted during field excavations, a large percentage of these fish bones are non-vertebrae, in particular ribs and spines. About 80–90% of the fish elements from the three floor deposits are non-vertebrae. This is higher than was found in other excavated areas of the site. This may simply reflect sloppy housekeeping or different abandonment conditions or it is possible that people were handling fish differently at this pithouse, perhaps butchering and consuming fresh fish.

Stratum VIII: Second Floor Occupation

Four shell fragments; 2,140 salmon bones; 2 bird bones; 253 mammal bones; 42 large mammal bones; 2 beaver incisors and 4 molars; 1 canid tarsal; 2 vole bones; 9 artiodactyl teeth, 1 skull fragment, 1 femur and 1 piece of costal cartilage; and 4 bighorn sheep teeth were recovered from this stratum (Table 6). Four dentalium shell fragments, 2 shell beads, 1 large fragment of worked antler (probably elk), 1 large antler (probably elk) digging stick handle, 1 bone awl, and 19 incised and charred bone fragments were also recovered from this stratum. About three times as many fish bones and five times as many mammal bones were recovered from this floor than from the basal floor. Faunal remains from a large storage pit (fill 1) are probably associated with this occupation (see below). This floor is discussed further in Volume II, Chapter 7.

Table 6. Taxa Recovered from HP 9. Numbers are Numbers of Identified Specimens

	Stratum						
Taxon	IV[2]	VI[1]	VI[2]	VII[2]	VIII[1]	X[1]	XII[2]
Shell	2	3	0	0	4	1	1
Salmon (*Oncorhynchus* sp.)	25	897	67	61	2,140	626	70
Bird	0	0	0	0	2	0	0
Common loon (*Gavia immer*)	0	1	1	0	0	0	0
Bald eagle (*Haliaeetus leucocephalus*)	0	0	0	0	0	0	1
Large mammal	5	27	18	4	42	12	1
Mammal	20	115	50	17	253	23	19
Snowshoe hare (*Lepus americanus*)	0	1	0	0	0	1	0
Beaver (*Castor canadensis*)	4	1	1	2	6	4	0
Packrat (*Neotoma cinerea*)	0	4	0	0	0	0	0
Vole (*Microtus* sp.)	0	0	1	2	2	0	0
Canid (*Canis* sp.)	1	3	0	0	1	0	1
Artiodactyl	1	42	3	2	12	6	3
Deer (*Odocoileus* sp.)	1	0	1	0	0	1	1
Bighorn sheep (*Ovis canadensis*)	0	8	1	0	4	0	4
Total	59	1,102	143	88	2,466	674	101

1. Floor deposits
2. Roof deposits (may contain some floor material)

Stratum XII: Basal Occupation Roof

One freshwater shell fragment, 70 salmon bones, 1 bald eagle mandible fragment, 19 mammal bones, 1 large mammal bone, 1 canid premolar, 1 artiodactyl rib and 2 metapodials, 1 deer mandible, and 1 bighorn sheep carpal and 3 horn fragments, were recovered from this stratum (Table 6). The attributes of these remains are consistent with use of the roof as a briefly-used refuse dumping area. A rabbit tibia "tube" or "bead" was also recovered.

Stratum X: Basal Floor Occupation

This stratum is one of 7 probably intact Plateau floors at the site. One freshwater shell fragment, 626 salmon bones, 23 unidentifiable mammal bones, 12 large mammal bones, 1 hare tibia, 4 beaver incisors, 6 artiodactyl antler fragments, and 1 deer phalanx were recovered from this stratum (Table 6). Their distribution is discussed in Volume III, Chapter 7. The few faunal remains tend to cluster around the periphery of the floor, suggesting the central floor was kept clear of debris and that debris was swept towards the walls. Fish remains are much more common on the floor than in the associated roof deposits (XII) and tend to cluster around the hearth and large pit. A bone pendant; a piece of worked bird bone, possibly from a whistle or drinking tube; and 2 bird bone bead fragments were also found in this stratum. A large piece of unworked antler was recovered from the trench in this stratum. A deer antler digging stick handle is probably associated with a dump on this floor.

Stratum VII

Sixty-one salmon bones, 17 mammal bones, 4 large mammal bones, 2 beaver molars, 1 artiodactyl skull fragment and 1 phalanx, and 2 vole bones were recovered from this stratum (Table 6) which may represent rim slump deposits. A large fragment of unworked antler was also recovered from this stratum.

Test Trench

Two shell fragments and 124 salmon, 1 loon, 1 deer, 1 artiodactyl and 9 mammal bone fragments were recovered from floor/roof deposits. Twenty-two salmon, 24 mammal, 1 beaver, 1 dog, 1 artiodactyl, and 2 deer bone fragments were recovered from rim deposits.

Features

Feature 4: Seven calcined mammal bones were recovered from this hearth.

Feature 5: Fourteen calcined mammal bones were recovered from this hearth.

Feature 8: One unburned mammal bone was recovered from this hearth.

Feature 6: Feature 6 is a large pit feature apparently dug and used for salmon storage during the first occupation (Stratum X) and filled in prior to abandonment. The pit was reexcavated and finally filled in during the second floor occupation (Stratum VIII). Fill Unit 1 (FU1) contained 1 shell fragment, 82 salmon bones, 6 mammal bones, 1 large mammal bone, and 1 beaver incisor. A large elk antler bark peeler (split and one end worked into a "wedge") and another, smaller, worked artiodactyl antler fragment were also found in FU1. The faunal remains from FU1 are consistent with the interpretation that this is refuse dumped into the pit, apparently during the second occupation.

FU2 contained 5 shell fragments, 487 salmon bones, 23 mammal bones, 5 large mammal bones, 1 loon ulna, 2 artiodactyl bones, 1 beaver incisor, 1 bighorn sheep patella, and 1 hare bone. A worked bird bone fragment, possibly a needle, was also found in FU2. FU2 apparently represents mostly refuse fill deposited during the initial occupation and the fish bones found near the bottom of the pit are probably from the original storage function of the pit.

Discussion

The faunal assemblage from HP 9 contains a number of rather unusual attributes when compared to other excavated housepits at Keatley Creek. HP 9 is a small housepit similar in size to HP 12, but up to ten times as many remains are found on the floors of HP 9 as on the floor of HP 12. While this may simply reflect different abandonment conditions, the presence of unusual items (i.e., loon, dentalium, beads and tubes, eagle, antler artifacts, shell, sheep, fish spines), and relatively high species diversity suggests HP 9 was used in a different way from HP 12. The presence of unusual items and relatively high number of taxa in all of the floor deposits suggests the different usage persisted through time. See Volume II, Chapter 7 and Volume III, Chapter 7 for further discussions.

Common loon (*Gavia immer*) bones were found in HP 9 and have not been found anywhere else in the site to date. The loon bones are as follows: 1 ulna and 1 fibula from Stratum VI, possibly associated with Stratum VIII since cultural material from Floor VIII is incorporated into Roof VI (Diana Alexander, personal communication); 1 ulna from pit feature 6 (FU1, probably associated with Stratum VIII); and 1 ulna from trench C (Stratum IV). The ulna from trench C is also probably associated with Floor VIII occupants since it was found at the bottom of IV (Diana Alexander, personal communication). These bones most likely represent loons collected for ornamental or ritual purposes and not for food. Common loons are found in freshwater lakes and large open rivers during the spring, summer, and fall. They migrate to coastal areas in B.C. in the winter.

Bighorn sheep (*Ovis canadensis*) bones are relatively abundant in HP 9 compared to other areas of the site. The remains are as follows: 1 patella from pit feature 6 (FU2, Stratum X), 1 carpal and 3 horn fragments from Stratum XII (basal occupation roof), 4 teeth fragments from Stratum VIII (second floor), and 8 tooth fragments and 1 phalanx from Stratum VI (last floor). This indicates bighorn sheep were utilized, or their remains dumped, thoughout occupation of the pithouse. The abundant, fragmentary, artiodactyl cranial and postcranial remains on the second and last floors may be from sheep as well as deer and suggests the structure may have been used to butcher sheep and deer.

One dentalium shell fragment was found in Stratum VI and four in Stratum VIII.

Large antler fragments/artifacts were found in the following deposits (see Vol. III, Chap. 2):

Stratum X:	1 large unworked piece from trench. Digging stick handle (EeRl 7:5252)
Stratum V:	Large unworked antler fragment
Stratum VI:	Large worked antler fragment (EeRl 7:2176)
Stratum VIII:	Large (probably elk) worked antler (EeRl 7:5253) Large (probably elk) antler digging stick handle (EeRl 7:5253) Feature 6, FU1 (this is associated with Stratum VIII) Large split and beveled elk antler bark peeler (EeRl 7:5251) Worked antler fragment (EeRl 7:5256)

Appendix III: Faunal Remains from Interior Storage Pits

Relatively extensive faunal remains were recovered from interior storage pits in HP 3 and HP 7. The remains from these pits and the possible function of the pits is discussed below.

Faunal Remains from Pit Features in HP 7

Roof Beam Foundations

Faunal remains were recovered from 4 pit features in the east rim of HP 7 in 1988 (P88-2, P88-3, P88-4, and P88-5). These large, shallow, basin- shaped depressions appear to be roof beam foundations (Vol. III, Chap. 6). The faunal remains from these features probably represent debris from infilling and roof collapse. One hundred and fifty-nine bones were recovered from the pits, including 68 salmon (Salmonidae) bones, 2 freshwater shell fragments, 1 fragment each of artiodactyl phalanx, metapodial, and antler, 1 deer (*Odocoileus* sp.) tibia fragment, 3 deer scapulae, 2 sheep/goat (Ovis/Oreamnos) horn fragments, 1 sheep/goat tooth fragment, 21 beaver (*Castor canadensis*) bones and teeth, and 58 unidentifiable mammal bones. Eighteen of the beaver bones and teeth are fragments of one mandible recovered from P88-5. The other beaver remains are 3 incisors, 1 from P88-5 and 2 from P88-2. One deer scapula was found in each of P88-3, P88-4, and P88-5. The scapulae are described in Volume III, Chapter 3.

Thirty-two percent of the bones are burned and 33% of the unburned, non-fish bones are weathered. Forty-three percent of the bones are fish. Sixty-seven percent of the mammal bones are <2 cm in maximum dimension and 32% are from 2–8 cm.

Medium-Sized Pits

Four medium-sized pits (50 cm deep and 70 cm wide) were found in HP 7.

P-34: Square P, 80 cm wide × 55 cm deep. This medium-sized storage pit is located near the northwest wall of the house in association with two other, smaller pits, a large pit (P-31) and a hearth. A total of 132 bones were recovered from the bottom of the pit and the pit fill. One hundred and twenty-two salmon bones were recovered, mostly from articulated salmon remains along the bottom of the pit. Two freshwater shell fragments, 1 artiodactyl long bone fragment, and 7 unidentifiable mammal bones were also found. The pit was apparently originally used to store salmon and then filled with debris.

P-4: Squares P and OO, 87 cm wide × 60 cm deep. This medium-sized pit lies near the north wall of the housepit. One hundred and four salmon bones, 2 beaver teeth, 4 unidentifable mammal bones and the skeleton of a western toad (*Bufo boreas*) were recovered. Toads are burrowers and this individual is probably intrusive. A toad skeleton was also found in a nearby small pit (P-3).

P-36 and P-36a: Square BB, 72 cm wide × 60 cm deep, 81 cm wide × 75 cm deep. This is a medium-sized storage pit located in the northwest corner of the house near 3 large storage pits and a hearth. Nine hundred and thirty salmon bones were recovered, primarily from articulated remains at the bottom of the pit. Also, 1 dentalium shell, 2 freshwater shell fragments, 2 artiodactyl tooth fragments, 1 deer incisor, 1 elk (*Cervus canadensis*) phalanx, 6 beaver incisors, 72 unidentifiable mammal bones, and 1 intrusive vole (*Microtus* sp.) skeleton were recovered. This pit appears to have functioned originally as a salmon storage pit and was subsequently filled with debris.

Large Pit Features

Five large pits (100 cm deep and 70 cm wide) were found in HP 7.

P-25: Square RR, 130 cm wide × 100 cm deep. This large, bell-shaped pit is located near the western edge of the house, near a hearth. A number of large and medium pits and hearths are located just to the north of it. Three hundred and thirty salmon bones, 1 dentalium shell, 1 whelk shell (*Thais* sp.), 1 bird bone, 1 grouse (*Tetraonidae*) wing bone, 6 beaver teeth, 1 beaver scapula, 1 canid incisor, 1 canid metapodial, 1 vole mandible, 1 artiodactyl tooth fragment, and 55 unidentifiable mammal bones were recovered from the pit. Also, 1 deer scapula, 1 bone point or needle, and 1 deer metapodial awl were recovered from the pit. These artifacts are described in Volume III, Chapter 2.

P-4: Square G and U, 65 cm wide × 165 cm deep. This large storage pit is located in the southwest part of the house near another large pit (F-2) and a hearth. A large quantity of fish remains were recovered from this pit (about 1,000 bones), mostly concentrated as articulated remains at the bottom of the pit and along the sides. Also, 2 beaver incisors, 2 phalanges, 1 metapodial, and 7 tarsals from deer, 1 vertebra, 1 rib, and 1 sternum from artiodactyl, and 40 unidentifiable mammal bones were recovered. Also, a bird bone whistle and a flat, large mammal bone tool were recovered (Vol. III, Chap. 2). Faunal remains from this pit indicate how rapidly the pit was filled after being depleted of salmon stores. Fragments of the same deer individual were recovered from 20 cm BS and 80 cm BS indicating that deposits from at least 20–80 cm BS are part of a single depositional event. This suggests pits were filled in fairly rapidly.

F-2: Square B, 113 cm wide × 120 cm deep. The original storage function of this pit apparently dates to the Plateau horizon. The upper layers of the pit appear to contain Kamloops horizon fill. Three hundred and twenty salmon bones, 1 hare (*Lepus*) metapodial, 3 incisors, 2 ribs, and 2 vertebrae of beaver, 1 pelvis and 1 metapodial of artiodactyl, 3 phalanges, 2 metapodials, 1 metacarpal, and 1 tarsal of deer, 1 bighorn sheep horn core, 1 one bone each of vole and deer mouse (*Peromyscus* sp.), 1 bird bone, and 107 unidentifiable mammal bones were recovered from this feature. One small artiodactyl scapula (sheep/goat?), two deer scapulae, and a bone wedge were also recovered (Vol. III, Chap. 2)

P89-5: Square NN, 130 cm wide × 130 cm deep. Remains of at least 5 dog (*Canis familiaris*) skeletons were recovered from the bottom of this large pit located in the northwest area of the house near the other pit containing dogs (P-31). See Volume II, Chapter 10 for a full description of the canid remains. The remains of the 5, relatively complete but mostly disarticulated, skeletons included 5 skulls and 8 mandibles which could be identified as *Canis familiaris*, 450 bones which could be identified as *Canis* sp., and 400 medium mammal bone fragments which are most probably dog. Also in the layers near the bottom of the pit were 70 salmon bones, 2 deer sternum fragments and 1 deer phalanx, 1 beaver humerus and 1 beaver femur, and 1 large mammal fragment. These remains were apparently dumped in quickly after the dogs were deposited. Upper layers in the pit contained 35 salmon bones, 1 beaver incisor, 24 unidentifiable mammal fragments, and one bone awl.

P-31: Square P, 135 cm wide × 130 cm deep. This large pit feature in the northwest section of the house is associated with three smaller pits and a hearth. It is also near P89-5, the other pit containing dogs. The remains of at least 4 dog skeletons were recovered from the bottom of the pit underneath a plank and layer of birch bark (Vol. II, Chap. 10). The dog remains consist of 1 virtually complete skeleton (NISP=230), 3 other dog skulls, and the partial postcranial remains of at least 2 individuals (NISP=170). Fifty salmon bones were also recovered from the bottom of the pit. Two hundred salmon bones, 12 freshwater shell fragments, 1 bird bone, 2 hawk (*Accipiter* sp.) wing bones, 1 vertebra and 3 phalanges of artiodactyl, 1 scapula, 1 ulna, and 3 phalanges of deer, 1 mandible, 2 phalanges, and 1 molar of beaver, 6 vole bones, 4 deer mouse bones, and 111 unidentifiable mammal bones were recovered from the upper layers of the pit.

Faunal Remains from Pit Features in HP 3

Sq. I, ssq. 3,7: Three hundred salmon bones were recovered from this pit feature.

Sq. F, ssq. 3,4.7: About 1,200 salmon bones were found near the bottom of this pit, many of them articulated. Also 2 freshwater shell fragments (*Margaritifera falcata*), and 2 unidentifiable mammal bones were recovered. This large salmon storage pit appears to have been used during the last occupation.

Sq. AA, ssq. 1,5,6: About 70 salmon bones, 1 deer (*Odocoileus* sp.) phalanx, and 1 hawk (*Accipiter* sp.) phalanx were recovered from this small storage pit which is apparently comtemporaneous with the floor.

Sq. I, ssq. 16: About 100 salmon bones, 1 Canidae astragalus, and 5 unidentifiable mammal bones were recovered from this pit, which may date to Plateau times.

Sq. M, ssq. 2 (89-P1): Thirteen salmon bones, 2 unidentifiable mammal bones, and 2 antler artifacts were recovered from this pit which appears to have been used for storage prior to the final occupation.

Sq. MM (89-P2): Thirty salmon bones, 1 artiodactyl tooth fragment, and 23 unidentifiable burned mammal fragments were recovered from this pit. This feature appears to have been partially filled with hearth cleanings during the last occupation.

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LITHIC REMAINS

Chapter 11

Results of the Keatley Creek Archaeological Project Lithic Source Study

Mike Rousseau

Introduction and Background

The procurement and use of lithic materials for tools constitutes an important aspect of the prehistoric economy of Keatley Creek residents. The procurement and use of distinctive lithic materials from different sources by identifiable subgroups within the Keatley Creek community can also provide important information about social and economic organization within the community, as demonstrated by Bakewell (Vol. I, Chap. 16). Thus, it is important to document, to the extent possible, the main sources of lithic materials used by the past residents of Keatley Creek. The goal of this chapter is to document these lithic sources to the extent possible given the financial resources available.

During a two week period in July of 1988, and a three week period in June and July of 1989, a small reconnaissance survey project was conducted to identify and record prehistorically exploited lithic material sources in the Mid-Fraser River region of southwestern British Columbia. Specific areas examined include the Lillooet locality, Fountain Valley, Botanie Valley, the Pavilion locality, the Marble Canyon locality, Maiden Creek Valley, Upper Hat Creek Valley and the north side of Carpenter Lake (Figs. 1, 2, 4, 7, 10, 12, 16, and 17). This project was undertaken as a research component of the Fraser River Investigation of Corporate Group Archaeology Project. The primary objectives of the 1988 lithic source study were: 1) to locate local lithic sources by following leads provided by local informants and other researchers, as well as from information in publications and reports, and by surveying selected geologic deposits deemed to have potential for containing flakable cryptocrystalline silicates and/or high quality basaltic rocks; 2) to secure a representative sample of lithic materials from each of the identified sources so that their general character and any variability could be subsequently documented; and 3) to briefly compare the main lithic material types recovered from the Keatley Creek site with those identified during the lithic source identification study to determine if any of the source types were represented there.

Study Area

The study area examined during the 1988 and 1989 field seasons includes much of the Mid-Fraser River region of southwestern British Columbia. The Maiden Creek area and Upper Hat Creek Valley are intermediate to the Mid-Fraser River and Thompson River regions (Figs. 1, 7, and 12) and were used historically by both the Shuswap and Thompson peoples. About 30 judgementally selected specific locales of varying size deemed to have moderate or high potential for bearing flakable lithic materials were intensively examined during this study (Figs. 1, 2, 4, 7, 10, 12, 16, and 17). A geological reference for the Braelorne/Goldbridge area that Ed Bakewell had during his visit indicated that cherty deposits are present along the north side of Carpenter Lake (Fig. 1) and this area was also examined in 1989. However, the "cherts" found in these metamorphosed deposits on the north side of Carpenter Lake are of very poor quality, and are unsuited for flaking purposes. Given the geological context of the area, it is highly doubtful that a source of flakable quality materials exists there.

Local surficial and bedrock geology in the Mid-Fraser River region is comprised of a number of separate geologic "groups." There are two main groups that are of interest to this study, the "Cache Creek Group" and "Kamloops Group." The Cache Creek Group is represented primarily in the vicinity of Marble Canyon, which lies east of the Keatley Creek site. Duffel and McTaggart (1951:15–24) document that:

> The Cache Creek Group consists of a thick assemblage of cherts, argillites, minor agglomerates and tuffs, and their metamorphic derivatives, exposed along Thompson River and the Cariboo Highway from Martel to Cache Creek and north to Clinton. It also includes the massive, recrystallized limestones typcially exposed in the Marble Canyon and Pavillion Mountains, and known as Marble Canyon formation. This limestone, forming a distinct subdivision that may be mapped separately, contains minor intercalations of chert, argillite, and greenstone.

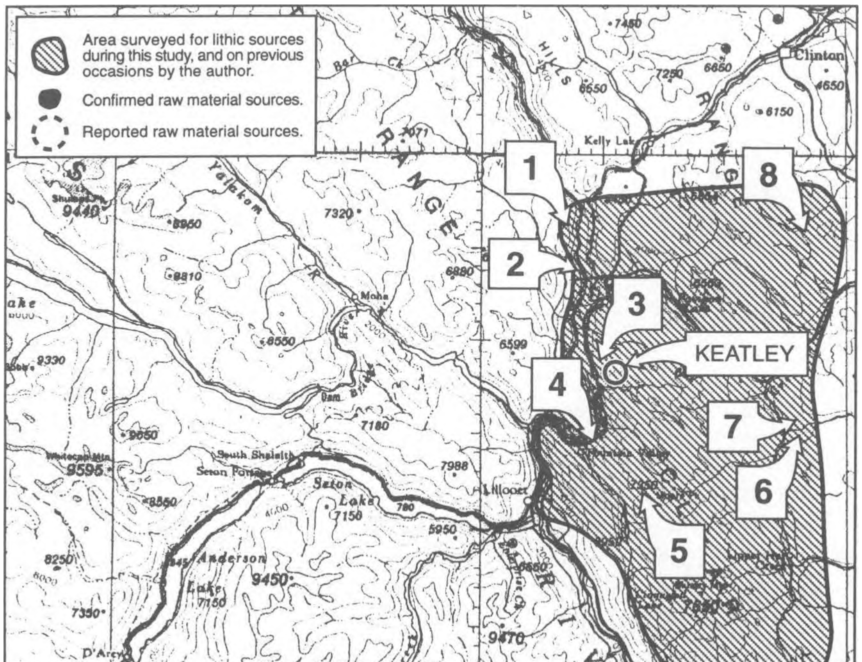

Figure 1. The general areas examined for lithic sources in the Mid-Fraser River region, and location of the eight sources discussed in this report. 1) Moran Chalcedony source; 2) Blue Ridge Ranch Chalcedony source; 3) Glen Fraser Silicate source; 4) Fountain White-Pink Speckled Chalcedony source; 5) Rusty Creek Red Chert source; 6) Upper Hat Creek Silicate source; 7) Upper Hat Creek basalt source; and 8) Maiden Creek basalt and Silicate source.

The other geologic group of interest to this study is the "Kamloops group." The Kamloops Group was initially described by Dawson (1896), and has been redefined several times since (see Drysdale 1914; Duffel and McTaggart 1951; Campbell and Tripper 1971; Ewing 1981). It consists primarily of Tertiary age basalts and sediments.

Tertiary age volcanics and sediments are found in several locations along the Fraser River from Lytton northward to the mouth of the Chilcotin River on valley sides and upland areas, and also in some of the mid-altitude and upland areas from Pavilion to Kamloops on the north side of the Thompson River. Tertiary volcanics and sediments are obvious by their conspicuous bright coloration, which include true and mixed shades of yellow, orange, red, purple, brown, green, and occasionally medium grey and even light blue. Tertiary sediments often stand out in sharp contrast against adjacent deposits or bedrock. Most are thick vertically but are often isolated or relatively localized. They appear to represent deposits that escaped removal or erosion by glacial and/or fluvial activity. In some of these sediments, chalcedonies and cherts have formed in cavities and bubbles within the sediments, and/or have replaced organic matter (i.e., petrified wood). They may also contain secondarily deposited pebbles and cobbles of similar materials that eroded out of associated Tertiary lava flows. The quality of basaltic rocks found within Tertiary volcanics varies from highly glassy to vesicular and granular columnar forms. The basaltic formations assigned to this group are most prominent on the north side of the Thompson River between Cache Creek and Kamloops, however, there are also several major areas northeast of Pavilion in the Maiden Creek area. While recent petrographic analyses have indicated that the black vitreous material commonly used for making stone tools prehistorically is probably a very fine grained trachydacite (Vol. I, Chap. 16), this material has traditionally been referred to as "vitreous basalt" by regional archaeologists. For ease of comprehension, I will continue to refer to these materials in this paper as "basalts" or "vitreous basalts."

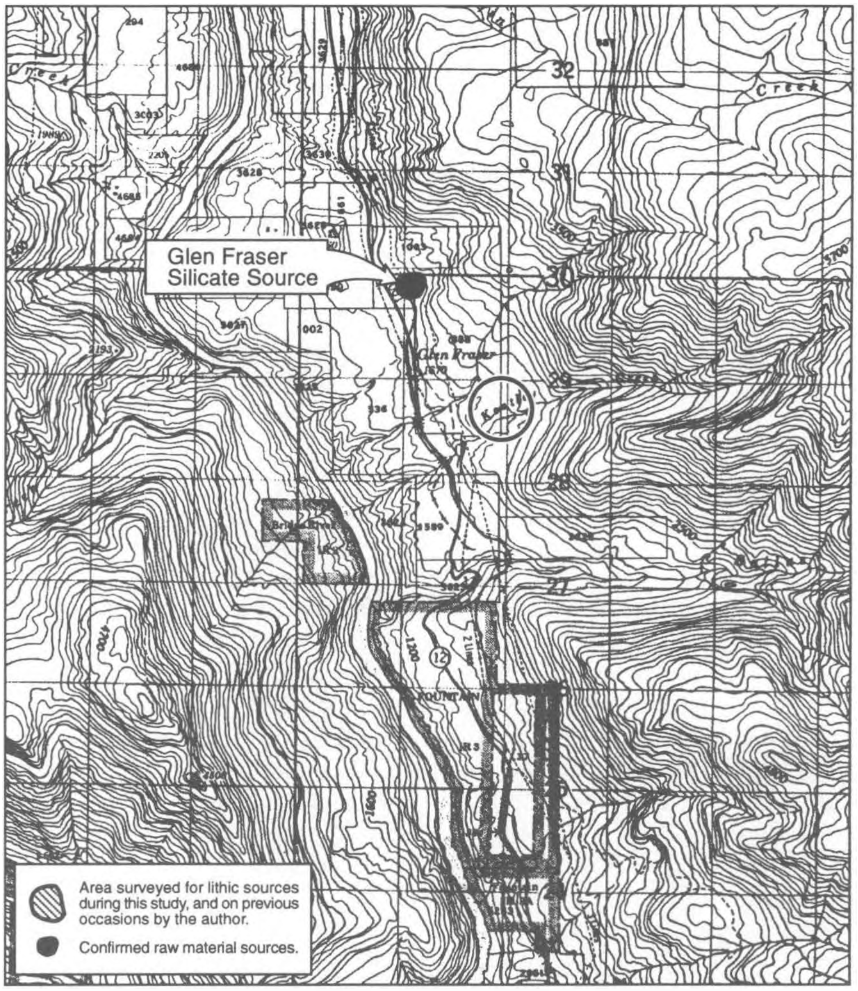

Figure 2. Location of the Keatley Creek site (circled), the Glen Fraser Silicate source, areas inspected in proximity to the Keatley Creek site, and master map legend.

Although most of the basaltic rocks are represented by lava flows, secondarily deposited pebbles and cobbles of flakable material up to about 50 cm in diameter have been found in great numbers in exposed glacial till and glacio-fluvial deposits near the town of Cache Creek. Unfortunately, a bedrock source for this material has yet to be identified (Richards 1987 and 1988). This basaltic source has been well known for many years, as reflected in local place names like "Arrowstone Hills" and "Arrowstone Creek." Although the Cache Creek basalt source is referred to several times in this report, details concerning it are not presented here. The reader is referred to Richards (1987, 1988) for further information. Occasionally small nodules, veins, or "pockets" of chert and chalcedony formed by crystalization of dissolved silica can be found in large air cavities formed in vesicular basalt lava flows. These high quality nodules are usually translucent white chalcedony (i.e., clear agate), although sometimes mineral impurities have imparted various chromatic hues and shades of yellow, orange, red, green, brown, grey, grey-blue, black, and sometimes even blue and purple. Presumably, the color of some of these silicates was derived from the colors of the lavas and sediments in which they were formed. Color mottling, striations, and banding are also common for some of these silicate types, and sometimes the odd macrofossil inclusions can be detected with the unaided eye in some specimens.

Further details concerning the local geomorphology and late Quaternary history of the area are summarized in Ryder (1978).

Survey Methodology

The most successful method used to locate lithic sources involved following leads provided by local rock collectors, other researchers that have previously worked in the area, and local native elders. Rock collectors queried during the study included George Kirschenstein (Lytton), Ron Purvis (Lillooet), Mr. Bouvette (previously of Lillooet, now in Princeton), Cliff and Gail Proznick (Ashcroft), and Brian Parke (Parke Ranch, Upper Hat Creek). Information was also provided by Dr. Arn Stryd (Arcas Associates), Dr. Martin Magne (Archaeological Survey of Alberta), Dr. David Pokotylo (Department of Anthropology, UBC), and Diana Alexander (SFU). Native elder Desmond Peters (Pavilion Band) provided information about the Maiden Creek source, and related that there may also be a source of white chert(?) within Botanie Valley (see below).

Lithic quarries were also sought by initiating a judgemental ground surface survey in areas where exposed geologic deposits were deemed to possibly contain silicate pebbles and cobbles. Most of these locations are indicated in Figures 1, 2, 4, 7, 10, 12, 16, and 17. As indicated above, prime target areas included intact or secondarily deposited Tertiary age volcanic and sedimentary geologic units.

Once a source area was located, it was inspected to determine its extent, and the nature and abundance of available materials. Samples of materials available on the surface were also collected for later description and future reference. All source locations were plotted on 1:50,000 NTS maps, and black and white photos were taken at several source areas.

All specimens secured from these sources were catalogued using SFU Archaeology. department lithic source reference numbers (e.g., SFU-B.C. 6). Samples from all four identified sources are presently being stored in the Archaeology Department at SFU.

Study Results

Of the seven possible lithic raw material sources reported by local rock collectors, previous researchers, and local native elders, only four were located and recorded during this study. They include the Glen Fraser Silicate source, Blue Ridge Ranch Chalcedony source, Upper Hat Creek Silicate source, and the Maiden Creek basalt and Silicate source (Sections 4.1, 4.2, 4.4, and 4.8; Figs. 1, 2, 4, 7, and 12). The remaining three unlocated sources include a source of good quality petrified wood on Arrowstone Mountain; a possible source of good quality chert in the Rusty Creek area of Fountain Valley, and a possible source of white chert in the Upper Botanie Valley.

Four previously unreported quarries were discovered. They include: the Upper Hat Creek basalt source; Fountain White-Pink Speckled Chalcedony source; the Rusty Creek Red Chert source; and the Moran Chalcedony source (Figs. 1, 4, 7, and 10).

Glen Fraser Silicate Source (SFU lithic source B.C. 39)

The Glen Fraser Silicate source is located only about 1.5 km north of the Keatley Creek site immediately east of the B.C. Rail tracks (Figs. 1, 2, and 3). The main source is an eroding debris flow lobe situated about 100 m east of the tracks near the apex of an alluvial fan (Fig. 3). This source was previously documented by Stryd (1973:189), and was reported to the author in 1986 by Mr. Bouvette, who used to own a rock shop south of Lillooet.

The main source area contains angular and rounded pebbles and cobbles of cherts and chalcedonies of various colors and qualities. Most pieces range between about 3 and 15 cm in diameter, although some larger chunks are also present. The most common materials observed are purple, purplish-pink, blood red, orange-red, orange, and yellow cherts. Small pebbles or pieces of translucent, opaque white, and milky white chalcedonies are also present in low frequencies. Mottling of colors and variation in grades and texture are common, even on the same piece of stone. The

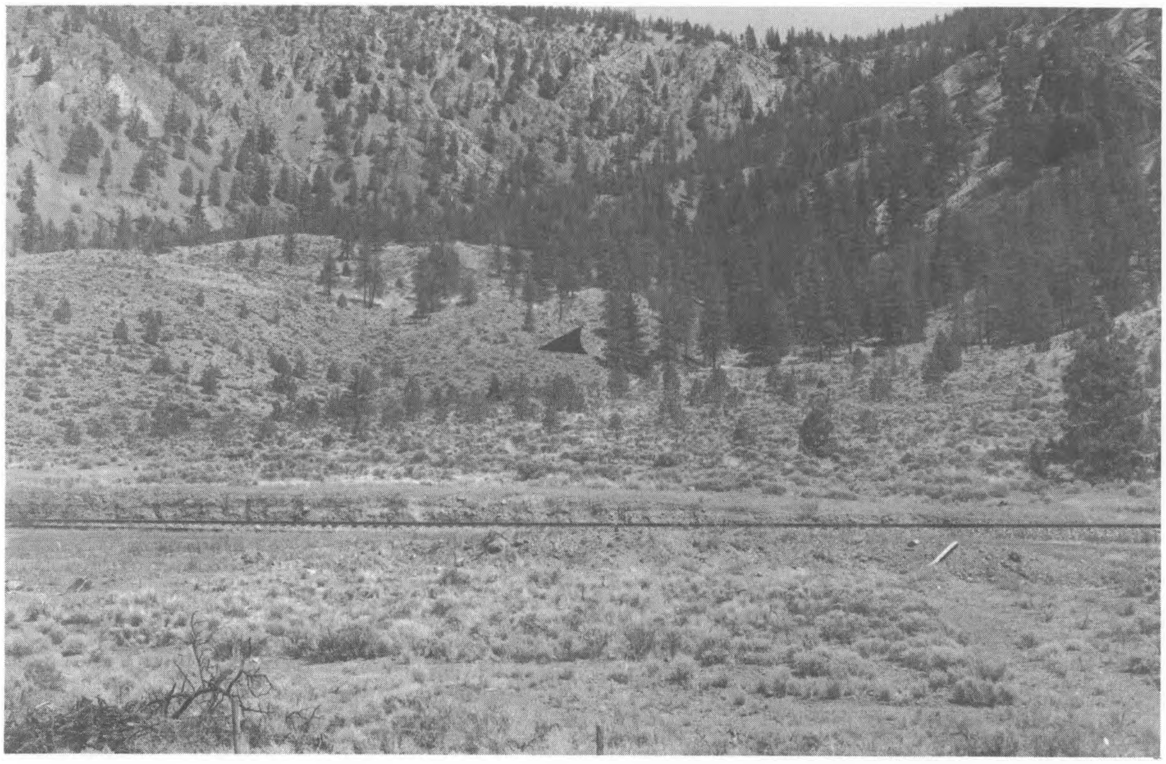

Figure 3. View of the Glen Fraser Silicate source, located about 1.5 km northwest of the Keatley Creek site, looking east. The arrow indicates the debris flow lobe where most materials are eroding out. The alluvial fan deposit between the main source and B.C. Rail tracks also contains a few pebbles and cobbles of similar fair to good quality materials.

cortex lacks patination on most pieces, but weathered surfaces have a frosted appearance.

When flaked, there is a tendency for most of these materials to shatter along planes of weakness that result in irregular fracturing. Most of the materials observed at the main source area are generally considered to be poor to fair quality for flaking and tool manufacture, but some small (i.e., 2–10 cm in diameter) pieces are quite isotropic and flake relatively well.

In addition to the main quarry area, small (2–10 cm) chunks of the same materials with a higher proportion of translucent, white, and sometimes puple and pink cherts and chacedonies are also present in low frequencies on, and buried within, the alluvial fan deposits to the immediate southwest (Fig. 3). Numerous small and randomly distributed prehistoric lithic reduction station sites containing vitreous basalt and a high incidence of these "exotic" silicates are scattered over the alluvial fan deposits. These sites were not recorded during this study.

About 500 m north of the main source area, occasional small platey pieces of translucent chalcedony and calcite nodules are eroding from Tertiary sedimentary beds at the southern base of a bluff. The chalcedony from this source is considered to have poor to fair flakability, as it contains numerous flaws, and thus potential for production of tools on large flake blanks is seriously hindered.

Initially, it seemed that the suite of lithic materials collected from this source was very rarely represented in the assemblage of materials secured from the Keatley Creek site (Spafford, personal communication 1988). However, because the main quarry source is known to rock collectors as a "jasper" source, it is possible that much of the better quality surficially evident materials were recently depleted prior to being inspected during this study. It is possible that better quality materials are buried within the debris flow lobe representing the main quarry source. However, I feel that this could only be demonstrated by excavating into the debris flow lobe comprising the main source area.

Blue Ridge Ranch Chalcedony Source (SFU-B.C. 40)

The Blue Ridge Ranch translucent chalcedony or "agate" source is located 11 km (linear distance) northwest of the Keatley Creek site on the west side of the Fraser River on property owned by Blue Ridge Ranch (Figs. 1, 4, 5, and 6). It was initially reported by Mr. George Kirschenstein of Lytton, and is accessed by

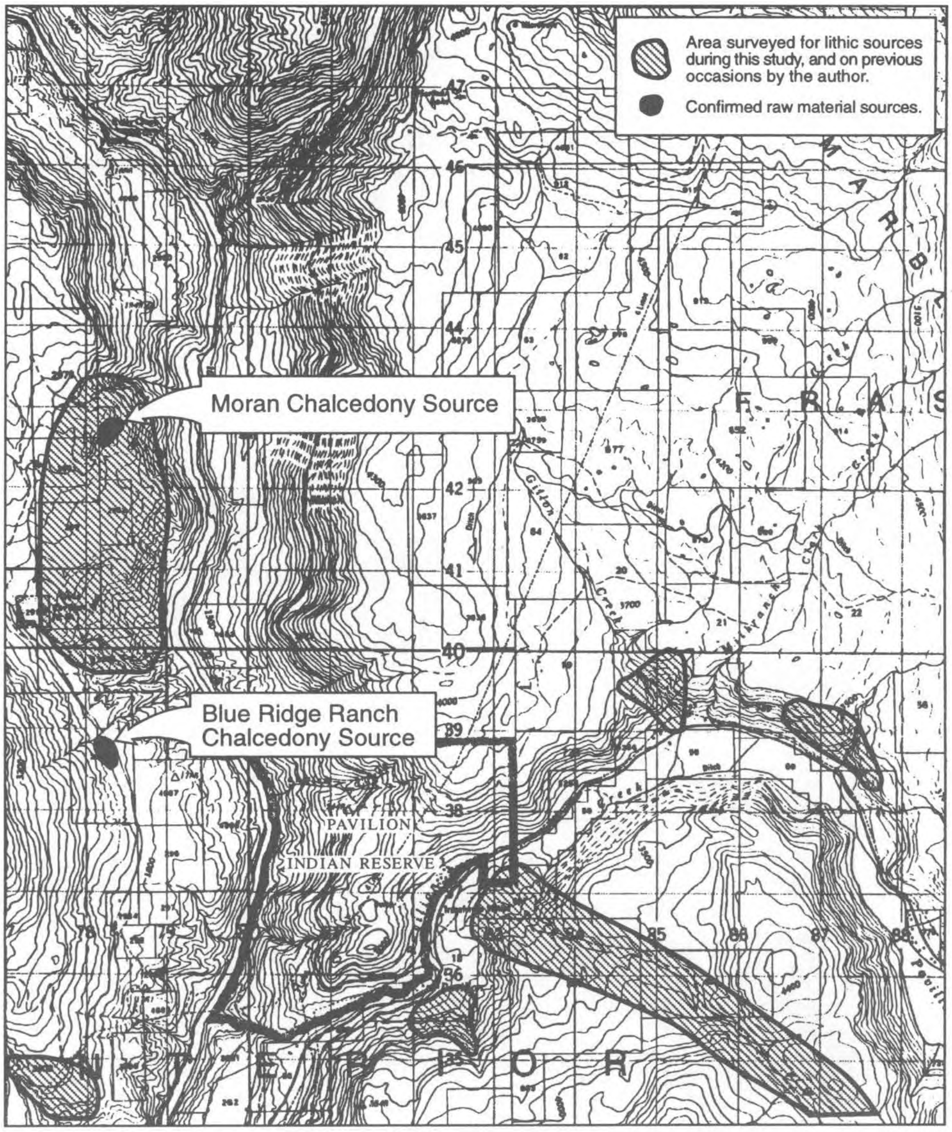

Figure 4. Location of the Blue Ridge Ranch Calcedony source, and the Moran Chalcedony source, and specific areas examined for lithic sources in the Pavilion locality.

Slok Creek Road, which begins at the confluence of the Fraser and Bridge Rivers. Ranch owner Mr. Clint Heichman was contacted by mail in 1988 to request that he plot the reported quarry source location on a 1:50,000 NTS map (Fig. 4), and if possible, to provide a small sample of lithic types represented there. I thank Mr. Heichman for his swift response, and the information and samples he provided. In 1989 I visited the quarry location and collected a larger sample of materials and inspected the geological context of the source.

At this source, thousands of small pebbles and nodules of calcite and chalcedony are eroding out of the fairly loose clayey silt which appears to be an isolated pocket of Tertiary age marine sediments (Figs. 5 and 6). However, most of the nodules within the sediments are only about 1 cm in diameter, and range between about .5–5.0 cm in diameter. An extraordinarily large cobble Mr. Kirschenstein collected from this source is about 30 cm long by 10 cm wide, and Mr. Heichman also confirmed that other fairly large cobbles have been found at this source.

Most of the nodules are either round, football-shaped, or egg-shaped. The larger ones (i.e., 2–5 cm in diameter) lend themselves very well to bipolar reduction. Some nodules contain surficially evident spherical inclusions which may be fossiliferous. A large proportion of the nodules have a distinctive "pock-marked" textural appearance, and many also have a dull, thick, earthy-looking grey-brown or orange-brown cortex over much of their surface.

The groundmass of most of the chalcedony is generally opaque white, although some have a yellowish, bluish, or blue-grey tinge. The quality of the chalcedony grades from poor to excellent. For most specimens the groundmass appears to be relatively isotropic, although internal flaws are present in some pieces. The sample flake from a large cobble from this source provided by Mr. Kirschenstein appears to contain a high frequency of dendritic fossilized inclusions of an unknown nature.

In general, flakability appears to be fair to excellent, however, the small average size of the pebbles would have certainly restricted the size of flake blanks that could have been obtained from them. This general suite of translucent chalcedonies cannot be visually distinguished from similar chalcedonies that are commonly found throughout most of the Mid-Fraser and Thompson River regions in glacio-fluvial outwash deposits.

It is important to consider that although this source, and the Moran Chalcedony source, are fairly close to the Keatley Creek site (Fig. 1), they lie on opposite sides of the Fraser River. The river would have almost certainly acted as an effective geographic barrier to the movement of materials across it, and it may be that these sources were only rarely (if ever) exploited or accessed by the inhabitants of Keatley Creek village.

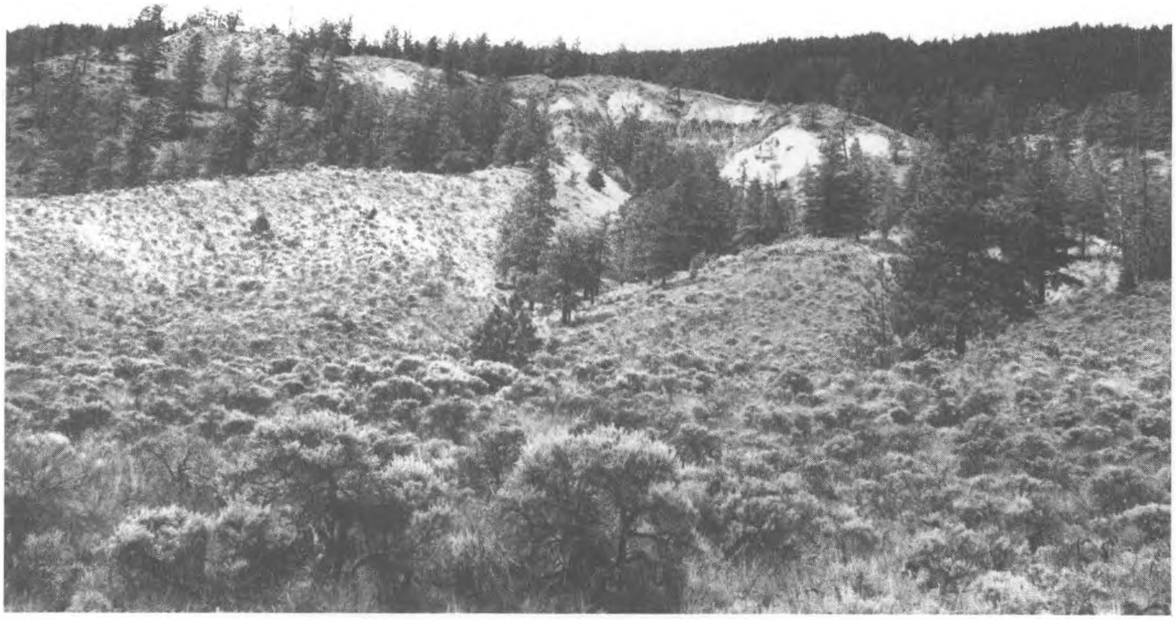

Figure 5. A general view of the Blue Ridge Ranch Chalcedony source. Thousands of small agate nodules are eroding from the sediments in the upper half of the photo. Looking west from Slok Creek Road.

Figure 6. Closeup view of eroding sedimentary deposits at the Blue Ridge Ranch Chalcedony source containing a high density of small chalcedony and calcite nodules. Looking south.

Upper Hat Creek Basalt Source (SFU-B.C. 41)

This lithic source is located about 1 km north of the intersection of Upper Hat Creek Road and Medicine Creek (Figs. 1, 7, and 8). Thousands of glassy to fine grained basalt pebbles are eroding out onto a steep talus slope occupying the southern and western sides of the northern end of a prominent ridge (Fig. 8). This basalt source was not previously identified during archaeological investigations conducted in the Upper Hat Creek Valley in the late 1970's (Pokotylo, personal communication 1988).

In 1989, Ed Bakewell examined the source and concluded that it is a steeply uplifted section of an eroding Tertiary(?) age fluvial deposit comprised primarily of sedimentary beds bearing moderate to high densities of small secondarily deposited basalt nodules. The relatively vertical disposition of the beds containing these nodules accounts for several localized areas where moderate to high densities of small pebbles appear to be "streaming" down the talus slope.

When compared to basalts from other nearby abundant sources (i.e., Cache Creek and Maiden Creek), the Upper Hat Creek basalt pebbles differ conspicuously by their smaller average size. Most range between about 2–4 cm in diameter, although a few cobbles up

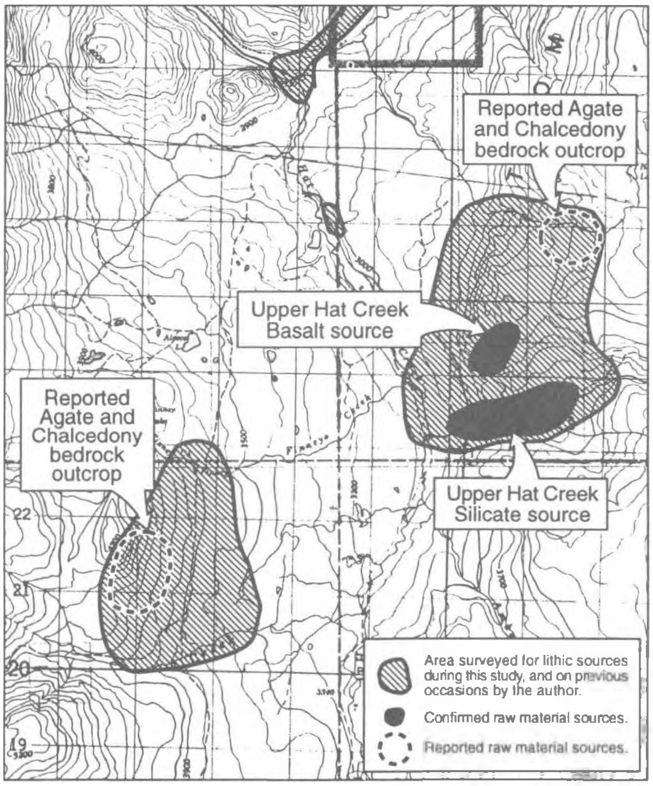

Figure 7. Location of the Upper Hat Creek basalt source and the Upper Hat Creek Silicate source near Medicine Creek, and reported chert and chalcedony bedrock outcrops and areas examined during the study.

to about 10 cm diameter were also found. Isolated basalt pebbles and cobbles can also be found in very low frequencies on the surface or in stream and roadcut exposures within a 1 km area surrounding the main source area. On average, these isolated pebbles and cobbles tend to be larger than those represented at the main source, and their character usually has greater visual similarity with the Cache Creek basalts.

Most of the Upper Hat Creek basalt pebbles can be visually distinguished from those found in the vicinity of Cache Creek and Maiden Creek in that the Upper Hat Creek basalts bear a very distinctive patina. It is light to medium grey and has a somewhat dull grey metallic luster, as if the pebbles had been coated with graphite or lead. Cache Creek and Maiden Creek basalts have patinas that are typically either white or light grey, and almost always have a dull or "chalky" luster. A high percentage of the pebbles (ca. 80%) from the Upper Hat Creek source are somewhat elongate discoidal or eliptical in form, and they have a smoothed weathered appearance. The internal consistencies and textures of these pebbles are visually indistinguishable from most of the other basalts represented in the adjacent Cache Creek source deposits.

When flaked, there is a tendency for the pebbles to split easily along longitudinal planes, and as a consequence, they lend themselves very well to bipolar flaking to produce small flakes. Their smaller average size would obviously have restricted the size of the flakes and tools produced from them. Indeed, Dr. David Pokotylo and I have noted a high incidence of small bipolar reduction sites in the immediate vicinity of the main source area. The basalt pebbles may have also been selected for microblade cores because of their small size, discoidal and eliptical forms, and platey flaking tendency, but this remains to be verified.

Cortex-bearing surfaces on basalt flakes recovered in the excavations at Keatley Creek lack the distinctive metallic luster observed on the Upper Hat Creek basalts. Therefore, I conclude that regular exploitation of this source by the inhabitants of the Keatley Creek site may have been quite rare, as there are several other nearby sources (i.e., Maiden Creek and Cache Creek) where significantly larger basalt cobbles of comparable quality are readily available. It may be possible to verify whether this material was being used by the inhabitants of Keatley creek using X-Ray florescence analysis.

Upper Hat Creek Silicate Source (SFU-B.C. 6)

The Upper Hat Creek Valley has long been known as a major source of chert and chalcedony by rock collectors and archaeologists. Pebbles, cobbles and boulders of yellow, brown, orange, red, purple, green, and black chert and chalcedonies have been found in glacial till contexts as float throughout much of the Upper Hat Creek Valley area. The most abudant types

Figure 8. **A general view of the Medicine Creek locality in Upper Hat Creek Valley indicating the location of 1) the Upper Hat Creek basalt source and 2) the Upper Hat Creek Silicate source. Looking north.**

Figure 9. A view of the Moran Chalcedony source in the West Fountain locality. Tabular chunks and nodules of chalcedony and clacite are eroding out of the bedrock outcrop in the upper-center of the photo. Looking northwest.

are yellow, light yellow-brown, and medium brown. Mottling is common, and some chunks bear red, green, and sometimes light grey patchy inclusions. Other lithic types, although rarer, include translucent chalcedony and various grades of grey or brown petrified (i.e., "opalized") wood (Cliff and Gail Proznick, personal communication 1989).

The area that has reportedly yielded the greatest concentrations of materials encompasses the lower portions of Medicine Creek valley and its immediately adjacent areas (Figs. 7 and 8). Here, most of the material has been found within, and beside the creek east of the cattleguard for about 1 km, and on the ridge to the immediate south (Fig. 7). Most pieces of these materials range between about 3 and 20 cm in diameter, but occasionally boulders up to about 1 m in diameter of yellowish brown cherts and chalcedony have been recovered. Several such boulders are owned by Cliff and Gail Proznick (Ashcroft).

Surficial examination of the lower Medicine Creek drainage area suggests that there is presently very little evidence to indicate that a major lithic source does indeed exist in this location. Because this source has been known to rock collectors and exploited by them for over 50 years, it has been depleted to the point where very little exists on the present surface either as outcrop or float pebbles. Dr. David Pokotylo informed me that during one weekend he observed about 15 vehicles belonging to rock collectors parked there. Nevertheless, for a patient and keen eye, some good-quality materials can still occasionally be found in the creek bed along some sections of Medicine Creek, and in several recently disturbed areas on the ridge to the south.

The serious depletion of materials from this source area by rock collectors in the last few years clearly indicates that it is quite possible to exhaust a relatively abundant source if it is well known. I suggest that this has important implications for prehistoric situations—especially during periods of peak population—when the Upper Hat Creek lithic resources would have been very heavily exploited. This may have been especially true during the Lochnore phase (ca. 5,000 to 3,500 BP) and the Plateau horizon (ca. 2,400 to 1,200 BP), when it seems that utilization of the Upper Hat Creek Valley area was most intense (Pokotylo and Froese 1983; Richards and Rousseau 1987; Stryd and Rousseau 1988).

Inspection of several areas in the uppermost reaches of Upper Hat Creek Valley indicate that flakable materials appear to be rare south of MacDonald Creek. This was also confirmed by rock collectors Cliff and Gail Proznick (Ashcroft) and Brian Parke (Upper Hat Creek) who have collected rocks in the area for a number of years.

Lithic raw material types from Upper Hat Creek sources appear to be well represented in the lithic assemblages recovered from housepits at the Keatley Creek site. Some of the tranluscent chalcedony and petrified wood recovered from this site may have also been derived from Upper Hat Creek Valley. However, it is important to point out that some of the chalcedonies and cherts from Upper Hat Creek Valley are visually identical to many of those found in the Maiden Creek source area which lies about 20 km to the north. Because of this very close visual similarity between certain lithic types from these two source areas, assignation of archaeological specimens to one specific source might be erroneous. This would be especially true for prehistoric peoples using the the Lower Hat Creek area which lies between these two abundant source areas, and for groups occupying the Pavilion and Fountain localities.

In 1988, Dr. Martin Magne (Archaeological Survey of Alberta) indicated the location of two possible bedrock sources of chert and "agate" in the Upper Hat Creek valley around Finney and Anderson Creek that he observed from the air (helicopter). The first is situated about 3 km northeast of the confluence of Medicine and Hat creeks. The other is located on the north side of Anderson Creek about 3 km west of its confluence with Hat Creek (Fig. 7). Inspection of these locations during this study failed to identify any outcrops of siliceous materials, however, brightly colored red and orange outcrops of volcanics exist in these locations and these may have been visually mistaken for chert source areas from the air.

Moran Chalcedony Source (SFU-B.C. 42)

The Moran Chalcedony source is located exactly 7.5 km (linear distance) NNW of Pavilion on the west side of the Fraser River opposite the abandoned trainstop called Moran (Figs. 1, 4, and 9). Tablular chunks and nodules of calcite and translucent chalcedony can be found in moderate abundance on the talus slope leading down from an isolated orange-red outcrop of eroding Tertiary volcanics and compacted or conglomerized sediments (Fig. 9). The material can also be seen in the bedrock outcrop and its related hoodoo-like formations.

The calcite and chalcedony appear to have formed in pockets, interstices, bubbles, and viens within both the basalts and sediments. Most chunks and pieces indicate that it was formed in cracks and crevices, thereby giving them a platey or tabular appearance. On many pieces where they interfaced with the bedrock, pock-marking or rippling is a prominent feature, as is the presence of a relatively thick light yellow, light yellow-green, or light green patina. Generally the pieces tend to be small (about 1–4 cm in diameter), but some bigger pieces up to about 8 cm diameter can also be found.

The internal groundmass is usually fairly hard, and either translucent white (i.e., pure colloidal silica), or sometimes pale yellow-white or pale grey-blue. Most of the specimens indicate some degree of flawing, notably where crystal growth plane fronts intersect. There is also a tendency for this material to shear more easily in a manner perpendicular to the planar axis of the chunks, hence producing the characteristic "tabular" appearance. This material has generally poor flakability because of its hardness, small average nodule size, and groundmass flawing and bedding planes. There was no evidence for prehistoric lithic reduction activities noted at this source.

The lithic assemblages recovered from the housepits tested at the Keatley Creek site contain small percentages of translucent chalcedonies resembling those observed at this source. However, positive identification of chalcedony obtained from this source would be difficult on the basis of visual criteria alone, as identical materials are also available as float pebbles in glacio-fluvial and fluvial deposits throughout the valley bottoms and sides in the Mid-Fraser River and Thompson River regions. Nevertheless, the distinctive outer surface texture, unique patination, and tabular tendencies of Moran Chalcedony may make future identification possible at some sites. Because this source, and the Blue Ridge Ranch Chalcedony source, lie on the opposite side of the Fraser River from the Keatley Creek site, I think it is very unlikely that they would have served as a primary focus for lithic material acquisition for the inhabitants of Keatley Creek.

Fountain White-Pink Speckled Chert Source (SFU-B.C. 43)

There is a distinctive white-pink speckled chert that sometimes constitutes a significant percentage of the exotic material lithic assemblage samples recovered from housepits tested at Keatley Creek. According to Bakewell's analysis (Vol. I, Chap. 16), this is technically a "pisolite." The color of this material is somewhat variable with most hues grading between pale yellow, white, and pink, and sometimes pastel shades of light purple and light grey. The texture of a fresh surface on most of the varieties ranges from dull to waxy, although some flakes can have a glassy luster. There is no apparent rigid correspondence between color and texture, although the white and yellowish hues sometimes tend to have a dull luster and greater incidence of flawing. The pink materials tend to be better quality, but also suffer from some flawing.

The most distinctive feature of this raw material is the presence of numerous small white or pale grey spherical inclusions about .5 mm in diameter in the groundmass that petrologist Ed Bakewell thinks may be fossiliferous (Vol. I, Chap. 16). Some flakes clearly indicate having been thermally altered. Thermal alteration of the material also changes its color.

The absence of any weathered surfaces on the archaeological examples of this material type indicate that it is a tabular chert that was probably formed in a metamorphosed sedimentary context, or perhaps within large cracks and fissures in bedrock. Initially it was thought that the source of this distinctive speckled material lay somewhere in upper Rusty Creek Valley to the south, but a source for it was not discovered in this location during a subsequent inspection despite several days of searching. Another attempt to locate the source of this distinctive material involved examining several lithic scatter sites in Fountain Valley, and inspecting a large collection of artifacts owned by Mr. Bert Lehman who lives at the south end of the valley. From these data, it was surmised that the source probably lay somewhere in proximity to the northern end of Fountain valley where it joins with the Fraser River. This was determined by the presence and sometimes high incidence of this material at sites in this area, its common use at both the nearby Bell site (Stryd 1973) and Keatley Creek site, and the almost total lack of this material in Mr. Lehman's artifact collection.

Through diligent searching, an area containing cobbles that bear this distinctive white-pink speckled material was identified on Fountain Indian Reserve 1A about 2 km east of the village of Fountain (Fig. 10). It lies only about 8 km south of Keatley Creek, hence local accessibility to this source for the inhabitants of Keatley Creek (and other local sites for that matter) is considered very high. Small chunks, tabular pebbles, and cobbles of poor quality white chert containing sections and viens of the distinctive yellow and pink speckled material described above are eroding out of a steep slope on what appears to possibly be a thick Tertiary age sediment near the apex of a promient ridge. The source area has been subjected to some erosion, and several small springs emerge from the base of the sediment unit. Several multicolored Tertiary age basalts and sediments lie immediately north of the source area, however, previous examination of the bases of these deposits suggest that they do not contain other sources of flakable stone.

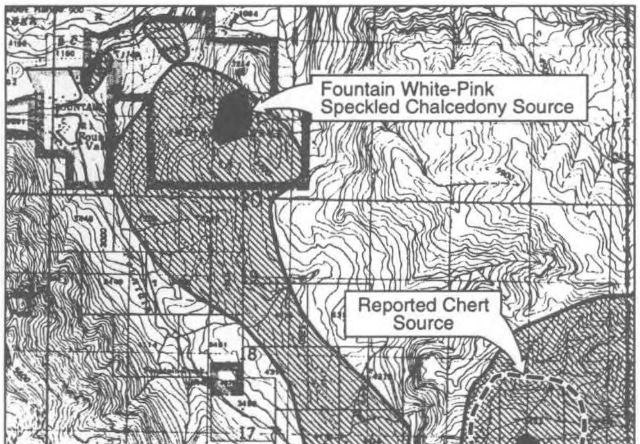

Figure 10. Location of the Fountain White-Pink Speckled Chalcedony source, the Rusty Creek Chert source, and areas inspected for lithic sources in the Fountain Valley.

Although large pieces of this very distinctive chert were not found in the identified source area, numerous smaller pieces of white chert were found that contain thin viens and small sections of this very distinctive white-pink speckled chert. It may be that there is a large isolated vien of the archaeologically observed high quality homogenous material somewhere in the immediate area, however, we did not locate one during this study. The apparent paucity of this material at the identified source location may also be due to almost total source depletion in prehistoric times as a result of heavy exploitation, or perhaps the main lode area has been buried by recent colluvial activity. Evidence for prehistoric lithic reduction activities were not observed at the source location identified in this study. Further intensive inspection of this area might reveal another highly localized and high density source of this distinctive material.

Rusty Creek Red Chert Source (SFU-B.C. 44)

Dr. Arn Stryd and local Lillooet resident Gary Taylor indicate that there is a reported chert source located within and/or adjacent to Lot 3453 in the upper reaches of Rusty Creek Valley, a tribuary of Fountain Valley (Fig. 10). Unfortunately, neither informant knows the exact location of this chert source, or the nature of the material supposedly found there. The current owners of Lot 3453, Reid and Cindy Frederick, have a site in their garden that has yielded hundreds of flakes of Fountain White-Pink Speckled Chert. Reid Frederick reports that some of the chunks and pieces are fairly large. Consequently, I concluded that there must be a source of this distinctive speckled chert in the immediate area, and in 1989 the upper reaches of Rusty Creek drainage area were extensively examined during a four-day search

Figure 11. A view of the Rusty Creek Red Chert source (arrow). Looking south. There may be another source of flakable stone in the area, however, it was not identified during this study.

for a source of this, and other, flakable materials. The area examined included the valley bottoms and sides of Rusty Creek and its tributaries (Fig. 10), and extended eastward to include the alpine meadow areas in the upper reaches of Gibbs Creek and immediately south of Chipuin Mountain (not shown on figure maps).

Although a source of the white-pink chert was not found within the upper Rusty Creek drainage area, a source of poor to fair quality, orange-red chert was identifed in the southern section of Lot 3453 (Figs. 10 and 11). It is eroding out of a large metamorphosed basalt bedrock face of unknown geologic age comprising the apex of a steep prominence on the south side of the valley (Fig. 11). The chert has formed in interstices and cracks within the basalt flow, and occurs in dendritic and large angular blocky chunks up to about 30 cm in diameter.

In general, the flaking quality of the material is significantly affected by microfractures and flaws, although small pieces with highly siliceous groundmass lend themselves well to being flaked. No evidence for quarrying activities were observed at the source. That this material would have been used on any regular basis by local prehistoric populations seems unlikely because it is difficult to access and the stone has comparatively inferior flaking qualities. Moreover, it does not appear at any of the archaeological sites inspected in the immediate area.

It should be noted that Dave Johnstone and I found that the cliff faces at the top of the angular ridge in the upper-centre of Figure 11 could not be accessed safely from the valley bottom due to steep talus slopes and precipitous terrain. It remains to be inspected, and there may be a more accessible route down to the base of these cliff faces somewhere along the top of the ridge; a moderate (2.5 km) hike from the main road to the west. As reported, there may still be another highly localized source of flakable silicates in the upper Rusty Creek, or perhaps in the Frantzen Creek drainage area to the immediate south. This potential for additional sources is inferred for these areas because of the sedimentary nature of the local bedrock, the presence of basalt flows and intermediary compressed and foliated sediments, and the confirmed presence of at least one chert source.

The Rusty Creek Red Chert source may in fact be the one referred to by Stryd (1973), however, this does not seem likely. Mr. Bouvette may know the location of another better-quality silicate source in the immediate area.* Another possibility is that the reported "chert" source in upper Rusty Creek is actually the disturbed site in the Frederick's garden that has yielded a very high incidence and density of Fountain White-Pink Chert. There used to be an old homestead on the north side of the creek about 150 m south of Frederick's log house that may have initially used this

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* Mr. Bouvette can be contacted at Bouvette's Rock and Gem Shop, Princeton, B.C.

garden plot, thus exposing the site and resulting in it being mistaken for a natural chert source.

Maiden Creek Basalt and Silicate Source (SFU-B.C. 45)

The Maiden Creek source area lies within Kamloops Group Tertiary volcanics and sediments. It is situated in the upper reaches of Maiden Creek and its adjacent mid-altitude areas to the south just northwest of Bonaparte IR No. 2 (Figs. 12–15). Pavilion Band elders have related that they traditionally used a source of basalt from the Maiden Creek area (Alexander, personal communication 1989), which can be accessed via Pavilion Creek or from Pavilion Mountain. Elders have also indicated that they hunted, and still hunt in this area, and it is possible that hunting and quarrying were synchronous activities in prehistoric times.

Walking distance along the easiest direct route from the Keatley Creek site to the uppermost drainage area of Maiden Creek is only about 25 km (Figs. 1 and 12). During the 1987 and 1988 field seasons, I had the opportunity to view the Pavilion Creek and Upper Maiden Creek drainage areas, and see no reason why human movement might have been seriously hampered through the pass connecting these areas, other than, perhaps, the marshy area southeast of Pavilion Mountain summit.

Duffel and McTaggart (1951:18) also mention that dark grey to green and sometimes black, fine-grained cherts can be found around this general area. I think it is possible they may have mistakenly identified the flakable basalts in this area as being chert. Also, Richard Brolly (Arcas Associates) related that he noted an unusually high density of basalt and exotic materials at several sites in the Maiden Creek area during a previous impact assessment survey.

In 1989, a judgmental survey was initiated over a large area encompassing the north and south side of Maiden Creek (Fig. 12). A large and fairly abundant source of flakable stone was found which encompasses an estimated 20 square km. These materials are represented in two separate geological contexts. The first lies in the bottom of the creek valley within and around the southwestern corner of lot 143 (Lill) and it continues southwest on either side of the creek for about another 500 m (Fig. 12). Here, small and large basalt cobbles are found in moderate to high densities in glacio-fluvial and fluvial deposits. The access road passes over the creek at this location, and there are several areas of extensive disturbance within these deposits relating to fairly recent gravel quarrying, and road and hydro line construction activities.

Here, several unusually large (15–25 cm in diameter) and many smaller (5–15 cm in diameter) cobbles of glassy and fine to medium grained basalt were found on and beside roads, in the gravel quarry, along the creek bed and banks, and in the fluvial deposits exposed within the hydro line right-of-way (ROW). About 95% of the flakable material here is basalt, although I also found several pieces of relatively poor quality yellowish chert and a large cobble of translucent grey-blue chalcedony.

There are also some basalt and silicate materials lying in the very upper reaches of Maiden Creek, however, I noted in several large disturbed areas that there was a general decrease in the abundance and average size (about 5 cm in diameter) of basalt cobbles, and only the rare small piece of silicate. There was abundant evidence for aboriginal lithic reduction activity immediately along and beside the creek where the apparent greatest density of large basalt cobbles was identified (Figs. 12 and 13). Sites were significantly more spotty further up the creek toward Pavilion summit, and most of these were small core reduction stations. It is not known whether any of these sites have been previously recorded, and they were not recorded during this study. The northwestern extent of this

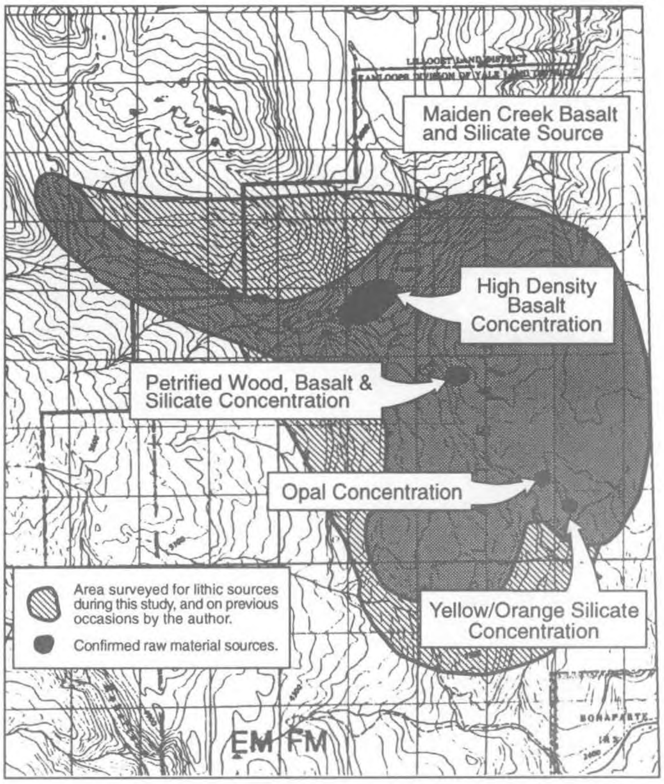

Figure 12. Location of the Maiden Creek basalt and Silicate source, and areas examined during the study. Specific material type clusterings noted during the study are also indicated.

source in upper Maiden Creek Valley could not be determined due to the lack of access and subsurface exposures. I suspect it probably extends to the base of Pavilion mountain where the Marble Canyon Formation interfaces with the Tertiary age volcanics.

The second geologic context identified to contain cobbles of flakable stone in the Maiden Creek area is the mid-altitude rolling upland area lying southeast of the main valley bottom basalt source (Figs. 12, 14, and 15). Almost all of the materials were recovered from glacial drift and till deposits which blanket the area. The till appears to be comprised primarily of reworked Tertiary volcanics and sediments which were eroded by glaciation and essentially "smeared" over the source area between elevations of about 3,000 and 4,000 feet asl.

The entire hydro transmission line ROW was surveyed within the identified source area (Figs. 13–15), as were numerous logging roads. This mid-altitude context also contains basalts identical to those found in the creek bottom to the immediate north, but the cobbles are notably less frequent, smaller (about 5–15 cm diameter), and comprise about 50% of the sample of flakable stone recovered during the survey. About 30% of the cobbles in the collected sample are chalcedony or chert, 10% are "opal," and the remaining 10% are petrified wood. These materials are described below.

Although isolated cobbles of exotic silicates are randomly distributed throughout the area, most silicates tend to cluster according to specific type, although some types were noted to occur together (Fig. 12). Some of the exotic silicate materials resemble those found in Upper Hat Creek valley, and in a few cases there is virtually no visual difference. The basalts appear to have been scattered randomly throughout most of the source area, but they are less abundant in its southern portion. Slightly greater densities of both basalts and silicates were noted in areas where cobbles and boulders of angular and rounded vessicular basalt, and a distinctive grey-brown-red marbled rhyolite were also very common.

Evidence for prehistoric quarrying and reduction activities, characterized by small core reduction stations, were observed along the transmission line ROW. This indicates that this source was known and exploited in prehistoric times, however, the intensity to which this happened is difficult to measure at this point in time.

General Description of Maiden Creek Basalt

The basalt cobbles from the Maiden Creek source are variable in shape, with many being either discoidal, eliptical, trapezoidal, or most often, polyhedral with large facet-like features. They also have a distinctive thick white or light grey patina, and in this regard they differ with Cache Creek basalts which typically have a thin white or whitish blue hue to their cortex. The Maiden Creek basalts also differ markedly with those

Figure 13. A view of the area noted to have a high density of large basalt cobbles in the bottom of Maiden Creek Valley (center photo). Looking north.

from the Upper Hat Creek basalt pebbles which are typically quite small and have a very distinctive dull silvery-grey patina.

Many of the Maiden Creek basalt cobbles, notably the larger ones, also have a very distinctive rough "corrogated" texture that always appears on a flat face. It seems that this corrugation corresponds with the lamellar flow planes within the groundmass. This potential diagnostic trait is also usually associated with the most heavily patinated sections of cobbles. Many cobbles also bear patches of calcium carbonate (caliche) adhering to their cortical surfaces.

In general, the groundmass of the sample of Maiden Creek basalts examined in this study is typically either jet black or very dark grey-black with no visually apparent mottling or striae. Some (20%) of the cobbles are quite glassy, but most are fine-grained (50%) and the rest are medium grained. When flaked, the material behaves in a manner similar to that of Cache Creek basalt which has a tendency to favor the direction of the platey flow planes of the groundmass. However, the Maiden Creek basalts also have a greater tendency to produce hinge and perverse fractures than Cache Creek basalts.

There is a large lithic scatter site associated with the high density basalt source in the valley bottom, indicating that it was well known and regularly frequented during prehistoric times. Most of the flaked materials suggest primarily core reduction and large flake blank production. An identical site type pattern is indicated for the Cache Creek source area.

It is likely, and probable that at least some of the basalt found in assemblages from Keatley Creek originates from the Maiden Creek source area. This might be testable through comparison of relative element abundance signatures (i.e., "fingerprints") for samples from the site with those from Maiden Creek using the X-Ray Florescence method (James, personal communication 1989).

Descriptions of Maiden Creek Silicate Types

Chalcedony. Many of the Maiden Creek chalcedonies closely resemble types found in Upper Hat Creek valley, which lies about 20 km to the south. The most common varieties are either semi-translucent yellow, yellow orange, orange, or orange brown. Weathered or slightly patinated cortical surfaces have a dull or frosted appearance, whereas fresh surfaces usually have pearly or waxy lusters. Cobbles varying between about 5 and 15 cm in diameter were found. A few pebbles and cobbles of translucent grey or grey-blue chalcedony were also recovered, one of which was about 25 cm in diameter. In general, the flakability of the chalcedonies are considered to be fair, being hindered slightly by its hardness, numerous inclusions and flaws, tendency for fracturing perversely, and relatively small core size. They resemble some of the chalcedonies represented in the sample assemblages recovered from several

Figure 14. A general view of the area noted to have the greatest density of both basalts and silicates at the Maiden Creek source. Maiden Creek is in the center of the photo, and Pavilion Mountain lies in the far distance. Looking north.

housepits at Keatley Creek, but a positive identification is not possible on visual criteria alone.

Cherts. The cherts from the Maiden Creek source are generally the same hues as described for chalcedonies (above), with yellow and yellow-brown being most common. The average cobble size ranges between about 5 and 10 cm in diameter. Some cobbles contain both chalcedony and chert. Weathered or patinated cortical surfaces tend to be dull or frosted, and fresh surfaces have a waxy texture. Some types have a strong visual affinity with cherts found in Upper Hat Creek; suggesting a probable common geologic origin for the basalt and silicate-bearing deposits represented in both these areas. Again I think that it would be almost impossible to separate some of the cherts common to either of these source areas relying on visual criteria alone.

In general, the flakability of the Maiden Creek cherts is considered to be poor to fair. As with the chalcedonies from this source, they are affected by some flawing and irregular fracture tendencies. Their visual characteristics clearly lie within the range of variation expressed by chert types recovered from the Keatley Creek site, and consequently some of them may originate from this source.

Opal. At least one localized source of a material commonly referred to as "opal" was also encountered. The material is represented in a variety of colors and grades of quality; many of which can be present and highly variable on the same piece of stone. Most pieces are either predominantly pale yellow, light yellow, light green, light green-brown, or pale yellow brown, although some small pieces are bright orange and/or blood red. It has a characteristic semi-opaque translucency and a waxy appearance, and it tends to break up naturally into blocky or tabluar chunks about 2–10 cm in diameter. Weathered surfaces have a dull or frosted appearance. There may be other localized sources for this material elsewhere in the source area, but these remain to be identified.

This material is quite brittle, and when flaked, is sometimes unpredictable because of extensive internal flawing. Perhaps this flawing could be partially rectified by thermal alteration, however, this was not attempted on samples during this study. I do not recall having recognized any of this distinctive "opal" material in assemblages from Keatley Creek. Nevertheless, a subsequent examination may reveal low frequencies at the site.

Petrified Wood. Several fairly large chunks of petrified (opalized) wood were found along the transmission line ROW immediately southeast of a pond (Fig. 12). One piece was about 50 cm in diameter and weighed about 50 kg, although most of the larger chunks in the collected sample were only about 10–20 cm in diameter. The rest were signifiantly smaller pieces, varying

Figure 15. A view of the southern extent of the Maiden Creek Basalt and Silicate source along the transmission line right-of-way. Several large cobbles of yellow and yellow-brown chalcedony and chert were found in the area lying in front of the transmission line standard. Looking north.

between about 2 and 10 cm in diameter. Isolated smaller bits of petrified wood were also found scattered throughout many parts of the source area.

The petrified wood from this source is generally opaque white, light grey, light brown, medium brown, or dark brown in color (or a mixture of these), but some pieces contain small sections which are fairly translucent and even slightly irridescent—much like true opal. Weathered surfaces are heavily patinated, and fresh surfaces are either waxy, pearly, or dull in texture. On large pieces, the annual rings of the wood are clearly visible, and they indicate having been formed from branches and trunks of fairly large trees.

Flakability is considered to be generally poor because of the tendency for most pieces to shatter and fracture into elongate chunks and blocky flakes. This is probably due to only partial replacement of the wood by silicates, and/or because the material has a tendency to shear more easily along the lamellar structure of the wood. For these reasons it was probably not a very popular lithic material in prehistoric times.

The petrified wood from Maiden Creek resembles that sometimes found in Upper Hat Creek (Cliff Proznick, personal communication 1989), and a direct geologic relationship between these two areas is again inferred. A few small flakes of petrified wood have been found in assemblages from Keatley Creek which may have originated from either of these two source areas.

Miscellaneous Float Pebble Lithic Types

Randomly dispersed float pebbles of chert and chalcedony are found throughout most of the Canadian Plateau within glacial drift, till, and outwash deposits on valley sides and bottoms. For those with a trained eye, it is not uncommon to find at least one or two cobbles of "exotic" silicate materials ranging from 3–7 cm in diameter during a typical day of surveying or casual hiking. Over the years, several cobbles of high quality siliceous materials have been found incorporated in the extensive outwash deposits flanking the Fraser River in proximity to the Keatley Creek site. Pebbles and cobbles of fine-grained and medium-grained quartzites are also very common in hues ranging between white, yellow, brown, and grey. The latter are quite well represented at the Keatley Creek site. Indeed, it is suspected that many of the low frequency lithic types represented in lithic assemblages from the Keatley Creek site were probably collected from these contexts during the course of subsistence-related activities.

Additional Reported/Potential Sources

Two other reported sources remain to be identified and recorded, and a sample of materials collected. These include the Arrowstone Mountain petrified wood source and the Botanie Valley white chert source.

Arrowstone Mountain Petrified Wood Source

Cliff and Gail Proznick of Ashcroft indicated that another source of petrified wood exists somewhere on Arrowstone Mountain, which lies several kilometers north of Cache Creek on the east side of the Bonaparte River valley. Samples of the material provided by Mr. Proznick are creamy-white, tan, or whitish-brown, and the annual rings of the wood are fairly thick and well-defined. It is highly opalized, has a very waxy luster, and is considered to have better flakability than the samples of petrified wood from either Upper Hat Creek or Maiden Creek source areas.

Unfortunately the Proznicks could not point out the exact location on a 1:5000 NTS map, and I did not have the opportunity later to rendezvous with them. This reported source is a fair walking distance from Keatley Creek, and there are closer and more abundant sources (i.e., Upper Hat Creek and Maiden Creek) of petrified wood and other better quality silicates. Also, Mr. Proznick indicated that the wood from this source tends to be rare, although the odd large log or sections of logs of exceptional quality wood have been found. The exact location of this source, and inspection of the area for other potentially flakable stone should be conducted during any further lithic source studies initiated in the area.

Botanie Valley White Chert Source

Pavilion Band elder Desmond Peters indicated that there may be a source of white chert somewhere within Botanie Valley, which lies between Lytton and Upper Hat Creek Valley. Desmond remarked that Mr. Nathan Spinks (Lytton) may know the location of this source, but Mr. Spinks was not available to be interviewed. Bob MacNevin and I surveyed several areas in the upper part of Botanie Valley for lithic sources, and we also inspected several sites in the area for the presence of white chert flakes. No such material was found in any of the sites we examined. An attempt should be made to contact Mr. Spinks during a subsequent lithic source study in the area.

Miscellaneous Unspecified Sources

Duffel and McTaggart (1951:18) also indicate that blue-grey to white, oval-shaped chert nodules between 5 and 15 cm thick and about 30 cm long can be found embedded in the limestone in some locations within the Marble Canyon Formation. Several localities in Marble canyon were inspected for flakable chert deposits with the assistance of Ed Bakewell during the 1989 field season. The poor quality observed "cherty" materials associated with the limestone formations in marble canyon are clearly not suitable for flaking. Indeed, given the nature of the geology (i.e., fossiliferous limestone) and results of our inspections, it seems unlikely that the Marble Canyon Formation possesses any significant source of flakable materials.

The suite of basalts from the Keatley Creek site contains a distinctive variety characterized by a very dark grey groundmass with very thin black parallel lines/planes passing through it. In 1988 I suspected that this material might be found in the Maiden Creek drainage area, however, the sample of basalts taken from this source in 1989 do not contain this distinctive basalt variety. This type is not commonly represented at the Cache Creek basalt source, although the groundmass of some cobbles come close in color, and it may be that the occasional cobble from this area is in fact medium or light grey.

"Whalachin Green" chalcedony, a very distinctive lithic type available in the vicinities of the community of Whalachin, and at the confluence of Tranquille River and Watching Creek northwest of Kamloops, is represented in very low frequencies at Keatley Creek. This suggests that the acquisition radius for most lithic raw materials probably rarely exceeded this distance in Late Prehistoric times. Exchange of this material may have been most intense during the Plateau horizon and early Kamloops horizon, when lithic material exchange seems to have been most common throughout the Canadian Plateau (Richards and Rousseau 1987).

Conclusions and Recommendations

The 1988 and 1989 lithic source identification program initiated by the Fraser River Investigation of Corporate Group Archaeological Project attempted to locate lithic raw materials sources that may have been exploited by the prehistoric inhabitants of the Keatley Creek site (EeRl 7) and also by people occupying the Mid-Fraser River region in general. A total of eight lithic sources were identified and recorded. Of these, it appears that only four source locations would probably have been frequented by prehistoric inhabitants of the area. These include the Fountain White-Pink Speckled Chert source; the Upper Hat Creek Basalt source; the Upper Hat Creek Silicate source; and the Maiden Creek Basalt and Silicate source. I suspect that the Glen Fraser Silicate source, the Blue Ridge Ranch Chalcedony source, and the Moran Agate source were probably only rarely exploited. The Rusty Creek Red Chert source is quite hard to access, very localized, and has only mediocre quality material, and for these reasons I suspect that it may never have been exploited.

The information gathered during this lithic source study permit several important observations to be advanced. The first of these is that a suspected source for the very distinctive white-pink speckled chert common in Keatley Creek lithic assemblages has finally been identified near the confluence of Fountain Creek and the Fraser River. This indicates that this "exotic" material was likely not involved in a long-range lithic exchange system as was previously speculated.

Second, it was determined that an abundant source of good and fair quality basalt and silicates is available in the nearby Maiden Creek area. There is a relatively high degree of visual similarity between some of the silicates from the Maiden Creek source and Upper Hat Creek Valley, and for this reason I strongly suspect that the two have a very similar geologic relationship and/or origin. This fact is important to consider when conducting the analysis of lithic material types for the Keatley Creek site, because some of the material types relegated to Upper Hat Creek may have actually been derived from the Maiden Creek area (and vice versa). This distinction may be of importance for attempting to reconstruct site catchment areas, or other aspects of the cultural system related to subsistence and settlement patterns.

Third, given the relative abundance and sometimes fairly widespread distribution of some of the lithic materials found at several of the sources identified and examined during this study, I conclude that any attempt to control or restrict access to specific lithic sources by certain individuals or groups during prehistoric times in the Mid-Fraser and Thompson River regions would have been a very difficult, if not impossible task. I submit that anybody could have simply walked through these source areas and collect materials exposed on hillsides (particularly south-facing) or along small creek channels and washout gulleys. This would be particularly true of the Upper Hat Creek, Maiden Creek, and Cache Creek area sources. Moreover, most of the abundant sources are also located in mid-altitude contexts, which were generally uninhabited or sparsely inhabited, and were frequented primarily during the spring, summer, and early fall for hunting and plant gathering purposes. Lithic raw material procurement at these sources was probably embedded into these activities. Therefore, it may be that differences in relative proportions of various material types represented at some sites in the Mid-Fraser River region may be related to knowledge about certain lithic source locations, exploitation rates and exhaustion of materials, and seasonal subsistence and settlement patterns.

Recent research involving X-Ray Florescence of various types of basalts and other silicates from different sources conducted by Malcolm James (Dept. of Arch. SFU) suggests that there appear to be some significant differences in the relative amounts of certain elements in samples of basalts obtained from Cache Creek, Upper Hat Creek, and Maiden Creek sources. Thus, elemental "signatures" unique to each source can be discerned, and these might be potentially useful for "fingerprinting" archaeological basalt specimens from sites in the Mid-Fraser and Thompson River regions in order to determine their source of origin.

The preliminary data obtained by the X-Ray Florescence method suggest that typical Cache Creek and Hat Creek basalts are similar in elemental composition, however, Niobium (Nb) and Yttrium (Y) are absent in Hat Creek samples, and only about 30 to 50% of the Cache Creek samples contain them. On the other hand, the Maiden Creek samples contain slightly more of both of these elements. Strontium (Sr) is more abundant in the Upper Hat Creek samples than in the Cache Creek samples, and Maiden Creek basalt contains significantly larger amounts of this element compared to the other two sources. Rubidium (Rb) is more common in the Cache Creek samples than in the Hat Creek ones, and the Maiden Creek basalt has only about one-tenth the Rb observed for these other two sources.

Any future research involving the identification and recording of lithic sources in the Mid-Fraser and Thompson River regions should attempt to undertake the following recommendations:

1) Visit the Arrowstone Mountain petrified wood source located northeast of Cache Creek to determine its exact location, relative abundance and quality of material, and to inspect the area for other flakable lithic raw material types. Cliff and Gail Proznick of Ashcroft know the exact source of this material.
2) Contact Mr. Nathan Spinks (Lytton) and attempt to determine the location of a reported white chert source within the Botanie Valley.
3) Examine the cliff bases along the ridge on the south side of upper Rusty Creek (Fig. 11). As reported, there may still be another highly localized source of flakable silicates in the upper Rusty Creek drainage area, or perhaps in the Frantzen Creek drainage area to the immediate north.
4) There might also be sources of flakable lithic materials within some of the Tertiary age deposits situated on the eastern wall of the Fraser River canyon between Pavilion and Kelley Lake. This would require walking the B.C. Rail ROW and abandoned mining access roads.
5) Examine the two prominent hills lying immediately southwest of the confluence of Maiden Creek and Bonaparte river between about 3000 and 4,000 feet asl (Fig. 12) to determine if the Maiden Creek Basalt and Silicate source extends into this area as well.
6) Examine selected areas within the Kamloops Group formation on the north side of the Thompson River from Cache Creek to Kamloops for additional sources.
7) Examine selected areas with Tertiary age volcanics and sediments along the Thompson River from Cache Creek to Lytton. At least one potential source is known in this area (Shaw Springs Chalcedony source), and others may exist.

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Chapter 12

Keatley Creek Lithic Strategies and Design

Brian Hayden, Nora Franco, & Jim Spafford

Introduction

The purpose of this analysis is to identify the general strategies of lithic utilization employed for different activities carried out at the Keatley Creek site. It is important to understand the use-nature of specific types of tools in order to interpret the nature of tool patterning across living floors and thus infer the nature of activity areas and past socioeconomic organization in pithouses. However, it is also important to have a comprehensive understanding of the procurement, production, resharpening, and discard aspects of individual types of tools in order to create clear site formation models involving artifacts and different types of deposits. The goals of this chapter are therefore to generate models of lithic procurement, production, and use in order to understand why certain materials were brought to the site, why some tools but not others were manufactured or resharpened at the site, and why some tools but not others were abandoned or discarded at the site and in different proportional frequencies. This is an essential part of understanding the prehistoric economy of Keatley Creek.

The framework that we shall use to structure the presentation and analysis of data is based on design theory (Pye 1964, 1968; Horsfall 1987; Hayden et al. 1996). This approach emphasizes various constraints in the production of technological solutions to given problems. Our analysis centers on the identification of probable activities requiring technological solutions at the Keatley Creek site, as well as the identification of important constraints for those solutions. These are described in detail below. We then attempt to match the archaeological procurement of materials (detailed in the preceding chapter and in Vol. I, Chap. 16) and production of tools to the technological problems and limitations faced by the prehistoric residents of Keatley Creek in order to understand how tool characteristics make sense in terms of needs and constraints. Where solutions are distinctive enough in terms of basic procurement, reduction, and production, we refer to them as distinctive "strategies." At a somewhat lower conceptual level are concepts such as "specialization," "reliability," "portability," and other design features (Nelson 1991; Bleed 1986). Following Nelson (1991:66). We prefer to view these aspects in terms of decision criteria, or design considerations rather than strategies.

Having established what lithic materials were available in the vicinity of Keatley Creek in the preceding chapter, our major goal now is to understand why a specific tool was made of a particular material, on a particular kind of flake, and shaped or resharpened in a particular manner. We seek to understand the criteria that people used in making decisions about creating their tools: was economizing raw material most important, or ensuring reliable performance, or efficiency, or portability, or other considerations? It must be emphasized that this analysis is exploratory and heuristic in nature. We are not aware of any other analysis of a complete archaeological assemblage that has attempted to deal with tools in this fashion. Rather than being conclusive or definitive, this analysis is meant to create the framework for future analyses and the identification and testing of assumptions used. We have endeavored to include all the most numerically important and distinctive tool types except for projectile points, which we feel are very complex and warrant a separate analysis. See Volume III, Chapter 1 for detailed definitions of all tool types.

The activities carried out with individual classes of artifacts were inferred mainly from ethnoarchaeological and experimental information and/or the presence of use wear damage. The ethnographic information available for the Interior Plateau was also used to generate expectations concerning the activities most frequently performed in and around winter pithouses. These expectations were compared with archaeological materials in order to identify specific areas of analysis that require more intensive examination.

Ethnographic Data

The ethnographical information for the Mid-Fraser River Area has been summarized by Alexander (Vol. II, Chap. 2; and 1992). She indicates that inhabitants of the area moved to their winter pithouse dwellings on the river terraces in November. In the Chilcotin, while the winter houses were being prepared, people hunted and fished near the village at lower elevations (Lane in Alexander 1992). Alexander believes that this was probably also the case in the Lillooet region. In addition, David Low (personal communication) indicates that few animals would be found below 1,000 m altitude in the Keatley Creek vicinity during the late fall and early winter. Hunting was the dominant subsistence activity at this time, when animals were fat and had thick fur, and were moving out of the mountains to their wintering grounds at intermediate elevations (down to 1,000 m). Deer could be especially easy prey at this time of year since they gathered in large numbers and responded readily to hunting calls. Communal hunts were most frequent in the fall, but they may have taken place in any season. Other animals were hunted in smaller numbers including: sheep, elk, marmot, bear, and beaver, all of which could be found in the mountains. During December, January and February people stayed mainly indoors. The principal food was dried stored fish (primarily salmon), but men continued to hunt deer and other animals, especially in milder weather. Ice fishing was also pursued. Men spent part of the winter manufacturing spears, daggers, and weapons for warfare, while the women dressed hides (Teit in Alexander 1992).

January was the coldest month. Most activities were confined to the interior of winter dwellings. Hunting was rarely undertaken. Ungulates were lean and provided a poor return for the effort involved in procuring them. However, hare and grouse were available close to the village and could provide small supplements to the diet.

Late February and early March could be a critical period, when stored food might become limited or exhausted. If the warm weather was late, people could not hunt or fish (Lane in Alexander 1992). During this period, the extremely cold weather might force everyone to stay in their winter dwellings. At the end of February and the beginning of March people began to move away from their winter dwelling sites. Game was easier to run down and kill because the snow was melting. However animals were scarce and in poor condition. Plants available year round on the terraces, such as cactus leaves, could be gathered if food was short.

By late March most families had moved out of their winter houses and into summer dwelling lodges, but historically the winter village was used as a basecamp while picking berries. In the past, the Lillooet sometimes occupied their pithouses during the summer (Vol. II, Chap. 2; Kennedy and Bouchard 1978 in Alexander 1992), but the reasons for this are unclear. Alexander believes that the winter village was probably revisited frequently throughout the warmer months to store food and supplies, and that it could also have served as a residence for the elderly, the infirm, or children, while the others were in the mountains.

With these ethnographic data in mind, and assuming the activities carried on during ethnographic and archaeological times were similar, it is possible to develop some general expectations concerning the activities which should be most represented at the Keatley Creek site (see Vol. II, Chap. 2 for detailed documentation of the following activities).

1) Since hunting was undertaken during part of the winter occupation, residents undoubtedly prepared the necessary tools at the site. Thus, broken and/or unfinished preforms and projectile points should occur in the pithouses. They could have been abandoned or lost during the manufacturing process or be brought into the site for repair and resharpening. In the case of tools abandoned during the manufacturing process, fractures difficult to deal with or internal flaws might be common. Loss might also be relatively frequent due to poor lighting and the small size and dark color of most Kamloops projectile points. Assuming arrows were used, residents would also have needed to prepare shafts and bows. Hunting should have also involved cut-

ting activities related to butchering or filleting the parts of animals brought into the site (or into hunting camps) for consumption or drying (Alexander 1992; Romanoff 1992).

2) Weapons. Tools for warfare were prepared in winter dwellings. The most labor intensive of these tools (e.g., carved clubs) would probably be removed from the site. Other tools used to make weapons are probably indistinguishable from tools used to make hunting paraphernalia.
3) Hide preparation. Tools related to hide preparation are also expected to occur, especially those used for dry skin scraping and softening in the manufacture of buckskin. Winter would have also been a good period for making buckskin clothing, since many hours were undoubtedly necessary for tailoring and sewing buckskin. Thus, evidence for sewing, hide cutting and puncturing should also occur.
4) Plant gathering. Some plant gathering activities would become important if the winter was long. Preparation of plant gathering tools and receptacles for the spring could be expected to occur in winter dwellings. Thus, baskets and digging sticks would be repaired or manufactured. For these tasks, we assume that scrapers and utilized flakes would be used.
5) Prestige and Ritual items. Because of the labor intensive nature of making ceremonial or status items and the abundant "down time" during winter residence in pithouses, it seems likely that most of the manufacturing of these items took place in pithouses. The presence of tools related to carving may be the only indicators of these activities, including: beaver incisors, drills, and different classes of utilized flakes. These tools can also be used for decorating bone objects (Teit 1900:183).
6) Dwelling preparation. Preparation of the winter dwellings would also involve the use of some tools such as those related to heavy wood working. Making posts, racks or shelves; making or repairing sleeping platforms and storage platforms; and digging out storage pits are activities that would require tools such as hammers, digging sticks, adzes, axes, and chisels. The tools used in these tasks were probably ground stone adzes or flaked quartzite celts, mauls (hammers), and antler wedges (Teit 1909:715; 1912:349; 1917:29) since no other type of heavy wood working tools have been found at the site.
7) Ice fishing. Evidence for the preparation of wood and bone fishing gear (e.g., hooks and leisters) may be difficult to isolate from other activities in which utilized flakes, scrapers, and notches were also prominent parts of the tool kit (e.g., arrow and basketry making). The low frequency of making leisters and fish hooks might make such activities even harder to detect. Their presence is therefore somewhat hypothetical.
8) Storage. In base camps of collectors, both food and artifacts should be stored for future use (Binford 1980). Cores, bifaces, weapons, site furniture, flakes of raw materials not available in the area, and valuables can all be expected to be stored in pithouses or nearby. Accordingly, Teit (1900:199) mentions the presence of an underground cache pit and of an elevated cache (both for food). Since most of the lithic sources for artifacts found at the site are in the mountains, storage of lithic materials in pithouses was probably one solution for winter needs when raw material sources were frozen in the ground or buried under snow cover.

In summary, on the basis of the ethnographic data, we expect the artifacts most frequently recovered in the Keatley Creek housepit assemblage to be those related to secondary butchering and filleting, hide working, tailoring activities, and preparation of hunting and gathering equipment (Table 1). Although there are only limited use-wear data as yet, analysis indicates that the working of hides, plant materials, and minerals took place in HP 7 (Vol. II, Chap. 3). For heuristic purposes we have constructed a model to explain general assemblage characteristics by examining the most important tool classes recovered at the site in order to determine whether a reasonable correspondence exists with the activities expected in pithouses and to see if the design and materials of the tools can be explained in terms of the constraints and task requirements that we presume to have existed during the occupation of the site.

In order to structure the analysis of the Keatley Creek assemblage in terms of technological problems and solutions, we have tentatively assigned tool types to specific tasks. According to local and comparative ethnographic data (mainly Teit 1900, 1906, 1909—see Vol. II, Chap. 2, Appendix B), the following tools could have been used in the following activities:

A composite inventory of all tool types and their relative frequencies from all excavations at the site is presented in the Appendix. Tool frequencies from individual housepits or other excavations are provided in Volume I, Chapters 14 and 15; Volume II, Chapters 11–14; and Volume III, Chapters 1, 10–11. With these preliminary considerations in mind, we can now examine some specific tool types, the constraints most likely associated with them, and the strategies apparently used in fabricating and using them.

Table 1: Activities and Tools Expected in Housepits

Wood working	**heavy**	adzes
		axes
		hammerstones or mauls
		bifaces?
	shaving	right angle flakes
		"knives" (Teit 1900:183)
		utilized flakes with acute to semi-abrupt angles
		scrapers (Hayden 1979a)
		notches (Hayden 1979a)
		core planes
	drilling	perforators
		borers
		drills
Meat procurement and processing (hunted game)	**hunting**	broken and unfinished preforms and projectile points
	skinning	scrapers
		bifacial knives
	cutting hide	"knives"
		flakes with acute angles and invasive retouch (retouched or utilized)
	disjointing	bifaces (Jones 1980)
		"knives"
		chopper or unmodified cores or blocks (Hayden 1979a)
		spall tools
	cutting tendons	bifaces (Jones 1980)
		any "sharp" acute angle tool (Jones 1980)
	cutting meat in heavy butchering	bifaces (Jones 1980)
		cleavers (Jones 1980)
		flakes with acute angles (retouched or utilized) (Frison 1989)
		scrapers
		unifacial knives
	filleting	knives ?
		flakes with acute angles and invasive retouch (retouched or utilized)
	cutting or carving of bone	flakes with semi-abrupt angles (retouched or utilized)
Preparation of skin		end scrapers (Hayden 1990)
		spall tools
		side scrapers (Cantwell 1979)
Making buckskin clothing		flakes with acute angles and invasive retouch
		piercers
		stone wedges (pièces esquillées) used to make bone awls
Basketry		"knives"
		flakes with acute angles (retouched or utilized)
		scrapers?
		expedient scrapers
		small notches?
Bark cutting (for baskets, etc.)		acute edged utilized flakes

Parameters to be Examined

According to design theory, a number of constraints can play important roles in solving technological problems. We have identified the problems most likely to be dealt with in winter pithouses. At the most basic level, the constraints that we will consider are:

- *suitable raw materials* for the successful and relatively efficient solving of specific technological problems;
- relative *availability* of the various suitable raw materials, including procurement costs (*travel time, transport costs, search time, exchange costs, seasonal changes*) and the *size range* of available materials;
- *cost and difficulty of manufacturing* tools for given solutions including producing the flake types necessary;
- *volume of materials to be processed and frequency of processing events;* these factors have been related to the degree of specialization and resharpening strategies used in tool designs (Hayden 1987; Hayden and Gargett 1988);
- *longevity* of given tool solutions and replacement rates;
- *time constraints* associated with specific tasks (Torrence 1982);

- *need to transport* tools as well as other materials.

In addition to these relatively basic constraints, we will also examine the potential roles of several "design criteria" that have been proposed as important for explaining tool characteristics. While they seem to emerge as a result of basic constraints, they are not clearly "strategies" in the usual sense of the term. These design criteria include concepts such as hafted versus unhafted, generalized versus specialized designs, and choices of resharpening techniques (Hayden 1987, 1989). The role of other, more abstract, qualities such as reliability, maintainability, flexibility, and versatility have been examined in detail in a previous publication (Hayden et al. 1996).

The resulting strategies that can be identified after examining all of the above factors will be discussed in terms of strategies of raw material procurement, use, reduction, and resharpening. The tools we discuss will be grouped according to their similarities in terms of these strategies. Because lithic raw-material plays such a central role in the following discussions, a major component of the research at Keatley Creek involved the identification of raw material stone sources as documented by Mike Rousseau in the preceding chapter.

Most of the raw material utilized at the Keatley Creek site is trachydacite probably from the upper Hat Creek drainage. Though it is located between 15 and 20 kilometers in a straight line from the site, the topography is very rugged and the "effective" distance is considerably greater. The sources of chert are located at the same range of distances. Although some closer potential sources have been located, their quality is inferior, and there is almost no raw material from these sources at the site. Quartzite and some other metamorphic and igneous rocks could have been obtained in the river or till gravels within of 1–2 km of the site. Bedrock sources for nephrite have not been located although isolated cobbles and boulders occur in the gravels of the Fraser and Bridge Rivers near Lillooet.

The introduction of raw materials into the site should have been limited because of the need to transport food and gear from mountain sources to the Keatley Creek winter village which served as a base camp for storing food and gear for the winter (Alexander 1992). Without travel aids prehistorically, the addition of lithic raw material to food and gear would have been very burdensome, and we thus expect minimal amounts to have been transported to the Keatley Creek site. It is also important to emphasize that the main sources of trachydacite and chert would have been totally inaccessible in the winter due to snow cover and frozen ground conditions. Therefore, lithic raw material was probably relatively costly to obtain and scarce at this winter village site.

I. Expedient, Block Core Strategy

In this strategy, cores are kept at the habitation site. Flakes are removed and modified according to immediate needs, and usually discarded after the immediate task is completed unless large, still-usable flakes are involved. Material is obtained from the most easily available sources, and there is generally no need for especially durable materials. Types included in this strategy are: expedient knives, scrapers, utilized flakes, notches, denticulates, borers, piercers and perforators.

1. Expedient Knives and Scrapers: Unifacial Knives, Retouched and Unretouched Flakes With Acute Angles (Types 170, 70, 140, 144, 74).

Constraints

Task Constraints. Unifacial knives and retouched and unretouched flakes with acute angles were probably used in some part of the butchering activities thought to be represented at the site (cutting meat, hide, tendons, or filleting) or in cutting rawhide thongs or buckskin for making clothes. Because of the complementary distributions of utilized flakes (which lack invasive retouch) versus expedient knives (with invasive retouch) on housepit floors (Vol. II, Chap. 11; Spafford 1991), utilized flakes appear to have been primarily used in other activities, perhaps such as basket making. Thus, we will not treat utilized flakes as part of the expedient knife activity complex, but as part of the scraper complex in the following section. Given the concentration of expedient knives close to the walls, these tools were probably not used in heavy butchering, but instead in light tasks such as cutting off pieces of jerked meat or cutting up hides for thongs, clothes or other purposes. These kinds of tools should be very frequent at the site due to: their expedient nature, the limited number of resharpenings involved (because many successive resharpenings would increase edge angles more than desired), short use-lives with consequently high discard rates, and the use of these tools in infrequently or sporadically occurring activities.

Time. Only if butchering fresh meat was involved would there be possible light to moderate time constraints in the use of these tools. Even then, because most fresh meat brought back to the winter village for butchering would probably not represent more than a single deer at any one time, time constraints were probably not very significant, especially under cool winter conditions. However, it does not seem likely that most of these tools were used for cutting fresh meat, given their occurrence near walls.

Material Constraints. The only requirements should be the use of fine-grained raw material.

Wear Rate. Cutting hide results in a very high wear rate (Frison 1989) with edges lasting only a few minutes. Cutting meat, however, results in very low wear rates.

Manufacturing Time/Effort. Minor or insignificant manufacturing times characterize all of these tool types although it would be necessary to procure or manufacture a pressure flaking tool in order to keep edge angles acute by removing invasive resharpening flakes. Although billet flakes were frequently used for all these tools, we view this as a matter of convenient and effective use of byproduct biface waste flakes rather than an essential aspect of these tools.

Frequency and Intensity of Use (Processing Volumes). At best, 1 deer or hide per month per housepit would have been processed, representing a very low volume.

Socioeconomic Constraints (Transport). There are no constraints involving the tools themselves since these tools do not need to be transported away from the site.

Constraints do occur in the transport of raw material to the site. In this case, the transport constraints would be significant since people would also be carrying as much food as they could to be stored and gear from the mountain lithic sources to Keatley Creek during the fall seasonal movements. Because of this, people could probably only carry minimal quantities of stone.

Flake Type. There are no special needs concerning flake types. Any kind of flake with acute angles and a straight edge would be adequate: hard hammer flakes, billet flakes, blades, and bipolar flakes. However, producing blades can be a technique wasteful of raw material. Systematic blade production requires the preparation of cores and the removal of many preparation flakes. Moreover, considerable skill, training, and time are necessary to systematically produce blades (see Nelson 1991:68). The risk of ruining blade cores, and therefore wasting a large amount of raw material plague the flintknapper at every step in the reduction process. Finally, blade cores require much more specific sizes and shapes of raw materials, as well as high quality materials, thus increasing procurement costs considerably wherever the optimal size and shape raw material is difficult to find, which was probably the case in the Lillooet and neighboring regions. For all these reasons, systematic production of blades for butchering at winter villages would not be a good design solution. In fact, as Parry and Kelly (1987) and Johnson (1987) have argued, the high investment and risks associated with blade production may only make sense under high mobility circumstances when at least one part of the seasonal round intersects abundant high quality sources of raw material of suitable size and shape, since blades clearly do provide more cutting edge per weight of *successfully* processed stone material. Another reduction strategy, bipolar reduction, produces a great deal of shatter and small flakes and would be wasteful of larger core material.

Billet flakes conserve raw material and they produce acute angles more consistently. Some researchers argue that thin biface reduction flakes are even better than bifaces for cutting hide in skinning (Frison 1989). The ratio of utilized billet flakes versus non-utilized ones can provide a general indication of the degree to which biface flakes were used for tools. If a high percentage of billet flakes are utilized, it can be tentatively inferred that billet flakes were often saved or even produced for use as cutting tools. If billet flakes do not show traces of utilization very often, they were probably simply a by-product of the resharpening or manufacturing of bifaces. However, use-wear analysis is required to fully evaluate this hypothesis. Examining the proportion of billet flakes with use retouch can provide an initial indication (Table 2). With the exception of size 2 flakes, billet flakes were frequently being selected for use. Size 2 is too small in general for this work.

Table 2. Utilized Billet Flakes

	Size 2 (1–2 cm)	**Size 3 (2–5 cm)**	**Size 4 (> 5 cm)**
Total billet flakes	1563	658	7
Billet flakes with utilization retouch	21 (1.3%)	230 (35.0%)	6 (85.7%)

What can be said about billet flakes utilized for producing retouched tools? For expedient knives, many of the flakes were originally billet produced (44.7% of those identifiable). The same is true of low angled utilized flakes (35.6% made on billet flakes) and bifacial expedient knives (45.1%).

Given the much more abundant occurrence of block core flakes in the assemblage, this seems to indicate a preference for the use of billet flakes over hard hammer flakes for expedient knives. This preference is probably related to the more acute edge angles of most billet flakes and to the desirability of acute edge angles for some kinds of activities (e.g., cutting hide). When dull, and given continued use in an activity, some of the billet flakes could be resharpened by pressure flaking into expedient knives.

Although the production of billet flakes may not have been the main reason for bringing bifaces to the site, it is clear that the convenient availability of flakes from biface manufacture and resharpening played an important role in the strategy of tool production and butchering or hide cutting activities. When billet flakes were not available, flakes from block cores were used.

Strategies and Design

Raw Material Strategies. Given the need for fine-grained materials, people could be expected to have used the closest available source (trachydacite and chert: 15–20 km away). Given the low constraints on flake types, any shape and most sizes of raw material could be used. In addition, we suggest that the more wear-resistant cherts and chalcedonies would be saved for tasks involving greater requirements of durability and longevity. Consequently, the main material expected to be used for butchering and tailoring at winter villages is trachydacite. In fact, the percentages of all types of expedient knives made of this material varies between 91–96%.

Acquisition/Procurement Strategies. The trachydacite utilized was not available through the winter occupation. However, it could easily have been directly acquired during fall hunts and spring plant gathering in the neighboring Hat Creek Valley. Caching raw material before winter time in the housepit village could therefore be expected.

Reduction Strategies. As previously discussed, the best strategy would involve the reduction of block cores from which a large range of flakes could be obtained (cf. Stiner and Kuhn 1992).

Tool Form and Resharpening. There are only minor constraints concerning form: adequate low angles and straight edges, plus the need to be held comfortably (tools needed to be more than 2 cm long). Thus, tool design simply involves selection of straight acute-edged flakes with edges longer than 1–2 cm as well as the use of the most appropriate resharpening technique. The minimal size for the utilized flakes is less than that of other types. This could indicate, perhaps, a range of sizes below which flakes are not retouched and are simply used in small short tasks if the edge angle is appropriate.

The sizes for all these tools, as for the assemblage in general, were relatively small with a mean of 3.3 cm and a standard deviation of 0.9 cm (Table 3). There is a general correspondence between these measures and the small size of the block (multidirectional) cores found at the site.

Longevity. The small size and thinness of most flakes used in this activity would have made it difficult to resharpen most of these tools extensively. In many cases this provides good use of flakes that would otherwise be discarded. In other cases, it is clear that large thin flakes were being carefully kept or produced for future purposes, and were often more intensively resharpened by invasive retouching.

Table 3. Minimum and Mean Dimensions of Expedient Knives and Scrapers

Type	N	Minimum	Mean (cm)	S. Dev.
170	340	1.1	3.31	0.97
140	89	1.3	3.62	1.34
74	144	1.1	2.98	0.78
70	139	0.8	3.29	0.091

The extent of resharpening varies widely from a fraction of a millimeter (type 74) to bifacial retouch that covers much of both faces (type 140). This indicates that many tools were only used for brief periods before being discarded or abandoned. Although the more extensively retouched pieces may have been curated between tasks.

Other Variables of Design. Maintainability was probably emphasized, because all of these tools can be easily replaced with other similar examples. All these tools can also be easily and quickly resharpened.

Multifunctionality. Larger flakes, in particular, could be used on more than one edge (either in the same task or different ones). Although there is no evidence for creating multifunctional tool designs, a surprising 48% of expedient knives exhibited additional types of retouch seeming to indicate alternative functions. This unusually high percentage is also reflected in other tool types produced with this strategy such as notches (44%) and piercers (46%), although utilized flakes (29–35%) and scrapers (26%) exhibited less frequent alternative uses. For a strategy used in a non-mobile context, these extreme high rates of multifunctionality accord poorly with Shott's (1986) postulated relationship between mobility and multifunctionality. We suspect raw material availability and transport constraints play a more basic role in this case.

Frequency. The frequency of these kinds of tools is relatively high when compared with the rest of the assemblage. This is especially the case of type 170.

Type	Count	Percentage
70	212	3.6%
74	187	3.2%
140	168	2.9%
170	577	9.8%

The high frequency of these tools is undoubtedly related to the recurring need for butchering and hide cutting tools, plus their short use lives and expedient nature, as well as the infrequent performance of other activities requiring tools.

Specialization. Due to the lack of time constraints, the episodic and relatively moderate volume of material being processed, as well as the relatively simple nature of the task, there is clearly no unusual need to develop any specialized or extra-efficient tool for butchering and hide cutting. Therefore, the simplest, lowest-cost, effective design solution was employed. In this case, the nature and frequency of the task as well as limits on raw materials made it desirable to use billet flakes from bifaces whenever possible, and to sharpen them using invasive pressure retouch. The result was small, easily maintainable and replaceable expedient tools used and retouched to varying extents under conditions where few time or risk constraints existed.

2. General Scraping Tools: Scrapers, Utilized Flakes, Notches, Denticulates (Types 150, 156, 163, 154, 54, 71, 72, 73)

Constraints

Task. All of these tool types were probably used primarily for shaving wood (Hayden 1979a). Some scrapers and utilized flakes may also have been used in hide working (Cantwell 1979), working bone and antler (Cantwell 1979), cutting meat in heavy butchering, and possibly basket making. However, such tools cannot be distinguished from the majority at this point. There would have been a need for moderately robust edges for working hard surfaces and/or in order to avoid damaging hide or skin.

Time. Low time constraints characterize the presumed use of all these tools, e.g., in relation to basketry, wood, and bone working.

Material. Fine grained material would have been preferred for effective and efficient task performance in all of the above undertakings, although less effective coarser grained materials might be used on occasion. There would have been no special requirements for long use life materials, due to the low frequency and intensity of tasks and their performance at sedentary home bases where raw material was cached.

Wear Rates. On the basis of ethnographic observations (Hayden 1979a), wear rates for most semi-abrupt woodworking tools were probably moderate, on the order of 5-20 minutes of use before significant dulling.

Manufacturing Time/Effort. Minor or insignificant requirements characterize all these tool types.

Frequency and Intensity of Use. These kinds of tools could be used in many of the activities thought to be represented at the site such as the preparation of hunting, fishing, plant collecting gear and the making of prestige items. We expect sporadic but relatively frequent use of short to moderate duration.

Transport. There are no requirements related to the transport of these tools. Once raw material was brought to the site, the tools could be manufactured and abandoned at the site, especially given the low investment in manufacturing time/effort. Raw material would be replenished as required the following year. As with expedient knives, there would be considerable constraints on the quantity of raw material transported from the mountain areas to the site due to the need to carry as much food as possible to be used for the winter plus necessary gear.

Flake Type. Like expedient knives, there is no need for special types of flakes. Any kind of flake with semi-abrupt angles would be adequate, including most hard hammer flakes. Assuming that semi-abrupt angles were important, most billet flakes could probably not be used without substantial retouch. Blades would not have been used in these tasks because of the same factors discussed under expedient knives.

Strategies and Design

Raw Material Strategies. Given low constraints on flake types, any shape and most sizes of raw material could have been used. People should have used the closest available sources of trachydacite or chert. Since there was no need for long use-lives most of these tools would probably be manufactured on trachydacite which did not last as long as cherts. As an example, 91% of all notches were made on trachydacite.

Acquisition/Procurement Strategies. These would be essentially the same as the strategies used for expedient knives, i.e., acquisition during foraging trips to Hat Creek in the spring and fall.

Reduction Strategies. These strategies are also the same as expedient knives, i.e., block core reduction (with little or no use of billet flakes in this case).

Tool Form. There are very few constraints concerning the form of tools used in these woodworking tasks: adequate angles, straight edges (except notches and denticulates used on shafts or strips), the need to be held comfortably (i.e., generally sizes greater than 2 cm—Table 4), and relatively smooth ventral surfaces. There is no apparent benefit in hafting these tools given their short use-lives.

Resharpening. Hard hammer percussion would provide the easiest means of resharpening any of these flake tools since no special resharpening equipment is required and the semi-abrupt retouch that hard hammer retouch generally produces would have been optimal for most of the tasks in which these tools are assumed to have been used. Occasional use of billets for resharpening might be expected on the basis of convenience, or perhaps intentionally to create lower edge angles for meat cutting. On the other hand, large notches (type 154) and denticulates were probably created specifically for shaving hard wood or bone shafts and tips (see Hayden 1979) and these edge forms could only be produced by hard hammer retouching. The smaller, more delicate notches (type 54) that we suspect may have been used primarily in shaping basketry elements, could have been produced by pressure flaking thin flake edges in some cases, (or even by use), or by delicate hard hammer percussion using small pebbles.

Table 4. Dimension of General Scraping Tools (Whole and Chipped only)

Type	N	Min. Size (cm)	Mean Size	S. Dev.
71 (Utilized flake on break)	44	1.6	2.91	0.94
72 (Utilized flake on acute edge)	443	1.2	3.02	0.90
73 (Utilized flake on semi-abrupt edge)	154	1.6	3.33	1.00
150 (Scraper)	248	1.3	3.58	1.26
154 (Notch or Multinotch)	196	1.2	3.44	1.23
156 (Inverse Scraper)	62	1.5	3.83	1.26
163 (Double Scraper)	98	1.8	3.50	0.97

Longevity. Due to the scarcity of raw material and the size of most woodworking projects, we expect there to be considerable indications of repeated resharpening and/or the use of multiple edges. Double scrapers represent 30.6% of all scrapers, which supports expectations about the intensive use of raw material. In addition, although some of the scrapers are relatively unused, most of them (60.5%) were worn, retouched, exhausted, or useless. The fact that of all scrapers (types 150, 154, 156, 163) the most heavily used examples were located near the wall of HP 7 may indicate that they were usually stored or curated for future use. On the other hand, the abundant occurrence of much more lightly use-retouched flakes (types 72, 73, 74) scattered over the center of the floor indicates that a large proportion of this tool class was expediently produced, used, and discarded.

Other Variables of Design (Recycling, Multifunctionality). These are again similar to design considerations discussed for expedient knives, i.e., they are maintainable. Given the small size of many of these tools and their relatively robust edge angles, there seems to have been little scope for recycling. Given the wide range of potential uses for many of these types, especially scrapers, their multifunctionality is an open question at this point.

Frequency. Due to their high discard rate and to their frequent expedient nature, we expect to find a relatively high percentage of this kind of tool. In fact, scrapers constitute 12.4% of the excavated assemblage. Utilized flakes on acute edges (type 72) and on strong flake edges (type 73) constitute 9.9% and 3.4% of the assemblage respectively. Notches and denticulates represent 5.6 and 0.2% of the assemblage.

In sum, general scraping tools are largely expedient tools (with unusually good or resharpenable flakes being saved and reused) occurring in a wide size range of flakes from block cores. The nature of the tasks and their frequency as well as the difficulty of obtaining stone material, were the main reasons for the use of unspecialized, largely expediently produced flakes from block cores. Lack of time or risk constraints contributed to the "maintainable" design of these tools.

3. Perforators, Borers, Piercers

These tools represent the same basic constraints and strategies that typify other tools in the Expedient, Block Core, strategy. They are relatively low frequency, limited use tools that can be made on many different kinds of flakes with few constraints. The only major differences with the other tools included in this major strategy are related to task constraints involving the piercing of skin (the need for sharp pointed projections); perforating (the need for slightly more robust projections capable of sustaining greater pressure on the tool); and boring (the need for much more robust projections capable of sustaining much higher loads as well as rotary movements without fracturing).

II. Biface Strategies

The bifacial strategy makes most sense in the context of high mobility (as tools used in traveling to seasonal camps) and high constraints on the amount of stone material that can be transported on such trips. The advantages of bifaces include their presumed multifunctionality, their economy of raw material use, and the potential utility of resharpening flakes. It is important to note that some authors like Shott refer to all bifacially retouched pieces (including flakes, projectile points, and handaxes) as "bifaces." In contrast to this excessively general use of the term, we use the term, "biface," *only* to refer to relatively large, bifacially *reduced* tools which are clearly not projectiles, drills, or other specialized flake tools.

Constraints

Biface Task Constraints. Bifaces are usually considered multifunctional tools (cf. Winters 1969; Ahler and McMillan 1976; Nelson 1991, Bamforth 1991:230; Johnson 1987). Because of this, they are often viewed as useful tools when there are strong constraints in the quantity of tools that can be transported. They thus make most sense in high mobility situations (see Bamforth 1991:226–229; Sassaman 1992:256–257) such as at seasonal hunting camps and when collector strategies involve the transport of large amounts of food for storage, thus reducing the ability to carry tools or raw materials. "Disk or bifacial cores maximize tool material; they provide a variety of flake forms for use as tools, yet they can be thin while having extensive, usable edge length (high edge-to-weight ratio) . . . In addition, the biface can be changed to a variety of forms and resharpened with minimal reduction of the stone; therefore, few need to be carried . . . " (Nelson 1991:74).

The use of bifaces could have had other advantages. They could have been used at sites as sources of raw material (Kelly 1988; Ingbar 1990; Nelson 1991). At Keatley Creek, for instance, billet flakes from bifaces were probably used as expedient knives for butchering or hide cutting. Nearly exhausted bifaces could also be sharpened into more specialized bifacial knives (Morrow 1987:141). In addition broken bifaces could be recycled as small cores to obtain a few more flakes or as wedges (pièces esquillées). They were sometimes intentionally further broken up, undoubtedly to obtain useful right angle edges. This was also true of many other large tools.

Bifaces could also have been useful in activities carried on at seasonally sedentary sites, like the Keatley Creek winter village. Activities may have included woodworking (e.g., work on arrows, leisters, net hooks) and butchering. The occurrence of broken bifaces in the center areas of housepits (Vol. II, Chap. 11), indicates that they were probably used in activities requiring considerable space or producing copious debris. Jones (1980) considers bifaces to be effective tools for butchering animals. He has efficiently used handaxes (which we consider functionally equivalent to bifaces) made on quartzite, phonolite, and basalt or trachyandesite for skin-cutting, skin removal and meat-cutting. He believes that these tools are more effective, longer-lasting and more comfortable to hold than simple acute-edged flakes (except for the initial cutting of the hide on medium size animals).

Time and Mobility Constraints. There would only have been light time-constraints in using bifaces within winter villages since most accounts indicate that people lived off of stored foods and had abundant time. None of the assumed tasks associated with bifaces would have had significant time constraints. While hunting, the time constraints associated with the use of bifaces would have been higher but so would mobility requirements. Theoretically, time constraints should lead to specialized tools, while mobility constraints should lead to multifunctional, recyclable tools (Shott 1986). At present, we cannot determine empirically how specialized versus multifunctional Keatley Creek bifaces were. We suspect they were multifunctional as others have suggested (Odell 1993:111; Winters 1969; Ahler and McMillan 1976), and as ethnographic observations seem to indicate (e.g., as butchering tools, woodworking tools, fish knives, making basket elements, and cutting buckskin—Fowler and Liljeblad 1986; Steward 1933:261, 277; Krocker and Barrett 1960; Gould 1966:57; Volgelin 1938:28).

Material Constraints. Fine-grained raw material would be easier to manufacture into a biface and would provide better cutting edges for butchering and wood working. Trachydacite and chert (and chalcedony) would consequently be the best materials for use. Table 5 displays the different manufacturing stages, the quantities, and percentages of raw materials employed for bifaces. The data clearly show that the vast majority of bifaces were made of trachydacite (especially the fine-grained variety), chert and chalcedony.

Flake Type. Most bifaces were probably produced via direct cobble reduction or from very large flakes. Flake sizes needed to be large and thin enough to be able to be reduced afterwards. No bipolar flakes, no blades, no billet flakes would be suitable.

Table 5. Raw Materials Used in Biface Manufacturing

	Stage 4 (Type 131)		*Stage 3* (Type 134)		*Stage 2* (Type 193)		*Stage 1* (Type 192)	
Fine-grain trachydacite	83	(82.2%)	27	(75.0)	31	(73.8)	11	(91.7)
Coarse-grain trachydacite	10	(9.9%)	3	(8.3)	3	(7.1)	1	(8.3)
Chert	3	(1.0%)	3	(8.3)	1	(2.4)	0	(14.3)
Chalcedony	4	(4.0%)	3	(8.3)	4	(11.9)	0	
Quartzite	1	(0.1%)	0		1	(2.4)	0	
Totals	101	(100.0%)	36	(100%)	42	(100%)	12	(100%)

Wear Rate. No estimates are available for wear rates of bifaces.

Technological Constraints. The manufacturing time and effort and skill required for bifaces is probably the highest of any chipped stone artifact type in the assemblage.

Frequency or Intensity of Use (Processing Volume). We do not expect high amounts of meat processing or work on wooden tools to have been undertaken at winter pithouse sites. Moreover, other kinds of tools could have been used in these tasks. On the other hand, it is clear that bifaces *were* used inside pithouses, because of the many broken fragments that occur in the centers of the floors. Interestingly, bifaces seem to have been resharpened in the sleeping areas between the hearths and the pithouse walls, (where billet flakes of all sizes concentrate), whereas the bifaces seem to have been used in the center floor area where broken biface fragments concentrate (Vol. I, Chap. 13; Vol. II, Chap. 11). However, as previously noted, bifaces could have been used as raw material sources for making other kinds of tools such as expedient knives made from resharpening flakes.

Socioeconomic Constraints (Transport and Mobility). In general, complex hunter-gatherers and collectors using logistical settlement patterns have high constraints on tool transport due to the need to transport food in bulk as well as carrying increased amounts of technological gear. There are, consequently, constraints on the weight and bulk of individual tools carried to sites, especially if food necessary for survival during the winter was also being transported. Bifaces might be especially important tools in early spring for foraging before lithic resources could be replenished. Other mobility constraints were discussed above under time considerations.

Strategies and Design

Raw Material Strategies. Fine-grained materials are best for controlled flaking and sharp, acute edge angles. Chert and chalcedony may have been most sought after because they are more wear resistant. However, the size of the nodules available may have been critical. Large chert nodules are probably rarer than large trachydacite nodules.

Acquisition/Procurement Strategies. Due to possibilities of breakage of bifaces during the manufacturing process (Johnson 1989) and/or the existence of internal flaws, it would make most sense to perform the initial stages of reduction (stages 1 and 2) at or near the quarry (except perhaps for the small thick variety of bifaces). Roughed out bifaces were probably taken to Keatley Creek at the beginning of the winter occupation or cached there previously. Because of the effort and skill required in the manufacture of thin bifaces, because of the high risk of breakage (especially during resharpening), and because of their suitability to be used in different tasks, they probably constitute personal gear carried by individuals. In fact, this constitutes the best case that can be made for a personally owned tool in the entire chipped stone assemblage, and it is unlikely that thin bifaces would have been generally lent to other people given their costs and risk of breakage. Sassaman (1992:257) explicitly relates the use of bifaces to hunting activities and therefore views them as men's tools.

Most of the bifaces (72% of *all* bifaces in the sample) recovered at the site represent the last manufacturing stages (types 131 and 134; Callahan's stages 3 and 4). This supports the idea of tools with very high longevity adapted to conditions of transport constraints on stone materials.

Reduction Strategies. These would consist of the removal of bifacial billet flakes to avoid rapid consumption of raw material, to minimize the weight of raw material in transport, and to maintain adequate low edge angles on tools.

Tool Form and Resharpening. The mean maximal dimension for *whole* and chipped primary thinned and edged bifaces is 5.1 cm, with a standard deviation of 1.2. These relatively small dimensions undoubtedly reflect the fact that all whole specimens of bifaces are the small, thick variety. Larger varieties are inevitably broken.

It is necessary to indicate that the bifaces in the Keatley Creek assemblage can be divided into two distinctive classes (Vol. III, Chap. 1). The first class is composed of bifaces or fragments that conform to the standard image of Callahan's stage 3 or 4 bifaces: they are thin, relatively straight edged, relatively wide, and medium or large in size. There are no whole examples of this class probably due to their relatively high value, their thinness, and their fragility.

The second class of biface, in contrast, is small, thick, and does not display the fine craftsmanship found so frequently in the larger class. Edges are generally irregular and sinuous. While these two classes of bifaces can be readily distinguished, it is not clear what the differences represent. The thin bifaces clearly correspond to the tasks and design problems we have been discussing. They are also by far the most numerous. The small class of thick bifaces may represent "learning" products similar to those produced by beginning university students, or very rough preforms for projectile points that were abandoned, or they may represent a different tool type used for different tasks or under different conditions. Small thick bifaces are relatively infrequent, although there are a number of whole examples. Due to the uncertainty concerning the use and role of small thick bifaces, we will concentrate exclusively on the large thin variety in this analysis.

Design

In design terms, the resharpening mode using billets, largely determines the overall shape of the tool, except for the proximal and distal ends. Hayden (1987, 1989) argued that thin biface morphology and billet flaking make sense primarily in terms of tactics to conserve low edge angles on tools while maximizing the number of resharpenings (in contrast to hard hammer resharpening). In this sense they are a maintainable tool. This design and resharpening strategy, although costly in terms of manufacturing time, effort, skill, and materials, provides important benefits where there are significant constraints on the transport of tools or on raw material availability, together with moderate or high processing requirements. The size of the tool is potentially important in understanding its role in butchering. Bifaces would be better for primary butchering than flake tools due to their larger size and greater weight (Jones 1980).

The distal tips theoretically could be shaped in any fashion, although most examples from Keatley Creek appear to be pointed. Pointed tips may have been useful for tasks requiring gouging tools, such as the hollowing out of indentations for the placement of fire drills, thus adding to the versatility of bifaces.

The proximal ends were probably shaped to facilitate holding or hafting, although this has not been studied in detail. Hafting would have extended the use-life even further by enabling relatively small stubs to be used. It would also have increased the weight and ease of manipulating the tool in butchering tasks—attributes emphasized as important by Jones (1980).

Longevity. Bifaces were clearly designed for prolonged use and many resharpenings.

Other Variables of Design. It is probable that one of the main design characteristics emphasized was multifunctionality although there are no morphological features *per se* that would lead one to postulate this. The inference of multifunctionality derives primarily from comparative use-wear (Lawrence Keeley, personal communication) and contextual or theoretical considerations. Thin bifaces are certainly not reliable tools given their high rate of breakage and their fragility although the gearing up investment and manufacturing effort might be considered as typical of reliable tools, as well as their assumed context of use (time constrained hunting). Although Bamforth (1991:230) has argued that bifaces are maintainable tools, it is questionable as to whether they should be considered maintainable since it is not clear what comparable alternatives would have been employed if a biface broke and there is no reason to believe that extra biface blades were carried by individual hunters while hunting or that such spare blades could have been quickly or easily inserted into hafts (contra Keeley 1982). On the other hand, bifaces are clearly made for multiple resharpenings and are portable. Thus, whether bifaces should be considered as unusually reliable or maintainable tools—or whether these distinctions are meaningful in this case—is open to debate. Bifaces obviously have considerable potential for recycling, however, this is primarily a function of their size. It is doubtful that recycling (flexibility) considerations played much role in the actual tool design, and there is certainly no operational way to demonstrate such an assumption at this point. Recycling of bifaces could easily have been an opportunistic afterthought.

Frequency. There are only 205 bifaces or fragments in the sample (3.4% of identifiable tools). Frequencies are expected to be low given long use-lives and use away from village sites. On the other hand, recycling and breakage into small fragments probably artificially elevates these frequencies.

Specialization. Jones (1980) thinks bifaces make excellent butchering tools due to their weight and holding characteristics. They may thus be considered specialized tools in this regard, although their potential for multifunctional roles is great, it is difficult to assess their status as specialized tools at this time. Certainly, the degree of investment of time, energy, and skill in their production is characteristic of specialized tools, but this relationship may be more complex than is often assumed. See the previous discussion of possible multifunctionality under Time Constraints.

Bifacial knives (type 130) are very similar to bifaces in that they are presumed to have been used for butchering activities. However, given their rarity, their thin and sometimes sinuous shape, they appear to be specialized and fragile tools, or perhaps high status items. Due to their rare (N=52), but usually complete occurrence, it seems likely that they were only stored (and occasionally lost or forgotten) at winter villages. Most of their constraints and design elements appear basically similar to bifaces.

III. Portable Flake Tool Strategies

The goal in this strategy is to carry specialized tools in high mobility contexts that will last as long as possible and thus avoid the need to carry excess stone weight. Thus, the most durable materials with high resharpening potential are often reserved for these tools. Because of their specialized nature and resharpening requirements, we suspect they were probably most often produced near quarry sites since a large proportion of the core reduction would not be suitable for making these tools. This is especially true of trachydacite cores which often contain stress planes often resulting in broken flakes. In the Keatley Creek assemblage, tools made according to this strategy include: end scrapers, "key shaped" scrapers, and drills. Projectile points can also be considered a special case of using this strategy.

1. End Scrapers (type 162)

Constraints

Task. There is good ethnographic, experimental, and use-wear data to indicate that end scrapers were used primarily to scrape off the epidermis (including hair follicles) and endodermis (the inner membrane) of skins as well as to thin the dermis if necessary (Hayden 1979b, 1990). Semi-abrupt or abrupt angles are necessary as is a smooth convex working edge. Tools must also be easily hand-held or hafted. Edges must be sharp in order to effectively remove dermis layers.

Time. There would only be light to moderate time constraints, especially if skins were scraped in a dry state.

Material. Fine-grained stone material is required to shave fine layers off skins.

Manufacturing Time/Effort. Manufacturing effort for the stone part was probably minor or insignificant assuming adequate raw material was available; however the manufacture of hafts could have entailed more time and effort.

Frequency and Intensity of Use. According to ethnographic data, preparation of hides occurred primarily at base camps during the winter and was a very time-consuming activity (ca. 2–3 hours of scraping per hide) involving the highly intensive use of end scrapers. However, the generally low number of deer available, indicates that, at most, only a few hides would be processed per family per year on average.

Wear Rate. Experiments by Hayden indicate that wear rates depend on the moisture content and the part of the dermis being scraped. Wear rates can range from low (one resharpening every hour or more) to very high (one resharpening every 5–10 minutes). Ethnographic accounts by Mason also indicate high wear rates for some facets of hideworking (see Hayden 1979b:225).

Transport. Tools could have been left as site gear at the winter village site if people were moving to areas where raw materials were available or if the activities that were going to take place on seasonal moves were not related to hide processing. Alternatively, it would be a minor cost to carry several endscraper bits to autumn hunting camps.

Flake Type. To the extent that this activity could consume large amounts of stone material due to its long duration and the rapid wearing out of working edges (see Hayden 1979b:225), the ability to repeatedly resharpen flakes would be desirable. Given the need for a small working edge, this would make blade-like flake forms a very good design solution. In contrast, bipolar and billet flakes would generally be too thin to support the contact pressures involved or to be repeatedly resharpened, or to be comfortably held or hafted in this task. We expect to find mostly heavily used short end scrapers at winter villages. The mean for the maximum dimension for whole or chipped end scrapers is 4.0 cm and the standard deviation is 1.1. Thus, they are relatively small.

Strategies and Design

Raw Material Strategies and Acquisition/Procurement Strategies. As chert dulls less quickly than trachydacite, some selection for chert should be evident where this material is available.

Reduction Strategies. If hide processing occurred on a frequent basis with each family processing many hides during a year, we would expect some effort to be made to systematically produce blades for hide working tools. However, given the scarcity of ungulates in the Keatley Creek catchment area, it seems unlikely that most families would process more than one or two hides per year. Consumption of hide scrapers was probably correspondingly low and non-specialized block core reduction of raw material could have been relied upon to produce the few blade-like flakes that were desired for use as end scrapers. The variable technical attributes of end scraper flakes at Keatley Creek indicates that this was, in fact, the strategy employed. Reduction of cores and selection of these flakes could have occurred either at quarry sites or at the winter village. Bifacial billet flakes would not be suitable in general because of their thin cross-sections and edges.

Tool Form and Resharpening. Blade-like flakes would be the most effective for shaving hides given the need for frequent resharpening and the required edge characteristics noted previously.

Other Characteristics of Design. End scrapers are clearly highly maintainable tools since they appear to be designed for resharpening and easy replacement in hafts. While this corresponds to Bleed's suggestions that maintainable tools should occur under conditions of low risk and time-pressure, we suspect that these features are much more the products of simple economy of effort under conditions of high material attrition (see Hayden 1987) and convenience rather than any consideration of risk or time pressures. While end scrapers can probably also be considered very reliable tools, there is no indication of overdesigned elements. Indeed, operationally, it is difficult to imagine how such tools could be overdesigned or more specialized other than by increasing their robustness.

There are no indications that recycling potential or multifunctionality played any significant role in the morphology, design, or manufacturing of these tools, although in other assemblages such as Eskimo and Upper Paleolithic assemblages, end scrapers are sometimes reshaped or recycled and appear to have been used for several different purposes but perhaps opportunistically rather than as the result of intentional design (Hayden 1979b). Thus, 30% of end scrapers in the assemblage appear to have several different uses.

Frequency. We expect a relatively low proportion of end scrapers, due to the low number of deer hides processed per year as well as the extended use-lives of these tools. End scrapers constitute 1.5% of the sample (plus thumbnail scrapers at 0.3%); 53.8% of them display heavy resharpening. Only 6.3% of the sample can be considered completely exhausted. Although this is not as high a proportion as we expected, some of them could have been stored for future use or transported to the mountains and lost or left at the village. In general, these data match expectations concerning the relative frequency of the task in which end scrapers were employed.

Specialization. This is clearly one of the most specialized tools in the assemblage. Whereas skin scraping can probably be performed with ordinary flakes (Kamminga 1982), the investment of time and effort in the manufacture of blade-like hafted skin scrapers for use during extended periods of time provides savings in efficiency that far outweigh the initial manufacturing costs of end scrapers. While end scrapers may have been used for other tasks as a matter of convenience (Hayden 1979b), it is clear that they were above all a tool designed and manufactured for a single, specialized, time consuming activity: hide scraping.

2. Key-Shaped Scrapers

Constraints

Task. According to Rousseau's analysis (1992), the primary function of key-shaped scrapers involved working stems and branches of woody shrubs and trees (especially Saskatoon berry branches), with specific tasks including bark stripping, removal of secondary branch nodes, smoothing, and significantly altering the primary branch shafts by scraping, shaving, planing, whittling, carving and/or engraving actions. They could have also been occasionally used to scrape soaked or boiled deer antler.

Time. Slight to moderate time constraints would normally characterize the above tasks. However, if these tools were carried on hunting trips to repair or replace hunting equipment (e.g., arrows, darts, snares)—as Rousseau postulates—time constraints involved in the tasks might be significantly greater.

Material. Any kind of fine-grained raw material could have been used for the above tasks. However, most key-shaped scrapers are made from hard, resilient and tough cryptocrystalline silicates (chalcedony and chert). For Rousseau, this indicates that they were designed to be highly efficient and they were intended to have long use-lives. Trachydacite has less hardness and durability, and also dulls rapidly compared to other silicates when used on moderately hard and hard contact materials. According to Rousseau, trachydacite is also quite brittle, and so it is more prone to breaking while being used or resharpened.

Manufacturing Time/Effort. There are moderate amounts of time invested in the production of the stone elements of these tools. Many of them appear to have been hafted, which would have considerably increased the manufacturing time and effort involved.

Frequency and Intensity of Use. Although these tools may have been used primarily on hunting trips and only infrequently at village sites, they could have been employed for relatively long periods for working on wood shafts at lookout sites or hunting camps.

Wear rate. Given the nature of the woody contact materials, the high edge angles, and the hard, tough, stone materials involved, wear rates must have been low to moderate and use-lives correspondingly long.

Transportability. Key-shaped scrapers constitute a larger proportion of mountain lithic assemblages than winter village assemblages (Rousseau 1992), indicating that they were used primarily in mobile contexts. The preference for longer lasting materials makes sense primarily under more mobile conditions. Moreover, they are relatively small and several stone bits could have been carried by an individual without adding excessive weight or bulk to their load.

Flake Type. Probably only hard hammer flakes big enough, thick enough and long enough (rectangular in form) could have been used to make key shaped scrapers. Most bifacial billet flakes would not have been suitable because of their acute angles and general thinness. Bipolar flakes from small cores were probably not large or thick enough. Bipolar flaking of large cores would be wasteful of material given the large amount of shatter produced. The intensity of use of these tools would probably not be great enough to warrant specialized blade production, although blade-like flakes would be suitable blanks.

Strategies and Design

Raw Material Strategies. Given the desirability of hard and durable raw materials in the above contexts, most of these tools should be made on chert or chalcedony or similarly hard materials. In fact, key-shaped scrapers made on these raw materials constitutes 81.8% of the sample (N=22).

Acquisition/Procurement Strategies. Since this kind of tool required a special size and shape of flake blank, it may well have been manufactured near quarries in the major hunting areas.

Reduction Strategies. Given the thickness and strength desired, the best strategy would probably have involved the utilization of hard hammer flakes.

Tool Design and Resharpening. Initially, it would seem that a simple scraper or adze such as those observed by Hayden in Australia would be adequate for performing the tasks attributed to key-shaped scrapers by Rousseau. Thus, the unusual shape of these tools must be attributed to other factors such as a) specialized bark stripping from branches in which the "hook" of the scraper serves to guide the tool along the branch shaft, or b) a desire to maintain the projecting part of the scraper for other specialized functions, such as gouging wood. Given Rousseau's observations on wear and damage to the tips of these tools, the argument that the unusual shape was for multifunctional purposes seems strongest.

For working wood, especially hard woods, edge angles between 65 and 85° are best according to ethnoarchaeological observations (e.g., Hayden 1979a; Gould, Koster and Sontz 1971), and this is the range of edge angles that characterizes most of these tools. The steep edge angles also reflect intensive and repeated resharpenings similar to hafted Australian chipped stone adzes. The inference for hafting is also supported by an unusual degree of standardization for the maximum widths of these tools (mean = 18.0 mm, s.d. = 2.4 mm; see also Rousseau 1992) and occasional resin deposits on proximal ends. Hafting would increase the amount of effective pressure that could be applied through the tool and facilitate tasks that had to be completed under time constraints or which lasted substantial lengths of time. Hafting would also make it possible to use smaller stone bits, thereby reducing the amount of stone required in transport. Evidence for hafting indicates these were probably personal gear tools. Resharpening retouch would have been achieved with hard hammers or batons to create semi-abrupt edges.

Other Design Variables. On the basis of morphological characteristics, key-shaped scrapers can probably be described as reliable and maintainable tools. There is a selective preference for particularly hard and durable materials, which enhanced tool longevity and efficiency and decreased the possibility of accidental breakage. They are relatively thick and robust, and they were clearly manufactured in advance for use. According to Rousseau (1992) they were designed to deal with a specific anticipated, important and recurrent task. Thus, they exhibit all the characteristics and proposed conditions of "reliable" tools. On the other hand, it is difficult to determine whether this emphasis on more durable material was motivated by concerns about the risk of tool failure, or simply by concerns for getting as much use out of a single flake as possible. These tools were also certainly made to be maintainable. Their composite (hafted) nature would make it easy to replace any stone bits that broke, while the ones that lasted could be and clearly were repeatedly resharpened many times. An important part of the design seems to emphasize multiple resharpenings.

Given the small size of these tools and the lack of evidence for recycling, we infer that this was not an important design consideration. On the other hand the morphology and the use-wear of the distal ends indicate that multifunctionality may have been an important design consideration, probably related in a general fashion to mobility and transport constraints. However, only 8% of key shaped scrapers display clear indications of multifunctionality.

Frequency. Because of their long use-lives, and because they were probably part of personal gear in storage (rather than being actively used) at winter villages, we do not expect these tools to occur in high frequencies in the assemblage. In fact, they constitute only 0.4% of the sample.

Specialization. This appears to be a highly specialized tool for use in a specific set of related tasks in a manufacturing operational sequence. Although it may be a multifunctional tool, each part seems highly specialized and inter-related in terms of tasks. It seems that time or mobility constraints rather than volume of material processed probably made the extra effort of hafting and specialized morphology worth the effort invested in them.

3. Drills

Constraints

Task Constraints. In order to be able to bore small deep holes in moderate to hard materials with reasonable efficiency, tools must be narrow, have a tip that will cut or abrade, and be capable of relatively fast rotation.

Time Constraints. Unfortunately, we do not know whether drilling small holes would have been part of practical technological gear or only prestige gear, and thus it is difficult to determine if there might have been time constraints involved in the repair of some practical items with drills. However, in general, most ethnographic drilling appears to have taken place during down times when there was abundant time for manufacturing with few time constraints.

Material Constraints. Optimal materials would be those that were tough, durable, finegrained, and easily flaked. Trachydacite or chert/chalcedony would be the best choice, with chert and chalcedony having more advantages in terms of toughness, non-brittleness, and durability.

Technological Constraints. Relatively large, long, thin, straight flakes would be required for making drills. Due to the elongated, narrow bit with a sub-circular cross-section, and due to the hafted nature of drills, these must have been some of the most time consuming and difficult chipped-stone tools to manufacture.

Frequency and Intensity of Use. Although these tools were probably infrequently used, the high rates of rotation associated with them meant that they were intensively used for varying periods of time possibly extending up to several hours per event.

Wear Rate. Wear rates were probably unusually high due to the small working edges, high pressures, and highly auto-abrasive environments. Frequent resharpenings must have been required although experiments are required to verify this.

Socioeconomic Constraints (Transport). Unfortunately, we do not know if drills were used exclusively at winter village sites, or whether they might have also been carried about on seasonal rounds and used at hunting or fishing sites. It would certainly have been a minor transport cost to carry the drill bit during seasonal moves, but whether there would have been a need for drills (e.g., in repairing fish net frames, snowshoes, or other items) is unknown. Nevertheless, transport constraints do not seem as though they would have had any great influence on tool design. Drills are highly portable and may well have been transported as part of personal gear.

Strategies and Design

Raw Material and Procurement Strategies. There would have been a clear selection for chert/chalcedony and perhaps extra efforts to procure this material, either by traveling farther, searching for suitable raw material longer, or via exchange. In fact 24% (N=33) were made of chert or chalcedony.

Reduction Strategies. Bifacial thinning flakes generally provide thinner flakes, however, these tend to have greater curvature than hard hammer flakes. Nevertheless, if relatively large, straight billet flakes did occur, they probably would have been selected as blanks for drills or projectile points. Relatively thin, straight hard hammer flakes could probably be produced more easily and more frequently. Most drills have been so extensively modified that it is impossible to determine the type of flake from which they were made. The infrequent use and manufacture of drills would not warrant the development of a specialized blade technology.

Tool Design and Resharpening. Clearly, the task constraints impose fairly narrow limits on the morphology of the bit. In order to facilitate rapid rotation, it would obviously be advantageous, if not necessary, to haft drill bits. Moreover, either due to the need to drill deep holes and/or the desire to prolong the use-lives of these tools, drill bits were relatively long. Resharpening would have been performed by pressure flaking due to the delicate nature of resharpening these tools.

Other Design Variables. Clearly, drills must be viewed as highly maintainable tools since they are designed for repeated resharpening and replacement and since they are not particularly robust or overdesigned. Indeed, given the task constraints, it is difficult to see how drills could be overdesigned or more specialized. Although risk and time constraints are not significant, it is difficult to imagine how drill morphology might change even if risk and time became important considerations. Thus, it is not clear that these conceptual constructs help in understanding tool morphology in this case. Other factors such as task constraints, amounts of drilling involved, and rate of material consumption seem far more important. Similarly, recycling and multifunctionality considerations do not advance understanding of drill morphology. In fact, there are no examples of multifunctional drills in the assemblage.

Frequency. Due to the infrequent need for drilling small deep holes, as well as their long-lived, resharpenable status, drills should be relatively rare in winter village assemblages. In fact, they represent only 0.6% (N=38).

Specialization. It is difficult to imagine a more specialized chipped stone tool. The high degree of specialization in this case probably does not stem from very high processing volumes, but from narrow task constraints.

IV. Quarried Bipolar Strategies

The intentional procurement of pebbles or cobbles from the outside environment for bipolar reduction is a strategy oriented to the special needs for large, coarse-grained, spall tools in the assemblage which could be left as site furniture or discarded after use.

1. Spall Tools

Constraints

Task Constraints. spall tools found at the site are generally similar to hafted ethnographic specimens recorded by Teit (1900, 1906) and Albright (1984). These ethnographers report that spall tools of coarse grained rock were used in order to stretch hides in the tanning process. Coarse grained stone is desirable for the final softening procedure in making buckskin because it will not cut through hides with the application of the very high pressures required to stretch the skins in order to break down the lignin fibers. Some of the larger spall tools also appear to have been used as beamers to remove endoderm membranes from wet skins. These beamers will not be dealt with in this analysis until further studies on them have been conducted.

Frequency and Intensity of Use. High intensity, but sporadic and low frequency use probably characterized these tools involving the same considerations as end scrapers, i.e., scarcity of deer and hides.

Time Constraints. There are moderate time constraints related to completing the stretching process before the skins become dry and such constraints do not affect the use or maintenance of these tools except to the extent that replacement due to tool failure would adversely affect the tanning process.

Material Constraints. As already noted, coarse grained stone is desirable for this task. Coarse stone also grips any remaining wet endoderm for its removal. Quartzite has coarse grain, does not crumble, and is flakable. These qualities are important for hafting and use. Few stone types in the area have similar characteristics, although some other coarse grained igneous and metamorphic rock types were also used. Quartzite was probably the best available raw material.

Technological Constraints. Little time or effort were required for the manufacturing of the stone component, although proper hafting involves substantially more time and effort. There is difficulty involved in shaping hafts to fit specific flakes and in binding flakes to withstand high stresses. Retouch would have been needed only if the original edge was too sharp or jagged, or for hafting modification. According to ethnographic information, the use-life of this kind of tool was very long, extending over generations (Albright 1984), thus minimizing average manufacturing time per year.

Flake Type. Large flakes are required to maximize the effect of stretching on skins. The main source of coarse grained materials large enough to produce these flakes is rounded quartzite river cobbles. Bipolar splitting is the most effective and perhaps the only means of producing large flakes from these relatively tough quartzite cobbles although occasional flakes produced by direct hard hammer percussion might also be suitable. In terms of beaming tools, large spalls useful for removing the endodermis membrane and hair layer are better to grip and can be used efficiently when a hide is draped over a log.

Wear Rate. Wear formation is very slow for these tools and is in any event an almost insignificant consideration.

Socioeconomic Constraints (Transport). There are a number of indications that spall tools were highly curated (Albright 1984) and were probably treated as site furniture rather than transported on seasonal moves. The unusual weight and size of the spalls, not to mention their long stout hafts, would have been an unusual burden to carry. Since these tools were only used in winter villages and perhaps at fall mountain hunting camps, and since they had very long use-lives, it would make far more sense to cache spall tools at the sites of their use. In fact, excavations at Keatley Creek revealed a number of clearly cached spall tools in Housepit 7. The high percentage of *whole* spall tools (N=41, i.e., 0.7% of the sample) supports this suggestion since there are no obvious reasons to abandon whole and still usable tools at the site. Alternative tool solutions such as pointed sticks (Teit 1900) could even be used for stretching hides in mountain locations.

Strategies and Design

Raw Material Strategies. Since coarse grained flakeable material would be most effective, quartzite should be most favored. In fact 41.5% of the sample is quartzite, 19.5% is fine and coarse grained trachydacite, 9.8% is coarse grained andesite, 4.9% is olivine, 2.2% is shale, and 22.9% is indeterminate material.

Acquisition/Procurement Strategies. Quartzite raw material could have been obtained in the form of river cobbles near the Fraser River. However, there would have been some restrictions in the availability of the quartzite, especially during the coldest part of the winter season due to frozen ground and snowcover. Therefore people would need to procure quartzite materials in advance or keep tools from previous seasons. One may wonder why this type of tool was kept if the procurement cost was low. In addition to the difficulty of obtaining raw material in the winter, and the difficulty involved in shaping hafts to fit specific large flakes, there was simply no reason to discard these tools from one year to another just as anvils and abraders were kept.

Trachydacite was not locally available near Keatley Creek. Spall tools could have been brought into the site as finished tools, or they could have been manufactured from cobbles that were brought to the site as cores. Some of the trachydacite utilized was fine-grained (12.2% of the sample). As this does not seem to be the preferred material for this type of tool, it may have been utilized because there was no better material immediately available at some times.

Reduction Strategies. There was a need to split cobbles in order to obtain the largest possible flakes. Because of this, and because of the round shape of river cobbles and the toughness of quartzite, bipolar reduction was probably the best reduction strategy, although direct percussion may also have been used in some cases. No other reduction strategies are capable of producing suitable flakes.

Tool Design and Resharpening. There is a need for dull edges or edges that grip slippery surfaces. Long handled hafted tools are much more efficient for "staking" (stretching) skins because much more pressure can be applied in this fashion. This pressure is critical for stretching skins and making buckskin. In addition, large broad edges are important for softening large areas at once. Thus, large broad flakes of coarse grained material, suitable for lashing to long wood hafts constitute the main tool design, although other technological solutions made entirely of wood could also be used.

Other Variables of Design. Reliable designs have strengthened parts, are overdesigned, have a sturdy construction and careful fitting of the parts. In the case of spall tools, there was a high investment in the shaping of the hafts to adequately fit the tools. Hafting use wear is frequently very evident on spall tools. The tools were specialized and robustly designed, apparently due to the nature of the task and the high pressures exerted. There was virtually no maintenance involved for the stone parts of these tools and they are probably the most cumbersome chipped stone tool to transport in the entire assemblage. The impression that spall tools were designed with reliability in mind is strengthened by the lack of indications that spall tools were maintainable. Many were never retouched or rarely needed resharpening. Nor was breakage frequent. There is no indication that recycling potential (flexibility) or multifunctionality (versatility) played any significant role in tool design or use. Only 9% show any other possible signs of alternative use, probably due to the specialized nature of the material and the tool itself.

While all of these characteristics have been suggested as typifying "reliable" designs, there is little correspondence to the risk factors that Bleed (1988) Torrence (1989) and Nelson (1991) suggest produces reliable designs. Thus, the reliability in this case was probably incidental to the basic task mechanics, or *de facto*. Reliable designs are supposed to be more suitable when there is a premium on resource capture and processing time. This is clearly not the case for spall tools. Any need for emergency tool replacements might have been achieved simply by keeping extra parts in storage or by using alternative solutions such as plain wooden sticks. However, this cannot be determined from tool morphology. On the other hand, Bleed (1988:741) also argues that reliable designs are optimal when there are predictable times of need and downtime as well as in situations where bulk and weight are not critical. This corresponds more closely to the use context of spall tools.

Specialization. Hafted spall tools are among the most specialized and non-versatile tools in the assemblage. However, this specialization does not appear to be due to risk considerations or time constraints, but to basic task mechanics.

Frequency. Due to moderate to low processing volumes, very low attrition rates, and extremely long use-lives, spall scrapers are expected to be rare, and they are (N=41; 0.7% of the assemblage).

2. Quartzite Spall Adzes

Spall adzes appear to constitute another tool type belonging to this lithic strategy. However, they are so rare and under-reported elsewhere that further analysis is required before discussing them in this context.

V. Scavenged Bipolar Strategy

This recycling of exhausted tools by using bipolar percussion to further reduce them makes most sense as a recycling strategy used when residents were faced with very low reserves of new material.

Although clearly present in the Keatley Creek assemblage, our original research design did not provide for the quantitative collection of data on this aspect of lithic related behavior. However, subjectively, it can be stated that large tools and flakes as well as bifaces and residual block cores often seem to have been "recycled" via simple intentional breakage (in order to use break edges) or via bipolar reduction to create new flakes. This strategy is obviously related to Nelson's (1991) "flexibility." Unfortunately, we cannot provide a detailed analysis of this strategy at this time. The importance of this strategy is expected to increase as lithic reserves decreased during the seasonal occupation of the pithouses at Keatley Creek.

VI. Ground Stone Cutting Tool Strategy

The creation and maintenance of cutting edges by grinding is used under conditions of high processing volumes and/or to display control of wealth and power.

1. Nephrite Adzes

Constraints

Nephrite Adze Task Constraints. The ethnographic information for the area mentions the utilization of ground stone adzes for heavy woodworking (Teit 1900). This kind of tool could conceivably have also been used for heavy butchering, and appears to have been used to shape antler prehistorically on the basis of adze marks found on large pieces of antler at Keatley Creek.

Adzes were probably used in the construction of the pithouse wooden roof superstructures, as well as interior planking for sleeping platforms, and other furniture. On the basis of Teit's accounts and drawings, the number of logs needed in the construction of a medium sized housepit can be estimated to have been about 312 (24 large logs, 44 medium logs, and 244 smaller poles). High, heavy duty cutting requirements might also be involved during the year in building deer fences in the mountains, removing large amounts of bark for cambium, canoes, baskets, roofing, and constructing drying racks, net frames, bows, log ladders and the log or plank sculptures documented by Teit (1906) and others. Thus, very large quantities of wood would have been episodically processed. Ground stone adzes may not always be more efficient in cutting wood than chipped stone equivalents (Hayden 1987); however, where cutting requirements were extremely high, it would have been more costly in terms of effort, time and scheduling to return to quarry sites at short intervals to replace exhausted tools or materials. In this respect ground stone cutting tools had major advantages over chipped stone tools. The cutting tasks themselves simply required sharp, semi-abrupt edges with considerable mass in order to render penetration effective.

Time Constraints. If the inhabitants of the site had to use late autumn for intensive procurement of the food necessary for the winter (hunting and fishing), and if food resources could be scarce if the winter lasted too long, the need for using a kind of tool that minimized replacement effort and time so that as much critical time could be spent in subsistence activities would be particularly important. In this respect, the use of ground stone tools for heavy wood working would make very good practical sense especially since the replacement of decayed pithouse roofs would also have had to be completed in a relatively short time during the fall, before severe winter weather set in. Therefore, efficiency and saving time were undoubtedly considerations in the design of these tools.

Material Constraints. A durable, tough, raw material with sharp cutting edges would be optimal. At Keatley Creek nephrite was utilized. Other igneous and metamorphic rock types in the area were also used and would have been easier to manufacture, although few would produce as effective and strong a cutting edge as nephrite (Darwent 1998). Smaller, chipped stone quartzite adzes, bifacial quartzite core adzes, and antler wedges may also have been used as an alternative tool by poorer families for some wood working or barking activities. Figure 1 shows one clear example of a groundstone adze made from igneous rock as well as a very probable chipped quartzite adze and a number of other possible chipped stone adzes, all from Keatley Creek. In addition, Teit (1900:183; 1909:644, 709, 715) refers a number of times to people using antler chisels or wedges for wood working. Thus, more than simple practicality may have played a role in the use of nephrite for adzes. The use of nephrite may well have been a sign of status or wealth (Darwent 1998).

Technological Constraints. By all measures, it would have been exceedingly time consuming to manufacture ground stone adzes, especially using nephrite. To cut 1 mm of nephrite with traditional techniques requires an hour of work (Darwent 1998). In addition, the maintenance of cutting tools by edge-grinding involves a considerable amount of work (cf., ethnographic data in Hayden 1979, 1987). However, other chipped stone alternatives may have involved greater total costs. Nephrite is extremely tough and durable, and would be unusually long lasting with low wear rates and low resharpening requirements thereby reducing average yearly costs.

Prestige and Ideological Constraints. Hayden (1987) initially related the importance of edge-grinding adzes or axes to high wood cutting requirements. In some instances, such as with the high manufacturing time involved in making nephrite adzes, the edge grinding may also be related to the existence of free time or to the control over others' labor in the form of slavery or the ability to commission work. The goal of prestige technologies is to use control over labor to produce desirable items that are too labor-costly for most people to be able to afford, thus displaying individual power and wealth. Given the inordinate amount of labor involved in producing nephrite adzes, they are prime candidates for

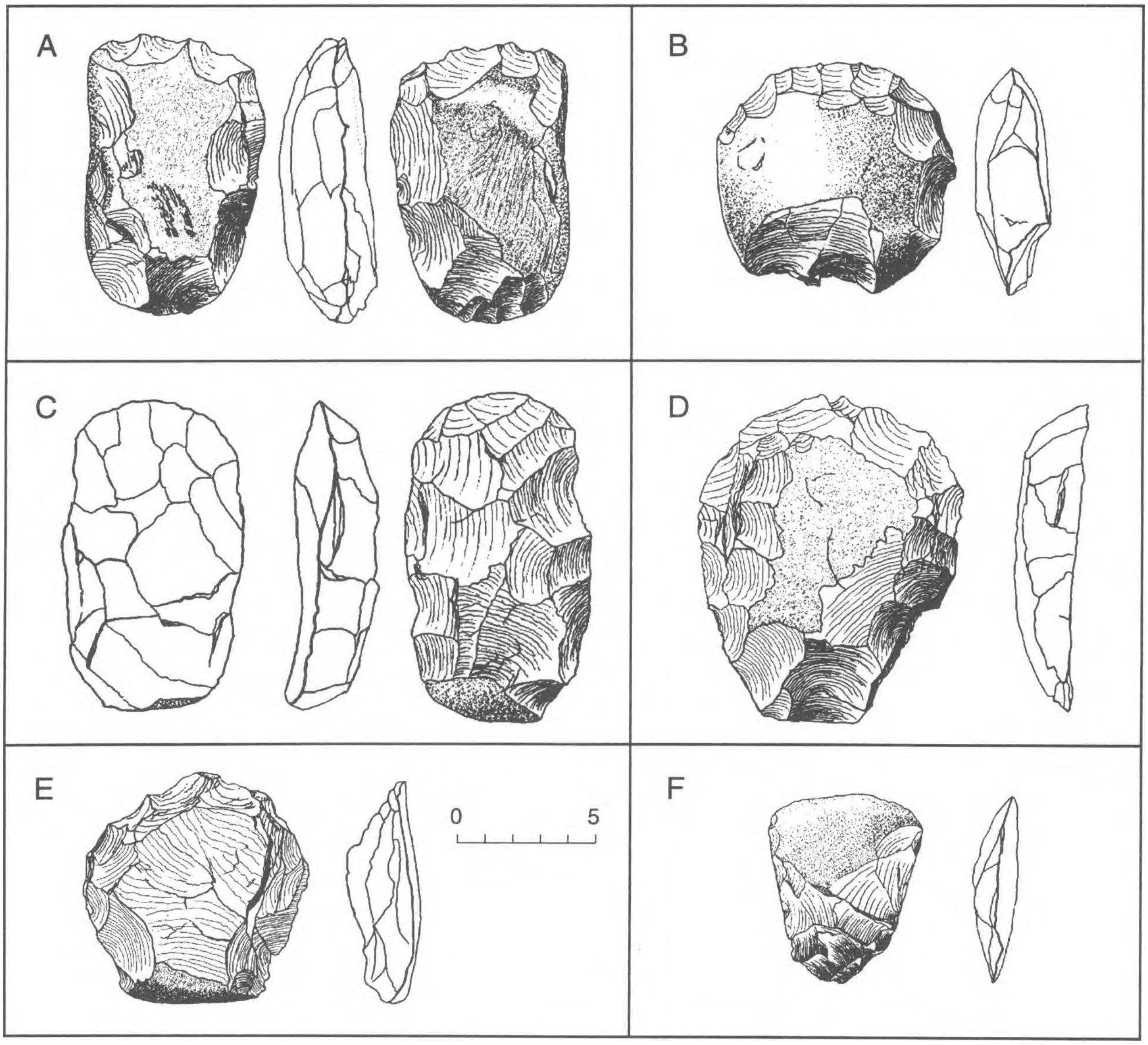

Figure 1. Examples of design solutions for heavy woodworking besides the ground stone nephrite solution. These include the use of ground or chipped igneous rocks and chipped quartzite adzes. A (Cat. no. 7312) is a basalt adze from HP 7; it has been fully ground on both faces and subsequently re-chipped on some edges. C (Cat. no. 6741 from HP 47) is a well formed quartzite adze. Other possible examples of chipped stone adzes include several examples of quartzite spall tools: B (Cat. no. 2238) and D (Cat. no. 7291) both are from HP 7; E is a surface find of andesite. A small version of these spall tools could also have been used for light woodworking. Several examples of this latter type were recovered from Keatley Creek including F (Cat. no. 3633) from HP 7.

prestige artifacts. Other types of stone may have been nearly as effective and involved much lower production costs, but would not have had as much prestige display value. In the Lillooet region, the existence of social hierarchies including slave labor was documented ethnographically (Teit 1906) as was the existence of some occupational specialization (Romanoff 1992), while unusually long nephrite adzes were clearly used as wealth and prestige display items (Smith 1900; Emmons 1923:26–27).

The use of some nephrite adzes by women (Teit 1917:11) is probably related to their high status role and the use of such adzes in marriage payments in high status marriages, even if women only used adzes for splitting up dead trees as opposed to men's use of adzes to cut up living trees (as is the pattern in New Guinea—Petrequin and Petrequin 1993:387).

Frequency and Intensity of Use. Very large quantities of wood would have been intensively processed at infrequent intervals (see Task Constraints).

Socioeconomic Constraints (Transport). Nephrite adzes were probably not left at winter village sites (in contrast to spall tools) because of their high procurement and manufacturing costs and the need for cutting tools at other seasonal locations. Given their very high value, they were probably part of personal gear. Ground stone adzes are good solutions to transport constraints because their replacement rate is far lower than that of chipped stone heavy woodworking tools. On the other hand, they might add significantly to the weight and bulk of items that an individual would have to carry on camp moves, especially if hafted.

Flake Type. The only requirements would be the need for raw material large enough to manufacture into an adze through grinding. Nephrite does not "flake," but must be reduced by grinding and sawing from a parent cobble.

Strategies and Design

Raw Material and Procurement Strategies. At the Keatley Creek site, several fragments of adzes made of nephrite were recovered. The source of this raw material was probably the Fraser and Bridge River lag deposits, where nephrite cobbles and boulders are found today. Thus raw material could have been obtained while other activities, such as fishing, were carried out. However, if more material was required than could be found opportunistically, it would have been time consuming to search for and to obtain due to its rarity.

In addition, the use life of ground nephrite adzes is very long (probably spanning more than one generation), thereby minimizing the average yearly procurement cost.

Tool Design and Resharpening. Due to the intensive and long duration of processing numerous logs, hafting provides critical advantages in easing the fatigue as well as the trauma to hands in contrast to hand held chopping tools. The manufacturing and maintenance costs of the haft are more than offset by savings in fatigue and perhaps an increased efficiency involved in processing large quantities of wood. Resharpening the cutting edge would require a non-permanent type of haft. The most practical would probably be a friction fit accompanied with binding. Smooth surfaces provide far superior friction fit hafts than irregular surfaces such as those typical of chipped stone tools. Thus, in addition to edge-grinding to prolong use-life (and reduce consumption of raw material), surfaces could also be expected to be ground. Sizes (width) should be a function of the size of the wood or antler being worked and the mass required to penetrate wood effectively. Initial lengths would probably have been as long as possible without creating loading conditions leading to breakage. Long adzes would maximize the resharpening potential and use-life of the tool.

Reduction Strategies. Grinding, using sands (preferably garnet sands), sandstone, water and wood or cord is the only effective traditional technique for shaping nephrite (Darwent 1998).

Other Design Variables. Nephrite adzes appear to be highly reliable on the basis of morphological criteria. They are made of much tougher materials than strictly necessary, they were robust, required elaborate advance manufacturing time and effort, specialized repair and resharpening, and appear to have been used under conditions of some time constraints. Nevertheless, it is not clear how intensive actual time constraints were, and there was also a strong maintainability element to nephrite adzes. Breakage would have to be dealt with by replacement (a very difficult, long-term process), or borrowing. However, there is a more fundamental question involved in understanding strategies behind the manufacture of nephrite adzes; notably whether the apparent "reliable" character of these tools was only incidental to, or a by-product of, a more basic concern with material conservation strategies used in the face of large processing requirements, or even more importantly, of a basic concern with displaying wealth and power.

Although ground adzes may have been multifunctional, this is difficult to demonstrate. Moreover, there are few arguments that support the idea that multifunctionality played any significant role in tool design or manufacture. Any adze multifunctionality appears to be strictly the result of *ad hoc* or opportunistic use of adzes. Nor does potential for recycling appear to have had any influence on raw material choice or tool design.

Frequency. Aside from loss, discard of this kind of tool at the site is probably due to breakage and abandonment of small or flawed pieces that could not be easily reshaped to form smaller adzes. Because nephrite adzes were by far the most costly tool to make, had high longevity, and were almost certainly unique items of personal or family gear, they should be very rare in winter village assemblages.

Specialization. Although ground stone adzes could be used for cutting many things, they were probably developed for a very specialized task: procuring and processing large amounts of timber. Since highly specialized materials were used, and since a great deal more time and effort and specialized hafting designs were involved in the manufacture of these tools (in contrast to more generalized forms of wood chopping tools), they must be considered highly specialized tool types.

Discussion

The technological organization of a group responds to different environmental conditions such as the distribution and predictability of resources, their periodicity, productivity, patchiness and mobility. It involves resource acquisition, manufacture, manipulation, and discard or loss (Nelson 1991, 1992). Our focus in this discussion will be on the acquisition, manufacture and manipulation of stone resources and the evaluation of basic strategies in these domains.

The groups that have inhabited the Lillooet region probably acquired most of the stone raw material they needed for their tasks during their seasonal round. Trachydacite, the raw material utilized for the manufacture of most of the tools, is not available near the site. However, most of the block cores found at the site are trachydacite (81 out of 106, or 79.4%). Since this raw material is not locally available, there should be a high percentage (91.1%) of exhausted block cores. In addition, cores should be small in size. The mean size for all the core types is small: 3.2 cm for bipolar cores; 5.2 cm for the multidirectional cores and 4.5 cm for flake cores. Flake cores are often made from larger flakes but are reduced to small sizes and are sometimes made on broken biface fragments, apparently as a way of saving raw materials. Chert, chalcedony, and obsidian should also occur primarily in exhausted states or bipolar forms. This is in fact the case.

Bipolar cores constitute 73.6% of all cores, matching expectations for the intensive use of raw materials. The percentage of completely exhausted or useless cores from which *no* further flakes could be removed (in all classes of cores) is only 20.3%, which is lower than might be expected, but still significant and probably reflects conservation of unexhausted cores as well as the inclusion of unsnapped bipolar cores.

We believe different core strategies were emphasized at Keatley Creek in order to manage the problem of limited raw material availability according to the minimal requirements of various classes of tasks involved.

Block (Multidirectional) Cores

Block cores were probably introduced into the site in order to obtain blanks for a broad range of tools, especially those for which very acute angles were not needed.

Block cores would have provided some large and suitable flakes for non-butchering tasks. This was probably the case for end scrapers, scrapers, notches, perforators, borers, drills, and acute, semi-abrupt, or obtuse utilized flakes. Blocks cores would have also provided many small flakes with a range of edge angles for a variety of expedient tasks.

Bifaces

Bifaces were probably introduced into the site primarily to store them for use on hunting forays and incidentally as a way of saving raw material. They were also undoubtedly used for some activities inside pithouses. Bifacial billet flakes obtained as byproducts of resharpening or for the purpose of obtaining thin flakes, were suitable for tasks requiring very acute angles, such as those related to butchering.

Quarried Bipolar Cores

Quartzite cobbles were readily available in the river terraces and shores. Therefore, they could be easily procured for bipolar reduction in the making of spall tools for hideworking and perhaps other activities.

Scavenged Bipolar Cores

Flakes could be obtained from exhausted block cores, bifaces, and large flakes or tools using the bipolar technique. Exhausted cores of trachydacite, chert, chalcedony and obsidian were probably frequently reduced further using bipolar techniques. This strategy could not be identified as having been used for the manufacture of any specific tool types. However, the scavenged bipolar strategy was certainly used for some tasks as indicated by the concentrations of bipolar cores in the southwest part of the Housepit 3 roof and around the hearth in the west sector of Housepit 7. We do not yet have any clear indications as to what those tasks were but the small size of the flakes involved and comparative ethnographic accounts (MacCallman and Groebelar 1965; Fidel Masao, personal communication) make it seem likely that scarification or cutting animal hide was involved.

Blade Cores

Blade cores do not occur at the site, except for bladelet cores from pre-housepit components. We propose that most prepared cores such as Levallois cores, and especially blade cores, are actually wasteful of raw material (contra Sheets and Muto 1972; Clark 1987; Nelson 1991:68) because of the high risk of failure at all stages, the initial need to shape cores, and the need for specific sizes, shapes, and high quality of raw material. These factors also increase search and procurement times and the investment in training required for successful blade production. On the other hand, once produced, blades have the advantages of having relatively long, sharp cutting edges per unit weight with little unusable edge, of being relatively thin and straight, and of facilitating multiple resharpenings for tools made on distal or proximal ends such as burins, end scrapers, borers, piercers, drills, and points.

Therefore, we suggest that blade technologies should occur: a) where processing large volumes of material involve distal-end tools such as those just mentioned; b) where there is an unusual need for large numbers of straight, thin, long flakes as in high volume butchering and filleting; and c) where high mobility places a premium on edge:weight ratios *and* where this coincides with seasonal visits to high quality lithic sources with abundant suitably sized nodules for blade making.

In the Keatley Creek case, none of these conditions seem to have existed in the Late Prehistoric (pithouse) tradition. The most sensible use of the generally small to medium sized blocks of raw material available within the seasonal round would have been as block cores from which almost all flakes larger than 2 cm could have been used. This reduction strategy relying on block cores would have provided maximum flexibility in terms of the production of different sizes and shapes of blanks for small expedient knives, drills, notches, and end scrapers and other small tools. The production of highly varied types of flakes depending on situational needs cannot be achieved with blade cores. It is therefore not surprising to find that block core reduction was the dominant strategy used at the site. The overall small size of tools also supports this interpretation. Whether it would have been most economical to reduce cores at quarries and simply carry away suitable flakes to the winter village or to carry cores to winter villages to maintain flexibility of blank production according to need and to ensure maximum sharpness of flakes, is unclear. Both strategies were probably used with an emphasis on quarry production of blanks with the greatest size and shape constraints (end scrapers, drills, key-shaped scrapers, bifaces) while production of flakes at pithouses was probably principally for tools with fewer shape constraints (utilized flakes, scrapers, notches). In fact, while cores occur at the site, refitting attempts so far have failed to produce a single conjoinable pair, indicating substantial off-site flake production (as well as substantial clean-up of debris for outside discard). At this point, however, we have not been able to distinguish expedient tool production at the site from the introduction of flake blanks from quarries.

Major Strategies

The term, "strategy" can be used at a detailed level (the resharpening or procurement strategy) as well as a broader, more encompassing level. This results in some confusion, and perhaps different terms ought to be applied to the different levels of intentional problem-solving approaches (e.g., minor vs. major strategies, or tactics vs. strategies). In the preceding pages, we have described six of the broader intentional problem-solving approaches that appear to be structuring the Keatley Creek assemblage. In sum, these major strategies are:

- The expedient, block core reduction and tool manufacturing strategy.
- The bifacial strategy.
- The portable flake tool strategy.
- The quarried bipolar strategy.
- The scavenged bipolar strategy.
- The groundstone strategy.

There are additional types of major strategies that occur in other assemblages elsewhere in the world (e.g., prepared blade strategies), or involving some of the other types in the Keatley Creek assemblage including granite anvils, sandstone abrading tools and saws, fire-cracked rock, pigments, crystals, and copper. However, we feel that the identification of the major types of strategies discussed in the preceding pages is a reasonable initial step in the systematic analysis of assemblages for our heuristic, exploratory goals.

It is clear from the tool and debitage analyses (see the following chapter and Vol. II, Chap. 11) that the housepit assemblages at Keatley Creek are dominated by the expedient block core and tool strategy. As others have suggested, this may be due to the lack of time stresses (Torrence 1982) when living off stored foods; or to relatively sedentary occupations involving the stock-piling and constant availability of raw material (Parry and Kelly 1987, Johnson 1987). We suggest that the expedient reduction of block cores is also the most efficient use of raw material in terms of procurement, reduction, and the use of minimal amounts of raw material in a wide array of tasks. We argue that there would have been considerable constraints on the amount of raw material that could have been brought to the winter villages and that it was used in an extremely economical fashion. This is indicated by numerous factors: 1) the unusually small size of the tool assemblage as a whole and the remarkably small size of many of the expedient tools; 2) the high rate of breakage (frequently intentional) and re-use of edges formed by breaks (detailed in the next chapter); 3) the high degree of culling of all usable flakes (also documented in the following chapter); 4) the high frequency of multiple edge use; 5) the high ratio of tools to debitage; 6) the great variability in the size range of tools and the extent of their resharpening; and 7) the frequent recycling of broken bifaces and exhausted cores through bipolar reduction. While the original research design used to record our data did not anticipate all of these variables, many of them became clearly evident during analysis and we can make relatively confident statements about them on a subjective basis.

The next most common strategy is the intensive use of bifacial reduction flakes as expedient tools, and this, too, makes sense primarily in terms of conditions where raw material is scarce. Although it is clear that bifaces were used in specific activities in the center of the large housepits during the winter occupations, the overall design of biface tools makes most sense in terms of high mobility (see Sassaman 1992). Bamforth (1991) has shown that in California there was a clear emphasis on bifaces in hunting campsites with a complementary emphasis on expedient "utilized flakes" (probably including types similar to the expedient knives at Keatley Creek) at the larger, more sedentary sites. This certainly fits our view of how lithic technology was used in the Keatley Creek case. The use of bifaces within pithouses may represent the incidental use of a handy and convenient tool for butchering, woodworking, or some related activity, rather than the condition under which bifaces could be expected to be adaptive , i.e., high mobility.

Clearly, the type of analysis which we have attempted here is still in its development phase. Yet the results seem promising enough for the explanation of tool forms and materials to warrant more detailed experiments, comparisons, analyses, and data gathering that could transform our initial formulations into much more robust conclusions about the organization of lithic technology and the strategies used prehistorically to deal with technological problems.

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Appendix:

Composite Frequencies of All Lithic Types from All Excavations at Keatley Creek — Artifact Totals from Keatley Creek (EeRl7)

Type	Abbreviation	Code	Frequency	Percent
UNIFACIALLY RETOUCHED ARTIFACTS				
Scraper retouch flake with hide polish	Scraper 1	143	42	0.63
Single scraper	Scraper 2	150	472	7.09
Keeled scraper	Scraper 3	155	2	0.03
Alternate scraper	Scraper 4	156	100	1.50
"Key-shaped" unifacial scraper	Scraper 5	158	39	0.59
Inverse scraper	Scraper 6	163	162	2.43
Double scraper	Scraper 7	164	74	1.11
Convergent scraper	Scraper 8	165	33	0.50
Expedient knife, inversely retouched	Flake 1	70	224	3.37
Lightly retouched expedient knife, utilized flake	Flake 2	74	183	2.75
Flake with polish sheen	Flake 3	148	9	0.14
Expedient knife, normal retouched	Flake 4	170	558	8.38
Flake with abrupt (trampling) retouch	Flake 5	171	85	1.28
Utilized flake (General)	Ut.flk 1	180	542	8.14
Utilized flake on break	Ut.flk 2	71	83	1.25
Utilized flake on thin flake edge	Ut.flk 3	72	583	8.76
Utilized flake on strong flake edge	Ut.flk 4	73	207	3.11
Miscellaneous uniface	Misc.Unif.	157	112	1.68
"Thumbnail" scraper: classified as endscrapers in this analysis (see type 162)	Thumb scraper	161	20	0.30
Endscraper	End scraper	162	104	1.56
Piercer	Piercer	153	135	2.03
Unifacial borer	Unif.borer	152	18	0.27
Unifacial denticulate	Unif.dentic.	160	13	0.20
Unifacial knife	Unif.knife	159	2	0.03
Unifacial perforator	Unif.perfo.	151	22	0.33
Blade with one retouched edge	Blade	188	1	0.02
Notch	Notch	154	331	4.97
Small notch	Sm.notch	54	130	1.95
Dufour bladelet	Dufour	88	2	0.03
Spall tool	Spall 1	183	22	0.33
Retouched spall tool	Spall 2	184	42	0.63
Miscellaneous	Misc.	1	32	0.48
BIFACIAL ARTIFACTS				
Stage 2 biface	Biface 2	192	17	0.26
Stage 3 biface	Biface 3	193	68	1.02
Biface: Stage 4	Biface 4	131	188	2.83
Fan-tailed biface	Biface 5	139	6	0.09
Knife-like biface	Biface 6	140	167	2.51
Scraper-like biface	Biface 7	141	45	0.68
Convergent knife-like biface	Biface 8	144	16	0.24
Bifacial fragment	Bif.frag.	6	69	1.04
Distal tip of biface	Bif.tip	135	2	0.03
Biface retouch flake with hide polish	Bif.flk 1	4	3	0.05
Bifacial knife	Bif.knife	130	62	0.93
Large biface reduction flake	Bif.flk 2	8	2	0.03
Bifacial perforator	Bif.perfo.	132	11	0.17
Bifacial drill	Bif.drill	133	23	0.35
Pièce esquillée	Pièce esquillée	145	43	0.65
Miscellaneous biface	Misc.Biface	2	115	1.73
POINTS				
Preform	Preform	134	52	0.78
Point fragment	Pt.frag.	36 & 100	94	1.41
Point tip	Pt.tip	35	3	0.05
Miscellaneous points	Misc.Pts	99	2	0.03

Appendix (*continued*)

Type	Abbreviation	Code	Frequency	Percent
Side-notched point no base	Side-notch	109	146	2.19
Lehman point	Lehman	102	3	0.05
Lochnore point	Lochnore	101	16	0.24
Kamloops preform	Kamloops 0	137	66	0.99
Kamloops Side-notched point concave base	Kamloops 1	110	85	1.28
Kamloops Side-notched point straight base	Kamloops 2	111	5	0.08
Kamloops Side-notched point convex base	Kamloops 3	112	51	0.77
Kamloops Multi-notched	Kamloops 4	113	3	0.05
Kamloops Stemmed	Kamloops 5	114	7	0.11
Plateau preform	Plateau 0	136	3	0.05
Plateau Corner-notched point concave base	Plateau 1	115	18	0.27
Plateau Corner-notched point straight base	Plateau 2	116	19	0.29
Plateau Corner-notched point convex base	Plateau 3	117	19	0.29
Plateau Corner-notched point no base	Plateau 4	118	12	0.18
Plateau Basally-notched straight base	Plateau 5	119	6	0.09
Late Plateau point	Late Plat.	19	41	0.62
Shuswap base	Shuswap 1	120	5	0.08
Shuswap Contracting stem slight shoulders	Shuswap 2	121	1	0.02
Shuswap Contracting stem pronounced shoulders	Shuswap 3	122	1	0.02
Shuswap Parallel stem slight shoulders	Shuswap 4	123	5	0.08
Shuswap Parallel stem pronounced shoulders	Shuswap 5	124	1	0.02
Shuswap Corner removed concave base	Shuswap 6	125	1	0.02
Shuswap Corner removed "eared"	Shuswap 7	126	2	0.03
Shuswap Stemmed single basal notch	Shuswap 8	127	4	0.06
Shuswap Shallow side notched straight basal margin	Shuswap 9	128	4	0.06
Shuswap Shallow side notched concave basal margin	Shuswap X	129	9	0.14
CORES				
Multidirectional core	Core 1	186	88	1.32
Small flake core	Core 2	187	42	0.63
Unidirectional core	Core 3	189	2	0.03
Bipolar core	Bip.Core	146	339	5.09
Microblade core	Micro.Core	149	8	0.12
Microblade	Microblade	147	52	0.78
Core rejuvenation flake	Rejuven.	182	16	0.24
GROUND STONE				
Celt	Celt	218	5	0.08
Ornamental ground nephrite	Grnd nef.	209	1	0.02
Ground slate	Grnd slate	203	3	0.05
Groundstone maul	Maul	219	3	0.05
Grinding stone mortar	Mortar	211	1	0.02
Hammerstone	Hammerstone	190	37	0.56
Steatite tubular pipe	Pipe	204	15	0.23
Sandstone saw	Sandstn saw	202	7	0.11
Miscellaneous ground stone	Grnd stone	200	4	0.06
Abraded cobble or block	Abraded 1	207	15	0.23
Abrader	Abrader	201	61	0.92
Wedge-shaped bifacial adze	Adze	185	1	0.02
Anvil stone	Anvil stone	206	3	0.05
ORNAMENTS				
Copper artifact	Cu art.	217	2	0.03
Mica	Mica	212	12	0.18
Stone bead	Stone bead	214	2	0.03
Ochre	Ochre	210	6	0.09
Stone pendant or eccentric	Stone pend.	215	19	0.29
OTHER				
Metal artifact	Metal art.	213	5	0.08
Glass artifact	Glass art.	220	2	0.03
Ochre palette	Palette	221	3	0.05
	Total		6,659	100.00%

Chapter 13

The Formation of Lithic Debitage and Flake Tool Assemblages in a Canadian Plateau Winter Housepit Village: Ethnographic and Archaeological Perspectives

William C. Prentiss

Introduction

Studies into the formation of the archaeological record have been termed "middle range" (Binford 1977a, 1981), typically focussing on the identification of probabalistic relationships between organized behavior (as in the organization of lithic technology) and the formation of archaeological patterning. Middle range research into the formation of lithic assemblages, has utilized a largely economic approach considering factors such as the effects of raw material accessibility (Andrefsky 1994; Hayden 1989; O'Connell 1977; Wiant and Hassan 1985), activity requirements (Hayden 1989), and mobility strategies (Binford 1977b, 1979; Kelly 1988). Some recent discussion, however, has also turned to social organization, gender, and ideology as conditioning factors as well (Gero 1989, 1991; Sassaman 1992). Finally, taphonomic processes such as soil mixing, trampling, fluvial modification, and downslope movement have received attention (Cahen and Moeyersons 1977; Prentiss and Romanski 1989; Rick 1976; Shackley 1978; Turnbaugh 1978).

Probably, one of the most important areas of lithic research today stems at least in part from taphonomic studies of faunal assemblages where multiple agents and processes are recognized as contributory towards the final appearance of archaeological assemblages (cf., Behrensmeyer and Hill 1980; Binford 1981; Brain 1981). Hayden (1990) has researched the sequential effects of multiple activities on use-wear formation on single tool edges. Dibble (1987) has researched the effects of use and resharpening strategies on the morphology of individual tools. A number of researchers have initiated research into the effects of occupation span and reoccupation type and tempo on archaeological lithic assemblage composition (Camilli 1983; Ebert 1992; Wandsnider 1992).

In this chapter, I present a case study in the formation of archaeological lithic debitage and flake tool assemblages from a housepit village in the Middle Fraser Canyon of south-central British Columbia. The ethnographic data (Vol. II, Chap. 2; Teit 1900, 1906, 1909) are used to develop a model of winter household occupation focussing on the sequence of processes occurring during a given winter period leading to the formation of lithic assemblages. I then examine the debitage and flake tools from the floor of a large housepit at the Keatley Creek site from the Middle Fraser Canyon in order to explore the possibility that similar formation processes occurred during the winter occupation of Late Prehistoric winter housepit villages. The debitage and flake tool analysis relies on pattern recognition criteria derived from utility index based mathematical models of assemblage composition (Prentiss 1993). Essentially, this approach allows the effects of multiple sequential processes on flake tool and debitage assemblage composition to be explored experimentally. Archaeological data can then be interpreted with the aid of the experimental models. Conclusions of the study are similar to those of Dibble (1987) and Hayden (1990), in that I argue for increased attention not only to the effects of individual agents (trampling, reduction strategy, etc.), but also for increased consideration of formation sequences.

This study is important to the goals of the Fraser River Investigations into Corporate Group Archaeology project for several reasons. First, it reconfirms some of the basic lithic strategies (block core, bifacial reduction, bipolar reduction) proposed and discussed by others using independent criteria (see Vol. I, Chap. 12; Vol. II, Chap. 11). Second, it reconfirms much of the basic activity patterning across living floors using debitage analysis, and hence it also reconfirms inferences concerning basic socioeconomic organization in HP 7. Third, this study helps document aspects of site formation processes concerning lithics, not dealt with by other studies, in particular trampling and recycling. These aspects assist in the modeling of the lithic economy at the site, help explain the overall similarities between deposit types, and also help identify high versus low traffic or activity areas.

Risk Management, Mobility, and Activities

The Upper Lillooet and the Canyon Division Shuswap utilized a wide range of tactics for reducing risk, or the potential for shortage or a loss of resources (Winterhalder 1986) including territoriality, resource sharing, socio-political organization, potlatching, trade, warfare, mobility and technology, and storage (Hayden 1992a). Most notably, these people relied on a strategy of intensive storage, logistically organized resource collecting, a biseasonal pattern of winter sedentism and spring, summer and fall mobility (Alexander 1992b), and a relatively complex technology (Teit 1906, 1909). These groups are also known for a fair degree of socio-political complexity with ownership and control of certain critical resources by individual bands and high ranking families (Romanoff 1986, 1992; Teit 1906:254), slavery (Teit 1906:264), household crests (Teit 1906:256), and extensive trade and warfare controlled by community leaders (Cannon 1992; Hayden 1992a, b; Teit 1909:576). Most critical for understanding archaeological assemblages produced by winter housepit occupations are the roles of mobility and technology, corporate group organization (cf., Hayden et al. 1985), and labor organization.

Kelly (1983) has drawn a distinction between the mobility strategy and the seasonal round, noting that while the seasonal round refers to the geographic movement of people, the mobility strategy refers to the decision making process behind residential group and task group movement. Mobility strategies in the Middle Fraser Canyon were organized in a logistical fashion (cf., Alexander 1980) being seasonably sedentary in winter villages.

At winter villages, Teit's ethnographic descriptions and Alexander's broader analysis (Vol. II, Chap. 2) indicate a primary focus on wood-working and hide-working using tools such as chisels, carving-knives, scrapers, and arrow smoothers for wood-working and knives and scrapers for working hides. It is assumed that lithic reduction was most typically oriented towards making tools for these purposes. The situation of intensive lithic tool use and possibly production, oriented towards production of other more complex tools, clothing, and shelter, probably occurred most commonly during the winter "down" time (cf., Vol. I, Chap. 12; Binford 1979; Bleed 1986). It was also at this time that lithic resources were most inaccessible due to snow and ice cover and difficult travelling conditions. Given this situation, it is likely that raw material stockpiling was practiced, perhaps in a somewhat similar way to that described by Parry and Kelly (1987) and as argued in the preceding chapter. If raw material stockpiling did occur in this fashion, then it most likely was accomplished by production and storage of cores and various sizes and shapes for use in producing tools throughout the winter months. Following Goodyear (1989), I also suggest that bipolar reduction strategies could have been a useful late winter activity for extending raw material use-life. During longer winters this strategy may have been common, particularly when combined with strategies for intensive reuse of tools and scavenging and reuse of discarded tools.

A Model of Lithic Assemblage Formation Processes for Middle Fraser Canyon Winter Housepit Villages

The composition and spatial organization of lithic artifact assemblages are expected to have been affected by three types of processes: lithic reduction and tool use/discard strategies, the spatial positioning of activities on the housepit floor, and taphonomic processes. The sequence of individual agents and events operating across a winter's occupation are considered to be the responsible factors governing housepit floor lithic assemblage formation. There may also be effects from reoccupations through different winter periods on the same floor. I consider these effects within the lithic reduction and taphonomic processes categories. All conclusions and predictions are drawn or extrapolated from the Middle Fraser Canyon ethnographic record.

Lithic Reduction, Tool Use, and Discard

Lithic reduction strategies are expected to have been most affected by economic considerations related to raw material conservation, immediate tool needs and expected future tool needs. If access to lithic raw materials is substantially reduced or eliminated, one would expect to see an increasing focus on raw material conservation. This might be indicated by higher degrees of edge preparation during core reduction, coupled with salvaging of flakes from exhausted tools and cores using bipolar techniques. In this fashion, flake tools might continue to be used, but in a more curated fashion. This could be indicated by more intensive resharpening of some tools and reuse for new purposes of other previously discarded tools. Archaeological assemblages resulting from this process would contain a range of heavily retouched and broken, but minimally retouched flake tools. On initial inspection, these assemblages could appear to represent largely expedient tool use, while the actual formation process may have been far more complex with some tools undergoing curated use and many others used expediently on multiple occasions (or serial expedient use). Teit's descriptions of a range of different types of specialized flake tools indicates that this could be likely.

The selection and use of flakes (or flake culling from debitage assemblages) can be predicted to have operated in three fashions. First, reoccupation of old house floors may have resulted in scavenging of flakes produced during earlier occupations. Second, lithic reduction likely focussed on production of primary flakes for either curated or expedient use. Thus flake culling focussed initially on those flakes, which were probably larger with either high or acute edge angles, depending on needs. Flakes culled for hafting and exceptionally long use probably had edge angles that facilitated further reduction and shaping. Third, specialized tool needs and late winter raw material shortages probably encouraged people to intensively use secondary biproducts of the reduction process. These are broken flakes resulting from accidental breakage of either primary or platform preparation flakes.

"Gearing up" is expected to have been an extremely important activity, particularly during late winter. Lithic reduction activities are expected to have focussed on production of flakes for use in manufacturing and repairing other gear. Some specialized lithic tools are expected to also have been manufactured at this time for use during spring hunting and gathering activities. Some of these included bifacially flaked projectile points, processing knives, and scrapers.

To summarize lithic reduction and tool use/discard processes, I argue that the primary goal of chipped stone technology in the Middle Fraser canyon was for the production and maintenance of other organically based tools including arrows, spears, traps, nets, digging sticks, baskets, and hide bags and clothing. A substantial amount of manufacture and maintenance of these items was conducted during the period of winter sedentism. An important, though secondary goal (in terms of raw material quantity used) was in production of lithic tools to be used as personal gear during hunting and gathering activities after winter-village abandonment in the spring. This required enough lithic materials to be available for continuous use over a period of at least three months. This was accomplished by stockpiling raw materials in the form of cores in winter housepits during the fall and second, by producing specialized flake tools for curated and serial expedient use during this period. Late winter shortages were dealt with using bipolar reduction techniques to salvage additional flakes from exhausted cores and worn out bifacial and flake tools.

Spatial Organization

The spatial associations between lithic artifacts on housepit floors is expected to be the result of a number of factors related to the spatial positioning of domestic (family) units, the social status of those families, the organization of activities on housepit floors, and any clean-up activities undertaken. It is expected, that unless modified by taphonomic processes or clean-up activities that the effects of social and activity organization will be recognizable on winter housepit floors. Clean-up activities are discussed further along with taphonomic processes below.

Teit (1909:492) described the interior spatial organization of Thompson and Shuswap winter houses as having four major "rooms." The "head" or "upper room" was located closer to uplands outside of the house. The "kitchen" or "storeroom" was located on the side of the house closer to water, opposite the upper room. The third area was called the "under-room" or the space under the ladder by which one entered the house from the roof. Finally, the space opposite the ladder was termed the "bottom room." In houses large enough to contain multiple families, individual family or domestic units were distributed around the walls with storage, work, cooking, and sleeping space set behind a prominant "fireplace" (Teit 1906:214). Though Teit's (1906) description is for a Lillooet wooden longhouse, it seems likely that a similar arrangement would have been practiced in larger housepits during earlier times.

By combining Spafford's analysis of stone tool occurrences across housepit floors (Vol. II, Chap. 11) together with Teit's various descriptions of winter residences it is possible to arrive at a composite picture of potential spatial organization of larger winter housepit floors, where multiple families may have wintered (particularly among larger co-resident corporate groups; Hayden and Cannon 1982; Hayden et al. 1985). In roughly the center of the floor existed the "under-room" containing the ladder and immediately surrounding space, perhaps also used by occupants moving between different parts of the house. The surrounding space adjacent to the walls was likely filled by domestic units, each with associated hearths and storage areas. If Teit's descriptions of the kitchen room are applicable here, then domestic units may have concentrated most intensively on the river-side of the house. The opposite or upland side of the house may have contained domestic units as well, depending upon population size, but it may also have housed special activity areas. Certainly space was required for some of the intense winter activities associated with gearing up for spring which might have included relatively intensive working of wood and bone and production and regular use of substantial numbers of stone tools.

Some effects of gender and status on

may be recognizable on winter housepit floors. Family social status could potentially have effects on lithic assemblage content through differences in the intensity of certain activities. Teit (1900, 1906, 1909) has documented substantial variability in status and ownership of property ranging from higher status families flush with high quality deer hide clothing and deer meat for food to lower status, poorer members of communities with only sagebrush bark clothing, salmon skin shoes, and limited food resources often resulting in "mooching" from other families and individuals (Romanoff 1992). Following Hayden (1990), it is expected that higher status families would produce more evidence for hide working in particular, perhaps as indicated by more numerous discarded hide working tools such as hide scrapers and piercers. Gender based differences in activities could also be recognizable. Traditionally female oriented activities such as food preparation and clothing manufacture may also be expected to have produced slightly different lithic assemblages from those of men, which consisted of tool and weapon manufacture (Teit 1900:295–296). It seems likely, however, that both men and women produced lithic tools, perhaps with women's lithic tools typically more expedient in nature and men's more durable and curated (Gero 1991; Sassaman 1992). At least one exception to this would be hide scrapers which were made for longer term, more intensive use by women.

To summarize some of the effects socio-political and activity organization on housepit floors, it is expected that regularly spaced domestic areas around the walls of the house would produce lithic assemblages which varied in terms of male versus female activities. From a spatial perspective, female activities might be more prominant around hearths and food storage areas, while male activities might be somewhat removed from these places, perhaps adjacent to sleeping areas near the walls or in special activity areas away from domestic areas entirely, as in the "upper" room opposite the "kitchen" room. Female activities, other than hide working, may have produced more flake tools and by proxy a greater degree of tool recycling and serial expediency, while male activities may have produced more robust and somewhat more intensely used and curated lithic tools. It is likely that men and women produced stone tools. Status differentiation is more difficult to recognize, perhaps best reflected by variability in manufacture of status related items such as deer hide clothing and ornamental items such as dentalium jewelry. The central portion of the house, below the ladder, may have had few activities in walking areas, though there could be expected to have been public work areas as well for situations where more space was needed. Thus, central portions of houses could be expected to contain lithic assemblages ranging from very sparse to dense and complex, depending upon activity intensity and variability.

Taphonomic Processes

The formation of housepit floor lithic assemblages is also expected to have been affected by taphonomic processes associated with human behavior such as trampling, sweeping, and burning. Middle Fraser Canyon winter housepits are thought to have been occupied by relatively high numbers of people often through a period of several months (Hayden 1992a, b; Teit 1900). As lithic reduction and tool use was probably a commonly practiced activity throughout the housepit, I expect that trampling of lithic artifacts was an equally common activity. Areas of reduced foot traffic could be the only locations exempt from trampling. Some of these areas might include floor margins, particularly under benches, immediately adjacent to posts or groups of posts, and in fireplaces used throughout the winter.

Some fireplaces may have received intermittent use, leaving open the possibility of containing trampled lithic artifacts. Some limited crushing of lithic artifacts may also have occurred during roof collapse.

Reoccupation of housepits used during previous winters is expected to have been preceded by some degree of floor cleanup. Thus, in many instances, floors may have been swept or even shovelled out to create an uncluttered, cleaner living surface for the inhabitants moving in for that particular winter. This process is expected to have removed many if not all lithic items, except possibly some micro- or meso-debitage. During the winter occupation, it is possible and perhaps likely that some degree of cleanup may have occurred, producing areas of swept-up lithic items. This process may also have resulted in dumps of lithics in pits, inside or outside of the house, not being used for food storage.

A final agent, potentially responsible for modifying lithic artifacts, may have been fire. Certainly lithic reduction occurred adjacent to fireplaces or hearths within the floor. Items falling into fires may have become heated resulting in thermal fracturing such as potlid and crenated fractures (Purdy 1975). The burning of old housepit roofs may also have created enough heat on some occasions to fracture previously discarded lithic debitage and tools.

Summary

The formation of housepit floor lithic assemblages is expected to be affected by a sequence of behavioral and taphonomic processes. It is likely that both biface and core reduction was practiced on Middle Fraser Canyon housepit floors with biface reduction oriented both towards production of small specialized flakes for tool-use and towards production of more specialized bifacial tools (knives and projectile points; cf., Kelly 1988). Core reduction is expected to have been oriented entirely towards flake production for tool-use. Many tools may also have been acquired through scavenging of available flakes and previously discarded tools. This and bipolar reduction of previously exhausted tools and cores may have become increasingly common during late winter occupation of housepits. Spatial associations of tools and flakes may have been greatly affected by the organization (perhaps gender-based) of a variety of activities ranging from food and clothing preparation to tool and equipment manufacture. The spatial organization of individual domestic units may also have affected lithic artifact assemblages, particularly in association with hearths. A variety of taphonomic processes may also have affected lithic assemblages. Trampling, in particular, is expected to have been common on crowded housepit floors.

Lithic Debitage and Flake Tool Assemblage Formation at the Keatley Creek Site

The large and diverse lithic assemblage excavated from the floor of HP 7 provided the ideal opportunity to study winter housepit floor lithic assemblage formation processes in the Middle Fraser Canyon. Excavations at HP 7 have defined a distinctive compact floor containing numerous post-holes, hearths, and storage pits (Vol. II, Chap. 11 and Vol. III Chap. 5). Research in HP 7 has focussed on identifying the locations of domestic and gender specific work areas on the house floor (Vol. II, Chap. 11). To date, a fair degree of success has been achieved. Spafford has defined a minimum of three primary domestic areas (located in the west-northwest, south, and east-northeast portions of the floor) and two probable gender specific work areas (female oriented activities in the central portion and male activities around the margins). Additional variability in artifact contents through these areas has led Spafford to argue that HP 7 was more complex in its internal arrangements than some of the other excavated housepits (i.e., HP 3 and HP 12). He has suggested that it may have been occupied by a multi-family residential corporate group, as opposed to a lower status extended family.

My research at HP 7 is complementary to that of Spafford. My primary intent is to evaluate the effects of the formation processes defined above (i.e., lithic tool production and use, spatial organization of activities, and taphonomic processes). I focus specifically on identifying the sequence of processes responsible for assemblage patterning across the floor of the house. I draw conclusions regarding the role of lithic technology in risk management strategies of the prehistoric occupants of the house. I also evaluate Spafford's conclusions regarding domestic areas and gender based organization of labor in light of these data.

Though many lithic raw material types were found on the floor of HP 7, the most common type was vitreous trachydacite (often referred to as vitreous basalt). This raw material type was used exclusively in this study in order to facilitate a "distinctive assemblage" approach to recognizing patterning in debitage and flake tool assemblages (cf., Sullivan and Rozen 1985). A more complex version of Sullivan and Rozen's (1985; Sullivan 1987) debitage typology, referred to as the Modified Sullivan and Rozen Typology (MSRT) was utilized as the basic instrument for gathering data and drawing conclusions on assemblage formation (Prentiss 1993). Pattern recognition was facilitated using experimental utility index data (Prentiss 1993).

Analytical Methods

For analytical purposes, a distinction was made between subsquares, analytical units, and analytical sectors. Ideally each of the 16 subsquares per excavation square would have been considered independently in the analysis. Unfortunately, flakes were not common enough on the floor to allow each subsquare to be considered in this manner. Thus, a grouping strategy was used. First, the floor was divided into 102 analytical units and 13 sectors, using Spafford's (1991) density significant sectors (Figs. 1 and 2). I added two additional sectors to the east side of the floor to segregate the bench from the floor areas. With few exceptions, each analytical unit was defined as four subsquares (1 m^2). Occasionally, three or five subsquares had to be used as an analytical unit to fit within each sector. Another complicating factor involved the placement of analytical units over features and adjacent to features such that a single unit was located either nearly entirely over or off of a feature. The purpose of this was to examine the contents of areas of significantly different densities and feature associations independently, assuming that different processes may have affected their formation. Analytical units were used to defined debitage assemblages for multivariate analysis, while sectors were used to define flake tool assemblages.

Both unmodified flakes and flake tools were sorted into MSRT flake types. The MSRT was chosen over the original five flake type Sullivan and Rozen (1985; Sullivan 1987) debitage typology (SRT: complete and split flakes, and proximal, medial-distal, and nonorientable flake fragments) due to the fact that in a reliability and validity analysis, the SRT failed to demonstrate substantial differences in debitage assemblage composition between tool production and core reduction, while the MSRT was able to segregate a wide range of reduction strategies and taphonomic effects (Prentiss 1993). The success of the MSRT led to the development of utility indices for use in conjunction with the MSRT for creating mathematical models of debitage assemblage formation processes (Prentiss 1993). Results of the modelling sequences are used to aid in the recognition of patterning in archaeological debitage assemblages from Keatley Creek.

Flake tools were defined as those flakes with evidence for use and/or modification in the form of retouched edges. Formal tools such as bifaces and end scrapers were not considered. The key to sorting flake tools into Sullivan and Rozen's flake types was to look closely at margin characteristics. Minimally retouched edges without evidence for fracturing were considered to be intact margins. Heavily abruptly retouched edges were considered not to be intact. For example, flakes with lightly retouched distal margins, which were clearly intact before modification were defined as complete. Flakes with invasive retouch, with margins which appeared to be intact before modification were

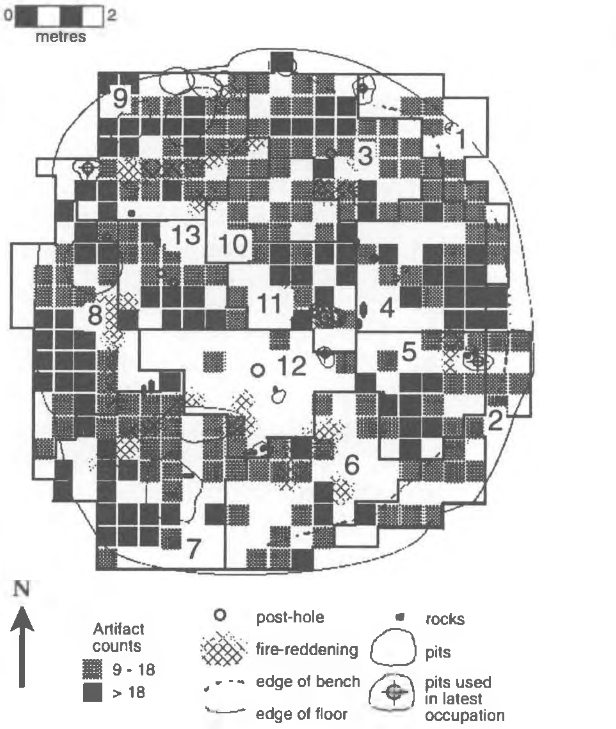

Figure 1. Housepit 7 floor artifact density and sector distribution (adapted from Spafford 1991).

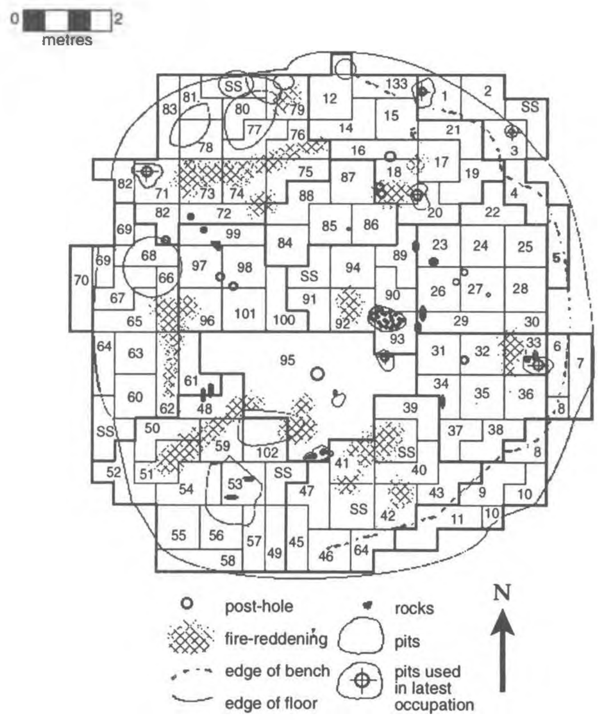

Figure 2. Division of analytical units on the floor of HP 7.

also defined as complete. Flakes with intensively abruptly retouched distal margins were defined as proximal, as they may have started with broken edges. Occasionally, platforms were partially removed to produce more working edge or to facilitate hafting. Where it was clear that the platform had been removed after production of the flake itself, the flake was defined as platform bearing and categorized into the complete or split flake, or proximal fragment types, depending upon margin characteristics. Approximately 95% of the flake type identifications from flake tools were accomplished unambiguously, as marginal retouch was typically minimal. In more difficult cases, strict adherence to these typological rules was followed.

All raw MSRT data were rescaled to facilitate multivariate analysis. Because of the large size of the tables containing these data, they are not reproduced here, but can be consulted in Prentiss (1993). I have found this scale to be extremely useful in allowing a close look at differences in the proportions of flake types present while eliminating problems resulting from assemblages with different sized flake counts. It also allows direct comparisons between archaeological MSRT distributions and experimental and modelled MSRT distributions. These distributions also require less data transformation for multivariate analysis than do chi-square scores (Binford 1989), or log transformations (Draper 1985) and the analyst remains closer to the raw data. In other words, by looking at rescaled data, the analyst is actually interpreting distributions which are closer to raw data than that of heavily transformed data sets. This produces fewer errors in interpretation (Jack Nance, personal communication).

The complex data matrices were analyzed using principal components analysis (see Prentiss 1993 for details). The interpretation of each analytical unit debitage assemblage (represented as cases in the principal components analysis) was accomplished by first gaining an understanding of the basic dimensions of variability in the data set as a whole. This process involved a thorough review of the rotated loadings matrices. Factor scores allowed an assessment of the contribution of each case to each factor (Prentiss 1993).

I employed debitage utility index data to enhance the interpretation of debitage and flake tool assemblage variability in a similar fashion to that of Binford (1981), Speth (1983), and Todd (1987), who used Binford's (1978) utility indices to enhance interpretations of faunal data (Prentiss 1993). Archaeological MSRT distributions were compared to two types of utility index distributions: utility indices and utility index residual models (Prentiss 1993). Utility index data reflect the potential utility of a class of flakes (i.e., complete flakes) within a given reduction strategy and when rescaled, can serve to anticipate the composition of culled flake or flake tool assemblages. Three utility indices were developed: the Flake Volume Index (FVI) measures overall flake size; the Acute Angle Edge Length (AAEL) index measures available flake edge with low edge angle, as might be useful in cutting activities; and the High Angle Edge Length (HAEL) index measures available flake edge with high edge angle, as might be more useful in scraping, planing, or engraving activities. Residual models simulate the contents of debitage assemblages previously culled for certain classes of flakes as predicted by the utility indices (see Prentiss 1993).

Debitage distributions were compared to trampled and untrampled reduction assemblage data and residual models in order to recognize reduction strategies and flake removal or culling strategies. In situations of very complex potentially mixed debitage assemblages, further mathematical sequences were developed to better understand the processes responsible for the patterning. Flake tool distributions were compared to trampled and untrampled utility index data in order to evaluate origins of these assemblages through reduction strategies and culling decisions. The formation of flake tool assemblages was assumed to be a complex process depending on the sequential effects of a number of processes including flake production technique, culling decisions, use, breakage, discard, trampling, scavenging, and reuse. The goal of this analysis was to identify as closely as possible, the sequence of processes affecting the formation of flake tool assemblages on the floor of HP 7. This required the construction of additional mathematically derived sequences designed to demonstrate the effects of multiple processes on basic utility index data sets (Prentiss 1993).

Analysis

I briefly review the results of both principal components analyses in order to focus the remainder of the paper on the results and implications of this study. Details regarding the interpretation of the individual data sets, including further MSRT utility index modelling and pattern recognition are found in Prentiss (1993).

The principal components analysis of debitage from the HP 7 floor produced six significant factors (eigenvalues greater than 1.00). Factor one emphasized medium size medial-distal fragments and small complete and split flakes in its positive dimension. No significant negative loadings were present (Prentiss 1993). Using factor scores to identify cases contributing to the factor solution, assemblages with high positive factor scores (> 1.0) from factor one were attributed to hard hammer reduction of prepared cores with acute edge angle flake culling (AAEL model) and trampling (Table 1). Cases with high negative dimension factor scores were considered to be the result of prepared block core reduction, trampling and culling for larger acute edge angle flakes (FVIxAAEL model). Some additional high scoring cases were also attributable to other processes better considered in relation to other factors.

Significant positive loadings from factor two were found only on small medial-distal fragments, while significant negative loadings were found on small and medium proximal fragments. As small medial-distal fragments are commonly produced in most lithic debitage assemblages, the negative dimension of this factor was considered most worthy of detailed consideration. Cases with strong negative factor scores were interpreted as the result of tool edge resharpening/modification with the possibility of biface reduction present as well, associated with acute edge angle flake culling and some trampling (Table 1).

Factor three produced significant positive loadings on large proximal fragments and medium nonorientable fragments. No significant negative loadings were produced. Factor three cases were attributed to associations between biface and block core reduction, and bipolar core reduction. All assemblages appear to have been culled for acute edge angle flakes and in a few cases high edge angle flakes. All were trampled, though some appear to have been trampled before bipolar reduction and associated flake culling occurred.

Factor four contained significant positive loadings on large complete flakes and significant negative loadings on small split flakes. High positive factor score cases were interpreted as minimally or unculled, trampled, prepared block core reduction assemblages. High negative factor score cases appear to have been heavily size sorted either through intensive larger flake culling or through cleanup, sweeping, and/or trampling.

Factor five produced significant positive loadings on large medial-distal fragments and medium split flakes. High factor score cases are not unique to this analysis focussing on trampled prepared core reduction.

Factor six contained significant positive loadings on medium complete flakes and proximal fragments and small complete flakes and nonorientable fragments. These are the flake types most modified by trampling (Prentiss 1993; Prentiss and Romanski 1989), indicating that factor six was a trampling factor. Most strongly patterned positive dimension cases were attributable to a lack of trampling, while those strongly patterned in the negative dimension were likely to have been trampled heavily (Table 1).

Principal components analysis of the *flake tool* MSRT data produced a five factor solution. Factors four and five are not considered here as their results are redundant with those of factors one through three. Interpretation of each factor was difficult and required construction of additional utility index modelling sequences to aid in understanding the sequence of formation processes (Prentiss 1993).

Factor one produced significant positive loadings on large medial-distal and medium proximal and medial-distal tool fragments, while high negative loadings were produced on small nonorientable tool fragments and split flake tools. As the significant positive dimension loadings are common to almost all cases, it was considered to be of limited usefulness in recognizing variability. A consideration of the negative dimension revealed two potential sequences of assemblage formation processes. The first consisted of the production of flake tools from prepared core reduction flakes culled for larger size and acute edge angles. Following a short period of use, these tools were discarded and subsequently culled from their discard contexts for additional use. Final discard found the original tools in much more damaged states due to intensive use, modification, and trampling (cases/sectors 3 and 4; Prentiss 1993). The second sequence of possible formation processes for the negative dimension of factor one appears to have been the result of a greater degree of larger tool curation. Essentially, smaller tools appear to have been much more intensely trampled than larger tools suggesting the possibility that they represent tools more quickly discarded, either through very short-term use and/or through discard of fragments of larger more curated tools (cases/sectors 1 and 2; Prentiss 1993).

Factor two contained significant positive loadings on large medial-distal tool fragments, medium nonorientable tool fragments, and small proximal tool fragments. Cases contributing strongly to factor two were interpreted as the result of a similar process as in factor one (intensive use, trampling, and reuse of prepared core reduction flake tools with acute edge angles), with the addition of discarded acute and high edge angle flakes from bipolar core reduction (cases/sectors 5, 10–13; Prentiss 1993).

Factor three produced significant positive loadings only on small medial- distal fragments. Like factor one, factor three aided in the recognition of two patterns of flake tool assemblage formation. The first, appeared to have resulted from a combination of intensive prepared core and biface reduction flake tool use, discard, trampling, and reuse (cases/sectors 6, 7, and 9). The second pattern was again related to larger tool curation with intensive trampling of smaller flake tools (case/sector 8; Prentiss 1993).

Table 1. Interpretation of Debitage Assembly Modifications by Subsquare Cases

Case	Interpretation
1	Tr., Prep. Core Reduction, FVIxAAEL type cull
2	Tr., Bipolar and Prep. Core Reduction, HAEL type cull
3	NT., Prep. Core Reduction, No cull
4	Tr., Prep. Core Reduction, FVIxAAEL type cull
5	NT., Prep. Core Reduction, FVIxAAEL type cull
6	Tr., Biface Reduction, AAEL type cull
7	Tr., Prep. Core Reduction, HAEL type cull
8	Tr., Prep. Core Reduction, FVIxAAEL type cull
9	Tr., Prep. Core Reduction, HAEL type cull
10	Tr., Prep. Core Reduction, FVIxAAEL type cull
11	Tr., Prep. Core Reduction, FVIxAAEL type cull
12	Tr., Prep. Core Reduction, FVIxAAEL type cull
13	Tr., Prep. Core Reduction, FVIxAAEL type cull
14	Tr., Prep. Core Reduction, FVIxAAEL type cull
15	NT., Prep. Core Reduction, No cull
16	Tr., Prep. Core Reduction, FVIxAAEL type cull
17	Tr., Resharp. and Biface Reduction, AAEL type cull
18	Tr., Prep. Core Reduction, FVIxAAEL type cull
19	Tr., Prep. Core Reduction, FVIxAAEL type cull
20	Tr., Prep. Core Reduction, FVIxAAEL type cull
21	Tr., Bipolar and Prep. Core Reduction, FVIxAAEL cull
22	NT., Prep. Core Reduction, HAEL type cull
23	NT., Prep. Core Reduction, HAEL type cull
24	Tr., Prep. Core Reduction, FVIxAAEL type cull
25	Tr., Prep. Core Reduction, FVIxAAEL type cull
26	Tr., Prep. Core Reduction, FVIxAAEL type cull
27	NT., Prep. Core Reduction, HAEL type cull
28	Tr., Prep. Core Reduction, FVIxAAEL type cull
29	Tr., Prep. Core Reduction, FVIxAAEL type cull
30	Tr., Prep. Core Reduction, FVIxAAEL type cull
31	Tr., Prep. Core Reduction, FVIxAAEL type cull
32	Tr., Prep. Core Reduction, FVIxAAEL type cull
33	Tr., Prep. Core Reduction, FVIxAAEL type cull
34	Tr., Prep. Core Reduction, FVIxAAEL type cull
35	Tr., Prep. Core Reduction, FVIxAAEL type cull
36	Tr., Prep. Core Reduction, FVIxAAEL type cull
37	Tr., Biface Reduction, AAEL type cull
38	Tr., Prep. Core Reduction, FVIxAAEL type cull
39	Tr., Biface Reduction, No cull
40	Tr., Resharp. No cull.
41	Tr., Prep. Core Reduction, SS or HAEL+AAEL cull
42	Tr., Prep. Core Reduction, No cull
43	Tr., Prep. Core Reduction, FVIxAAEL type cull
44	NT., Prep. Core Reduction, HAEL type cull
45	Tr. (minor), Biface Reduction, AAEL type cull
46	Tr., Prep. Core Reduction, FVIxAAEL type cull
47	Tr., Prep. Core Reduction, FVIxAAEL type cull
48	Tr., Prep. Core Reduction, FVIxAAEL type cull
49	Tr., Prep. Core Reduction, SS or HAEL+AAEL cull
50	Tr., Prep. Core Reduction, HAEL type cull
51	Tr., Prep. Core Reduction, FVIxAAEL type cull
52	Tr., Resharp. and Biface Reduction, No cull
53	Tr., Prep. Core Reduction, HAEL type cull
54	Tr., Biface Reduction, AAEL type cull
55	NT., Prep. Core Reduction, No cull
56	Tr., Prep. Core Reduction, FVIxAAEL type cull
57	Tr. (minor), Biface Reduction, no cull
58	Tr., Prep. Core Reduction, no cull
59	Tr., Prep. Core Reduction, HAEL type cull
60	Tr., Prep. Core Reduction, FVIxAAEL type cull
61	Tr., Prep. (FVIxAAEL cull), Bipolar (HAEL) reduct.
62	Tr., Biface Reduction, AAEL type cull
63	Tr., Prep. Core Reduction, FVIxAAEL type cull
64	Tr., Prep. Core Reduction, no cull
65	Tr. (minor), Biface Reduction, AAEL type cull
66	Tr., Prep. (FVIxAAEL cull), Bipolar (HAEL) reduct.
67	Tr., Bipolar and Prep. Core Reduction, no cull
68	Tr., Prep. Core Reduction, FVIxAAEL type cull
69	Tr., Prep. Core Reduction, FVIxAAEL type cull
70	Tr., Prep. Core Reduction, FVIxAAEL type cull
71	NT., Resharp. and Biface Reduction, HAEL cull
72	Tr., Prep. Core Reduction, FVIxAAEL type cull
73	Tr., Prep. Core Reduction, FVIxAAEL type cull
74	Tr., Prep. Core Reduction, HAEL type cull
75	Tr., Prep. Core Reduction, FVIxAAEL type cull
76	Tr., Prep. Core Reduction, FVIxAAEL type cull
77	Tr., Prep. Core Reduction, FVIxAAEL type cull
78	Tr., Prep. Core Reduction, FVIxAAEL type cull
79	Tr., (minor) Biface Reduction, AAEL type cull
80	Tr., Prep. Core Reduction, FVIxAAEL type cull
81	NT., Prep. Core Reduction, HAEL type cull
82	NT., Biface Reduction, No cull
83	Tr., Prep. Core Reduction, FVIxAAEL type cull
84	Tr., Prep. Core Reduction, FVIxAAEL type cull
85	Tr., Prep. Core Reduction, FVIxAAEL type cull
86	NT., Prep. Core Reduction, No cull
87	NT., Prep. Core Reduction, HAEL cull
88	Tr., Resharp, No cull
89	Tr., Prep. Core Reduction, no cull
90	Tr., Prep. Core Reduction, no cull
91	Tr., (minor) Biface Reduction, AAEL type cull
92	Tr., Prep. Core Reduction, FVIxAAEL type cull
93	Tr., Prep. Core Reduction, SS or HAEL+AAEL cull
94	Tr., Prep. Core Reduction, FVIxAAEL type cull
95	Tr., Prep. Core Reduction, FVIxAAEL type cull
96	Tr., (minor) Biface Reduction, AAEL type cull
97	Tr., Bipolar and Biface Reduction, AAEL cull
98	Tr., (minor) Biface Reduction, AAEL type cull
99	Tr., Prep. Core Reduction, FVIxAAEL type cull
100	Tr., Resharp, No cull
101	Tr., (minor) Biface Reduction, No cull
102	Tr., Biface Reduction, AAEL cull

Tr = trampled; NT = non-trampled; SS = small sample; HAEL = High Angle Edge Length; AAEL = Acute Angle Edge Length; FVI = Flake Volume Index. Spatial Patterning in Lithic Reduction, Flake Culling, and Trampling.

Following a complete interpretation of the principal components analyses, spatial patterning of lithic reduction and culling activities and trampling was explored by plotting the results across the floor of HP 7.

Cases interpreted to be the result of tool edge resharpening or other minor modification were located almost entirely adjacent to hearth features (Fig. 3). Cases interpreted to be the result of biface reduction also cluster tightly around hearths (Fig. 4). Prepared core reduction is ubiquitous on the floor (Fig. 5). Several areas adjacent to hearths have been least affected by prepared core reduction. It is important to realize here that some core reduction (and other reduction types) overlaps may occur in units not identified as primarily the result of this technology. As interpretations are based on flake breakage and size distributions it is inevitable that minute inputs from other reduction types will not be recognized.

Bipolar core reduction occurs intensely in two restricted areas, the northeast corner and the west-central side of the floor (Fig. 6). An independent analysis of bipolar reduction flakes has identified some bipolar flake clustering as well in the northwestern part of the floor, though not enough to pattern strongly in this analysis (Prentiss 1993). Bipolar reduction overlaps with prepared core reduction on the northeast side and biface and prepared core reduction on the west side.

Trampling is common throughout the floor with some significant exceptions (Fig. 7). Untrampled areas tend to be located where post-holes are dense, in some hearth areas, and along walls. This is to be expected as these are the types of places least likely to receive foot-traffic. Lack of trampling in some hearth areas may indicate continuous use or designation of that location as a place not to be stepped on. Presence of trampling in other hearth areas may indicate discontinuous reuse of those places.

Culling for acute edge angle flakes from biface and prepared core reduction is found throughout the floor (Fig. 8). Culling for high edge angle flakes is found in the southwest, northeast, and northwest corners of the house floor (Fig. 9). Cases without indications of culling behavior are found primarily against walls or in clusters of post-holes (Fig. 10). Exceptions to this pattern are found in the southeast corner and in the west-central portion of the floor. One of these is a maintenance assemblage which would have been of little value to the prehistoric inhabitants of the housepit due to the small size of the products. The other is harder to explain as it is the result of biface reduction. In this case, the primary goal of reduction may have been the biface, not the flakes.

The results of the flake tool analysis presented a spatial pattern of flake tool discard closely paralleling that of the debitage. Cases (sectors) 1–3, and 4 were

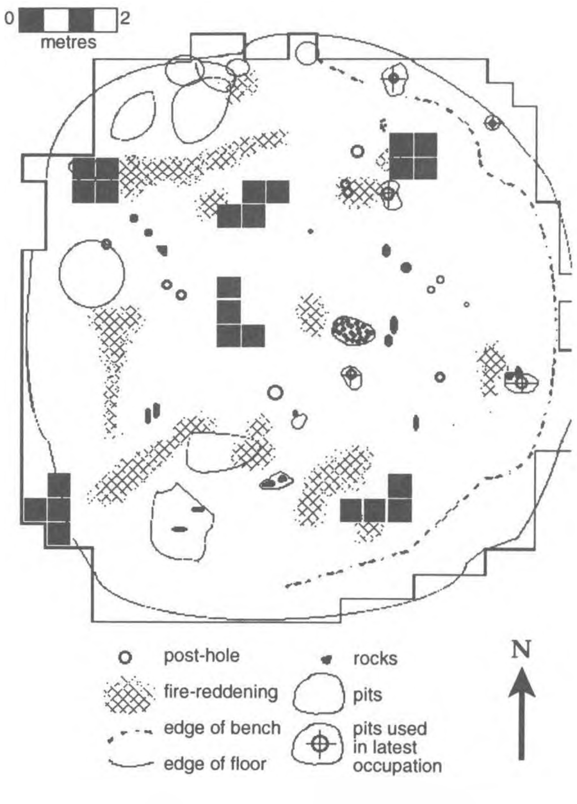

Figure 3. Distribution of analytical units interpreted to be associated with tool maintenance/resharpening.

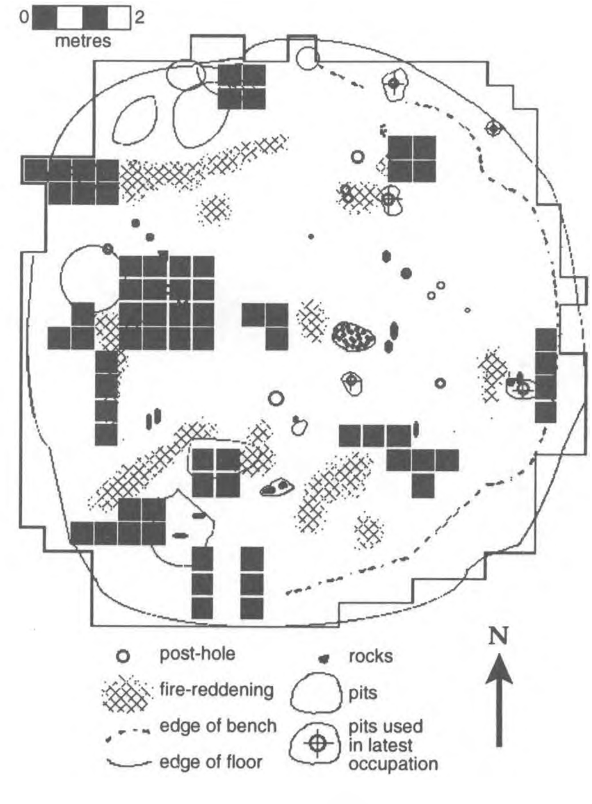

Figure 4. Distribution of analytical units interpreted to be associated with biface reduction.

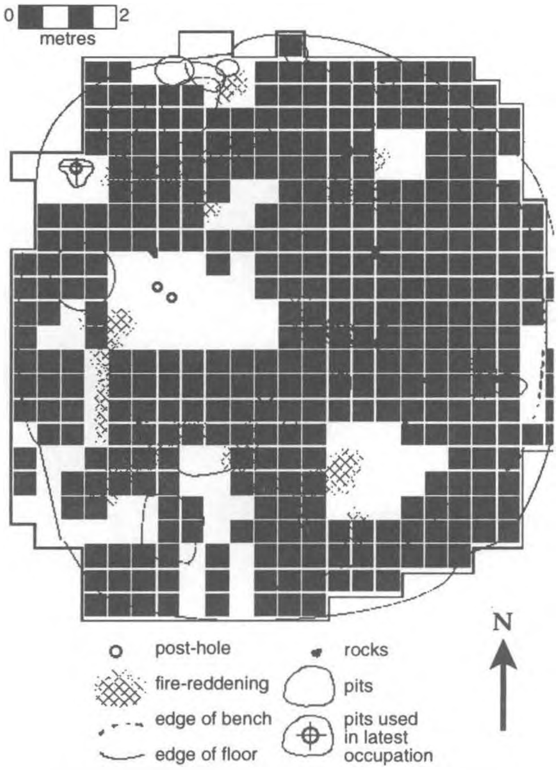

Figure 5. Distribution of analytical units interpreted to be associated with prepared core reduction.

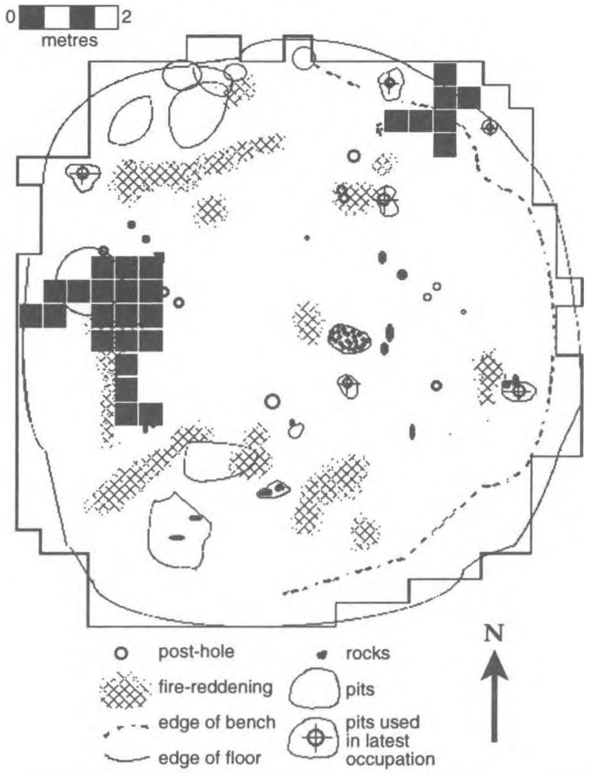

Figure 6. Distribution of analytical units interpreted to be associated with bipolar core reduction.

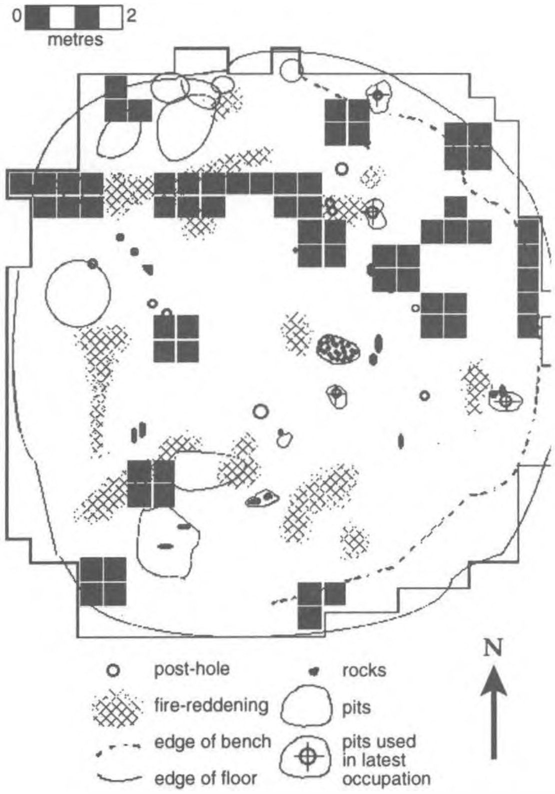

Figure 7. Distribution of analytical units not interpreted to be associated with trampling.

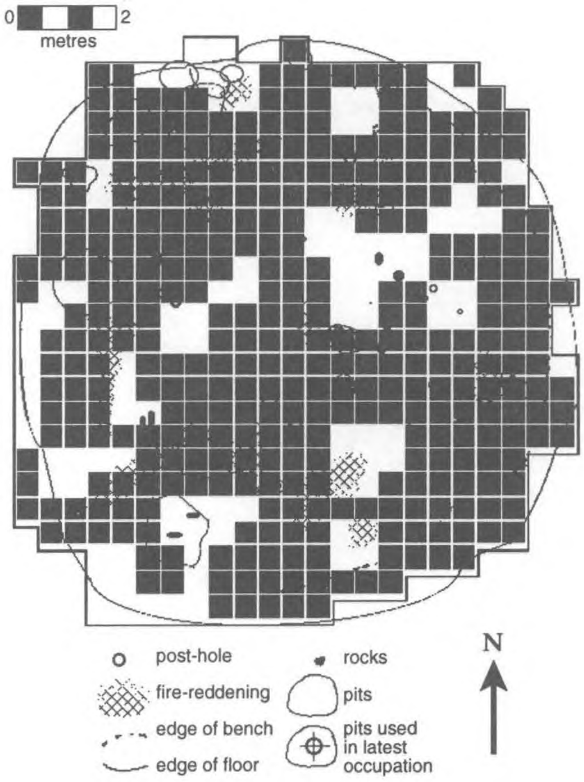

Figure 8. Distribution of analytical units interpreted to be associated with acute edge angle flake culling.

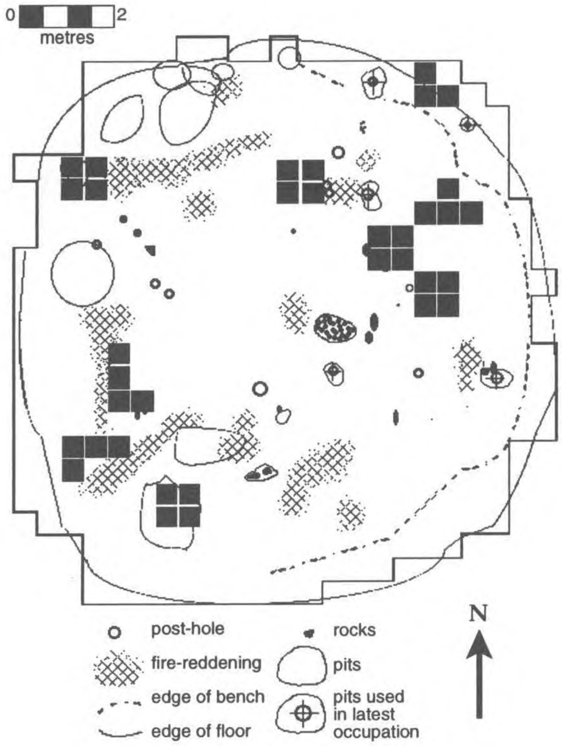

Figure 9. Distribution of analytical units interpreted to be associated with high edge angle flake culling.

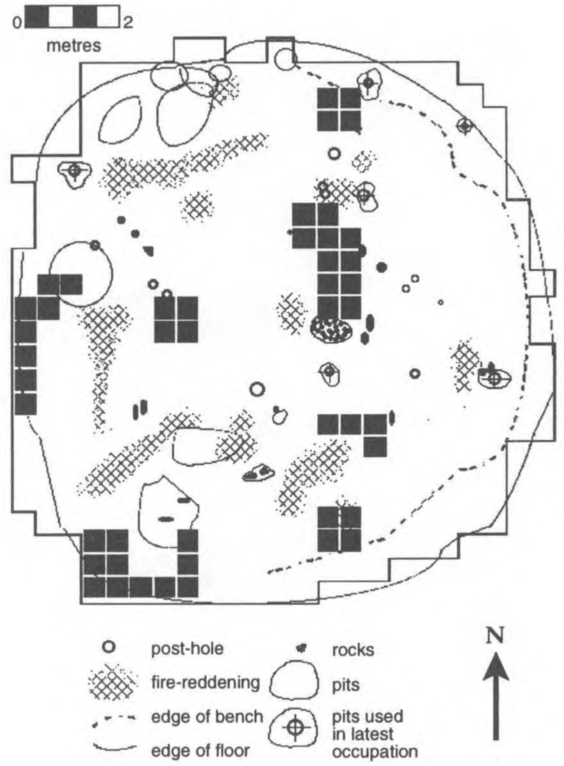

Figure 10. Distribution of analytical units interpreted not to be associated with any form of flake culling.

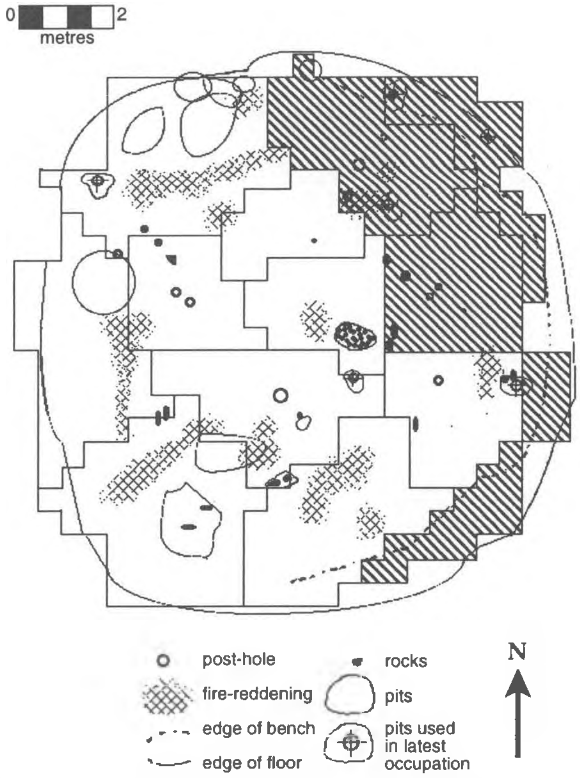

Figure 11. Distribution on the HP 7 floor of sectors with flake tool assemblages interpreted to be derived from prepared core reduction flakes only.

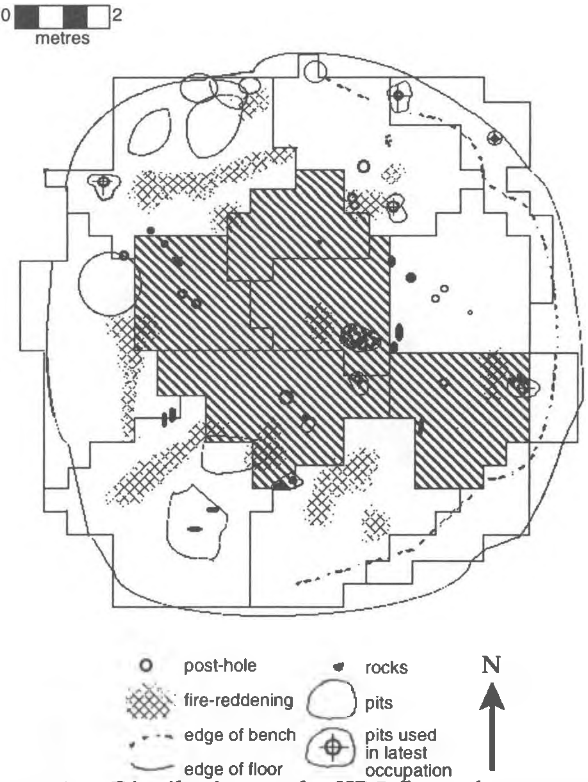

Figure 12. Distribution on the HP 7 floor of sectors with flake tool assemblages interpreted to be derived from prepared and bipolar core reduction flakes.

interpreted to be the result of prepared core, flake production followed by culling of larger acute edge angle flakes for use as flake tools, expedient tool use, discard and trampling, culling and recycling of previously discarded tools, reuse, and final discard (Fig. 11).

Flake tool assemblages resulting from mixed prepared core and bipolar core flake production occur in the central and southeastern part of the floor (Fig. 12). Prepared core reduction flakes appear to have been culled for larger size and the presence of acute edge angles, while bipolar flakes were culled for acute and high edge angles. The flake tool assemblages produced through prepared core reduction have been heavily culled following initial tool discard while bipolar flake tools do not appear to have been intensely culled in this manner. All have been trampled.

Mixed biface and prepared core flake production assemblages occur around the western side of the floor (Fig. 13). Culling of previously discarded tools does not appear to have been a major factor here, though culling of the original flake assemblages focussed on both acute and high edge angle flakes.

Cases 1–3, 6, and 8 distribute roughly around the edges of the floor. They contain patterns of intense use of larger flakes, while small flake tools are trampled far more intensely than the larger ones (Fig. 14).

Discussion

Earlier in this essay I discussed some of the potential agents identified from the ethnographic literature, including reduction and tool use strategies, spatial organization of activities, and taphonomic processes, which could be expected to contribute towards the formation of lithic assemblages in Middle Fraser Canyon winter housepits. From this analysis of the debitage and flake tools at HP 7 at the Keatley Creek site (and as corroborated by Spafford in Vol. II, Chap. 11), it is clear that similar processes occurred during the occupation of Late Prehistoric winter housepits.

The floor of HP 7 contained a dense concentration of lithic artifacts reflecting fairly intensive lithic reduction and tool use during its final occupation. The most typical form of lithic reduction was that of flake production from prepared platform block or spheroid cores. This activity was apparently practiced in all portions of the housepit floor. Biface reduction was practiced more typically on the western or "kitchen" side of the house. Tool resharpening activities were typically located adjacent to hearths, presumably to aid in visibility, though this may also reflect the use locations of many lithic tools. Bipolar reduction was practiced on the western and northeastern sides of the house. Flake tool discard paralleled the locations of

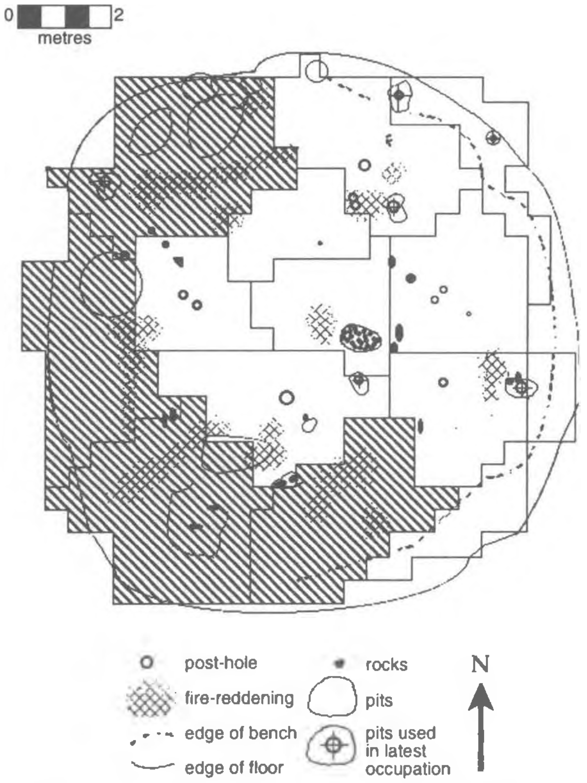

Figure 13. Distribution on the HP 7 floor of sectors with flake tool assemblages interpreted to be derived from prepared core and biface reduction flakes.

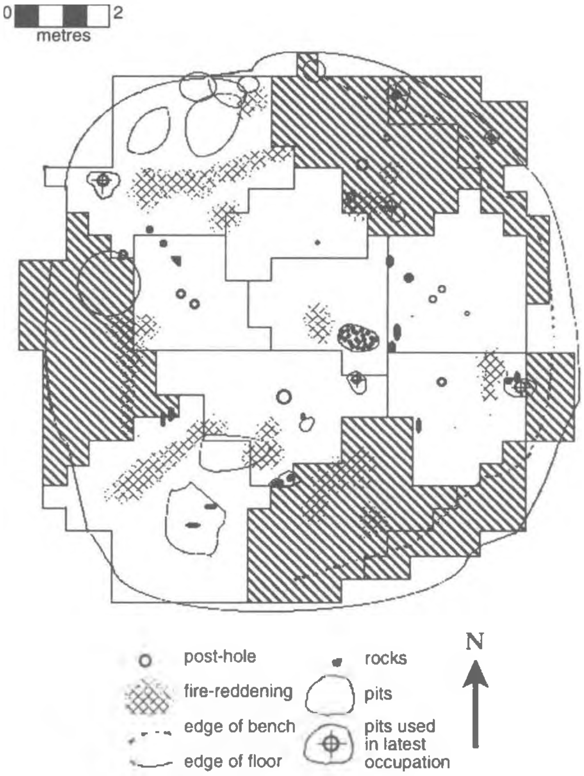

Figure 14. Distribution on the HP 7 floor of sectors with flake tool assemblages interpreted to be derived from some degree of larger flake tool curation.

reduction areas to a large degree. Core reduction flake tools were discarded throughout the housepit floor, while biface reduction flake tools were primarily discarded on the west side of the house. Interestingly, bipolar flake tools were discarded in the center of the housepit. Larger tool curation appears to have occurred around the margins of the housepit floor, while central areas of the floor received more intensive short term tool use-reuse cycles, accompanied by intensive trampling.

The focus on reduction of prepared cores to produce flake tools is reminiscent of the ethnographic prediction that lithic raw materials would be stockpiled for winter use in preparing food for daily consumption and tools for spring and summer use. Likewise, the intensive reuse of flake tools either through curation, as indicated around the floor margins, or serial expediency, suggests the need for raw material conservation. Finally, there were some indications that bipolar assemblages were minimally or even untrampled, as opposed to all other lithic assemblages which were heavily trampled. This may suggest that bipolar reduction was an activity practiced late in the winter occupation as a means of extending the use-lives of some cores and tools during this time. This also suggests that the lithic assemblages from this floor are the result of only one winter's occupation. I suggest that it is likely that if the house was occupied during previous winters, the latest occupation was preceded by intensive floor cleanup activities, allowing for the development of the crisp spatial patterning recognized here.

It appears unlikely that many flake tools were exported from the housepit during the final occupation. Dense lithic artifacts are found in the rim deposits of the housepit (Vol. I, Chap. 15) and appear to be largely the result of older reoccupations of the houspit which excavated old floors and collapsed roofs, depositing debris on the rim of the housepit. Distributions of tool types between the floor and the rim deposits at HP 7 are very similar. Further, the intensive recycling industry on the floor of HP 7 is not expected to have left many flakes or flake tools in conditions warranting further use beyond the confines of the housepit floor. Finally, the ratio of flakes (larger than 1/4 inch square) to tools is approximately 4/1. Even considering intensive tool breakage, through use, trampling, and possibly purposive action, this is a high number of tools compared to waste flakes. Certainly, some flake tools were removed from the house. However, there does not appear to have been enough for this to have significantly affected the overall patterning of debitage and flake tool assemblages within the house.

Based upon these arguments, I suggest that, similar to ethnographic descriptions and derived expectations, lithic tools were primarily used to produce other tools from organic materials (wood, bone, horn, and leather). Some lithic tools such as bifaces and some formal unifacial tools such as end scrapers were likely produced for export and use during group movements in the spring and summer. This implies an approach to risk management, using technology and mobility very similar to that described ethnographically. I conclude that lithic assemblages from the floor of HP 7 formed during the period of winter sedentism used as down-time for the production of anticipatory gear (Binford 1979) critical for survival in winter and throughout the rest of the year.

The repetitive patterning of lithic assemblages around hearth features has led Spafford (Vol. II, Chap. 11; 1991) to identify three and possibly more domestic areas located in the northwest (sectors 8, 9, 13, and west half of 10), the northeast (sectors 1, 3, 4, east halves of 10 and 11) and southern (sectors 2, 5, 6, and 7). He argues that each area potentially contained a multi-family group belonging to the larger household social unit and that each domestic unit used several hearths. Some hearths were used more as domestic hearths (large hearths in sectors 6, 7, 8, and 11), while others were perhaps more often used for warmth and light during special activities (hearths in sectors 3 and 5). The hearth in sector 9 appears to have been used for both domestic and special activities. In addition, Spafford identified a number of specialized activity areas in different portions of the floor. Based on cached spall scraper tools, a portion of sector 5 was identified as a possible hide working area. He also identified a portion of the northwest corner of the house as a special activity area, based on a concentration of heavily retouched scrapers, utlized flakes, and fire-cracked rock. The south-central portion of the floor (sector 12) was classified as a possible corridor area. Finally, Spafford has provided a distinction between inner and outer zones on the housepit floor. He notes that the outer perimeter contains high numbers of heavily retouched tools and far fewer numbers of minimally retouched tools. The inner zone is characterized by high numbers of minimally retouched, possibly expedient tools, biface fragments, spall tools, fire cracked rock, and numerous hearths. On the basis of these distinctions, he argues that the inner zone was possibly the focus of most female activities such as food and hide processing, while the outer zone was more commonly associated with male activities such as equipment repair and lithic reduction acivities.

Spafford's identification and explanation of spatial variation in artifact patterning were based largely on criteria not considered in this study. However, the results of this study reflect his conclusions to a substantial degree. From the perspective of vitreous trachydacite use, sectors 4, 10, 11, and 12 appear to be places where a fair degree of human movement occurred, as might be expected from the central location of three of these sectors. Tool production and use appear to have been consistently of an expedient nature, focussing on hand-held core reduction and bipolar reduction based flake tool production, use, and discard. Sector 12 is particularly sparse in artifacts, though the general pattern is no different from that of the central or eastern sides of the floor with core reduction and large acute edge angle flake culling. This corresponds to Spafford's identification of sector 12 as a corridor. I add that sectors 10, 11, and 4 may also have received a fair amount of foot-traffic.

Sector 5, identified by Spafford as a hide working area, contains some elements of hearth-oriented patterning such as associated core and biface reduction debris, both culled for acute edge angle flakes. This sector does not contain any strong indicators of tool edge retouch/modification and it has been heavily trampled. Flake tools discarded here are primarily the combination of core reduction flakes with some bipolar core reduction flakes. All have been used and reused expediently and heavily trampled. Thus, this area appears little different from sectors 4, 10, 11, and 12 other than the presence of minimal biface reduction. Spafford's argument, based on available space and the presence of spall tools, may be a useful explanation of this sector. Identification of this sector as a female oriented activity area is concordant with my identification of this area as generally more similar to the central portions of the floor. The presence of biface reduction in sector 5 indicates, however, that some male oriented activities may also have been conducted in this area. This is likely given the proximity to the edge of the housepit floor.

My analysis has identified a consistent hearth associated pattern in sectors 1, 3, 6, 7, 8, and 9. This pattern is one of continuous core reduction and large acute edge angled flake culling which is also associated with clusters of biface reduction and acute edge angle flake culling and tool edge maintenance/resharpening clustering immediately adjacent to hearths. Flake tool use/reuse/discard strategies of mixed core reduction and biface flake use and discard are found in sectors 6–9. Sector 1 and 3 flake tools are primarily the result of core reduction flake culling and use. Biface reduction appears to be far less intense in these sectors than in others. This repeated patterning around hearths appears to be indicative of regular domestic activities requiring flake tools and biface preparation. This generally supports Spafford's identification of the northeastern, northwestern, and southern sectors as domestic areas. It also indicates that other hearths may have been the loci of additional independent domestic units. Further support comes from the distribution of high edge angle flake culling, which occurs in clusters in the southwest, northeast, and northwest portions of the floor.

The identification of domestic activities on the northeast side of the floor (sectors 1 and 3) is still somewhat problematical as the hearth is small, food storage pits are few and, although small amounts of tool maintenance and biface reduction are present, core reduction is by far the dominant lithic reduction activity. Further, the hearth is separated from the central portion of the floor by a row of post holes. Debitage assemblages from this area of dense posthole patterning have only been minimally trampled and, in places, not culled for any flakes. This suggests that some form of barrier existed between these areas. Thus, one must keep open the possibility that the northeast portion of the floor may have served as a place where special activities occurred, rather than an exclusively domestic occupation. Another possible explanation is that it is possible that lower status people occupied this area. Lithic reduction and tool use activities certainly appear little different from other potential domestic areas, only in somewhat different proportions. A third possibility is that this area was used domestically by lowest status people such as slaves and, because of this, the area was also used as a special activity area (possibly wood working) by slaves and possibly others, as indicated by the focus on culling high edge angle flakes and the presence of numerous cut beaver teeth from this area (Vol. II, Chap. 7).

My identification of flake tool use/reuse variation between the perimeter and interior portions of the floor is concordant with Spafford's identification of outside and central gender-related areas. Spafford argued that the use of outer areas focussed on tool curation, while the central areas saw more expedient tool use. My results indicate a system of intense trampling of small lithic artifacts and very minimal trampling of larger artifacts around the perimeters. Interior floor flake tools were all heavily trampled regardless of size. This variability in potential flake tool use and discard strategies may well have been gender-related as suggested by Spafford.

Conclusions and Implications

The results of this study demonstrate a link between predictions about lithic assemblage formation processes derived from the ethnographic record and those recognized from archaeological study of a Late Prehistoric winter housepit. In particular, ethnographic predictions regarding the economic use of lithic raw materials through reduction of cores to produce flake tools and use of flake tools to aid in winter food preparation and in gearing up for spring activities appear to be relatively accurate predictors of Late Prehistoric behavior at HP 7 at Keatley Creek. Likewise, ethnographically predicted housepit floor spatial arrangements including a series of domestic units around the margins of the floor, more intense "kitchen" oriented activities on the river-side of the house (west), spatially segregated gender based activity areas, and a central corridor area associated with housepit access (ladder), are also borne out at HP 7. Finally, taphonomic processes such as trampling are highly visible among the lithic artifacts in HP 7.

Probably the most crucial aspect of this research has been the identification of spatially bounded assemblage formation sequences. Patterning in lithic reduction, culling, tool discard, and trampling, are tight enough that, even without associated features, floor spatial structure could have been recognized. Floor boundaries, hearth areas, and post-hole clusters are partially identifiable through artifact trampling and culling patterns in that it is these areas which received the least intense foot traffic (and thus artifact trampling) and scavenging of flakes or previously discarded tools. Clusters of tool edge modification, biface reduction, and high edge angle flake culling activities clearly are associated with hearth based work areas. Presumably gender based activity areas are identifiable by examining flake tool assemblage formation sequences. Possible female activity areas are defined based on intensive expedient tool use/reuse cycles (or serial expediency) associated with prepared and bipolar core reduction, and biface reduction to a reduced degree on the west side of the house. Potential male activity areas are associated with a different sequence of flake tool use/reuse derived from prepared core and biface reduction, indicating a higher degree of tool curation and resharpening around the margins of the house.

I suggest that while understanding distributions of flake and tool types (i.e., Vol. II, Chap. 11; Spafford 1991) is very important for assessing spatial organization, researchers need to focus much of their efforts on understanding the sequence of processes responsible for the final associations between artifact types. To date, much attention has focussed on the processes of individual tool formation through resharpening (Dibble 1987) and tool use (Hayden 1990). While these studies will continue to be extremely important, further attention must be placed on examining the combination and sequence of events and actions of each agent responsible for affecting assemblage composition (Todd et al. 1987:40). Within this study, a number of agents were identified (reduction techniques, flake culling, trampling, tool use, tool discard, tool scavenging/reuse) and an attempt was made to recognize variation in the effects of those agents. Probably one of the biggest near-future contributions towards the goal of better understanding assemblage formation processes will be further experimental work designed to develop linkages between organizational behavior, site occupational sequences, and lithic assemblage formation. Researchers will wish to experimentally consider not only the effects of reduction strategies, culling, trampling, and discard processes, but also variation in the application and sequence of these agents under different economic, social, and occupational conditions.

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Chapter 14

An Analysis of the Distributions of Lithic Artifacts in the Roofs of Three Housepits at Keatley Creek

Jim Spafford

Introduction

The analysis of the lithic artifacts found in three of the extensively excavated housepits at the Keatley Creek site has primarily focused on the floor strata. The floors were given special attention because, each was thought to represent a single occupation, because the floors were thought to have simpler depositional histories than the roofs, and because spatial organization inside the houses was thought to be especially relevant to questions about social organization which were the focus of this project.

However, prehistoric activity at the site was not confined to the interior of the houses. Indeed, given the estimated population densities for these structures, (Vol. II, Chap. 1) people probably spent as much time out of doors as the weather allowed. It was therefore considered appropriate to examine roof deposits in order to determine whether any activity patterning could be detected from the distribution of artifacts and whether such patterning could add any new perspectives to the understanding of socioeconomic organization at Keatley Creek. In addition, it was considered important to examine the roofs in order to determine if any discard of lithic materials onto the roofs was creating a biased view of the activities that were taking place inside the houses.

The rooftops or roof edges of the pithouses may have been the preferred area for many outdoor activities because:

- Unlike the areas surrounding the houses, the rooftops would have provided large, regular surfaces which did not need to be cleared of vegetation before they could be used.
- The rooftops were clearly part of the owned area of the houses and could be used by the residents without any contention. Things left lying on a roof might be recognized as belonging to the house while things left lying in the space between houses might not.

Both concerns may have been especially important at a large site like Keatley Creek, where houses were fairly densely clustered.

While it seems likely that the rooftops were used for some activities, it is even more likely that they were used as dumps for refuse collected from the interior of the houses. Where space was at a premium, few other dumping sites would have been as immediately accessible. In fact, since the smokehole in the middle of the roof also served as the doorway, at least in the larger houses, there could hardly have been any more convenient dump site than the roof. It was, so to speak, just outside the door.

The three housepit roofs in this analysis were chosen to represent a broad range of the housepit sizes and, by inference, diversity in social organization at the Keatley Creek site. The smallest is HP 12 with a diameter, measured from rim crest to rim crest, of 9 m.

Housepit 3 has a diameter of 14 m; and HP 7, one of the largest at the site, has a diameter of 19 m. It seems unlikely that the social organization was as important in the organization of space on the roofs as it was on the floors. Still, housepit size may have had some bearing on the uses to which the roofs were put, especially if the slope of the roof surface or other aspects of roof structure varied with size.

The analysis of roof assemblages is complicated by their relatively long and complex depositional histories and by the great volume of the roof deposits. Only a preliminary analysis can be presented here and our understanding of the processes which resulted in the formation of the roofs is far from complete. However, rooftop activities may have been very significant in the lives of the inhabitants of this site. So the rooftop assemblages cannot be ignored.

This paper will address the following questions:

1) How did lithic artifacts get into the roof deposits in HP's 3, 7, and 12?
2) What similarities and differences are there between roof assemblages and assemblages from other strata?
3) What activities may have occurred on the roofs?
4) Were different parts of the roofs used for different activities?
5) What factors may have determined which areas on a roof were selected for which activities?

How did artifacts get into the roof strata?

Most lithic artifacts were probably deposited in the roof strata by one of the following processes:

1) refuse produced during activities on the floor was discarded on roof;
2) refuse produced during activities on the roof was discarded or abandoned on the roof;
3) artifacts were stored on the roof or in the roof structure;
4) during the replacement of decayed roofs, artifact bearing deposits, which had been removed from the housepit and deposited on the rim, were redeposited on the roof. These artifacts may have originally been from the floor, the roof, or the rim.
5) Artifacts from sources outside the housepit may have been deposited in the roof either before or after final collapse.

All of these processes probably contributed, to some extent, to the formation of assemblages in most parts of the roofs. During periods when the houses were occupied, material from the floors which was dumped on the roofs and material discarded in the course of activities on the roofs probably accounted for most of the accumulation and most of the variability in the roof lithic assemblages. Dumps may have been unpleasant areas to work in and dumping of refuse may have interfered with some types of work. So it seems likely that separate areas of the roofs were reserved as activity areas while other areas were used as dumps. Storage of artifacts between poles on the inside of the roofs, as documented ethnographically elsewhere (Hayden & Cannon 1983), probably had much less impact on these assemblages than did dumping and roof-top activities.

Reconstruction or replacement of roofs probably resulted in some mixing of artifacts deposited by dumping and artifacts deposited as the result of roof-top activities, as well as with artifacts from floor deposits that were removed during re-roofing (Vol. I, Chap. 17). Occasional dumping of artifacts from sources outside the housepit as well as the use of collapsed housepit depressions by later hunting parties may have further disturbed patterns resulting from regular roof-top activities and local dumping. Nevertheless, lithic assemblages from the roofs may have characteristics which indicate whether reconstruction, dumping, or roof-top activity were significant contributors to the formation of the lithic assemblages in different areas of the roofs.

Distinguishing Reconstruction, Rooftop Dumping, and Rooftop Activity as Formation Processes

Assuming that lithic assemblages in the roof strata are not mixed beyond recognition or complicated by the introduction of extraneous material, their characteristics will be the product of one or more of the following three processes:

1) During reconstruction of the roofs of the three structures discussed in this study, debitage and modified lithic artifacts would have been scraped from the floor of the house along with the floor matrix, then deposited first on the rim and then on the rebuilt roof. The remains of the collapsed roof may have been mixed with this material but this introduces a level of complexity which is beyond the scope of this initial scenario. The existing floor assemblage is the best model we have for the expected characteristics of a lithic assemblage left on the floor when a house was abandoned. So if the roof, or some part of the roof, contains only lithic artifacts deposited in this manner it should resemble the floor assemblage quite closely.

2) Lithic artifacts were removed from the floor while the house was occupied and dumped on the roof or on some part of the roof. This is a somewhat more selective process than that just described. Some tool types and states of tools are more likely to be dumped than others. The lithic assemblage recovered from an area used as a rooftop dump should resemble the floor less closely than an assemblage from an area which contains only material scraped from an abandoned floor. However, a rooftop dump assemblage should also be somewhat similar to a floor assemblage in that it was, presumably, originally generated by the same suite of activities.
3) Lithic artifacts were deposited on a roof only as a result of activities which occurred on the roof. The roof may have been selected for messy or smelly activities for which the interior of the house was not well suited, that is, for activities which rarely occurred on the floor. So the assemblage of artifacts deposited as a result of these activities might be quite different from the assemblage deposited as the result of activities on the floor.

Some specific characteristics of lithic assemblages in the roof strata are suggested below depending on which of the above processes was dominant in their formation.

Density Distributions

The thickness of the roof strata varied considerably in different areas of the housepits and was, everywhere, much greater than the thickness of the floors. So density distributions (expressed in terms of objects per litre) rather than frequency distributions were calculated for comparative purposes.

Generally, areas in a roof which include only artifacts deposited during the reconstruction process can be expected to have lower densities of all classes of lithic artifacts (fire-cracked rock, debitage, and modified artifacts) than areas used as rooftop dumps or rooftop activity areas. They should also have lower artifact densities than the floors. This is simply because some quantity of soil and other material which did not contain artifacts was almost certainly added to the floor scrapings during the reconstruction of the roof.

All classes of lithic artifacts can be expected to be more densely distributed in areas used as rooftop dumps or rooftop activity areas than in areas of the roof which were not used for either purpose. More specific expectations can be generated for different classes of lithic artifacts.

Fire-cracked Rock

Disposal of fire-cracked rock in activity areas which were in current use would probably have made these activity areas uncomfortable and interfered with work in progress. So fire-cracked rock is likely to be more densely distributed in little used areas than in activity areas on the roof.

Debitage

Rooftop activity areas may have been preferred to the interior of the pithouses as sites for lithic reduction due to better lighting and more convenient waste disposal. If so, debitage should be highly concentrated around rooftop activity areas. On the other hand, the presence, on the floors, of large numbers of unmodified flakes in a wide range of sizes indicates that some lithic reduction did occur inside the houses and high debitage densities could also occur in rooftop dumps as a result of core reduction inside pithouses and subsequent secondary dumping of waste. Clearly separated concentrations of debitage and fire-cracked rock may distinguish rooftop activity areas from rooftop dumps. Areas where concentrations of debitage and concentrations of fire-cracked rock overlap are more likely to have been dumps.

Modified Artifacts

The densities in which all modified artifacts (tools) are distributed in different parts of the roofs might also be expected to vary according to the relative intensity with which dumps or activity areas were used. Also, some activites will have resulted in denser distributions of modified artifacts than others. So differences in modified artifact density are as likely to distinguish between areas which were used more or less intensively or for different activities as they are to distinguish between activity areas and dumps. Areas of a roof which were not used either as dumps or as activity areas should have tool:debitage ratios very similar to that for the floor. On the other hand, dumps and activity areas on the roofs might have tool:debitage ratios somewhat different from those in the floor assemblages.

Modified Artifact Types

Different activities which might have occurred on a roof (butchering vs. primary lithic reduction, for example) are likely to have resulted in the deposition of specific types of modified artifacts. Dumping on the roofs of materials from the floors is more likely to have produced assemblages containing modified artifact types in similar proportions to those on the floor.

For the purposes of this analysis, each modified artifact from the floors and the roof samples from the three housepits was assigned to one of the following categories. The various artifact types are described in greater detail in Volume III Chapter 1:

- expedient knives (including types 70, 74, 140, 159, and170)
- utilized flakes (including types 71, 72, 73, and 180)
- scrapers (including types 141, 150, 156, 163, 164, and 165)
- projectile points (including types 19, 100, 101, 102, 109–129, and 137)
- notches (including types 54, 154, and160)
- key-shaped scrapers (type 158)
- bifaces (including types 131, 134,139,185, 192, and 193)
- bifacial knives (type 130)
- bipolar cores (type 146)
- small piercers (type 153)
- drills and perforators (including types 132, 133, 151, and 152)
- spall tools (including types 183, and 184)
- cores (including types 186,187, 189, and 149)
- hammerstones (type 190)
- ground stone (including types 201, 202, 211)
- ornaments (including types 205, 209, 210, and 212–217)
- and miscellaneous artifacts (including types 1, 2, 4, 6, 7, 8, 36, 50, 55, 76, 88, 135, 142, 143, 147, 148, 157, 171, 173, 182, 188, 191, 195, 200, 203, 207, 208, 213, 220).

The latter category consists of fragmentary artifacts, flakes with abrupt (probably accidental) retouch, and flakes removed from the retouched edges of artifacts.

Initially, a sample of the excavated subsquares from each of the three roofs was selected for analysis. The sampled subsquares, which represent at least 10% of each roof, are shown in Figure 1. Utilized flakes alone represent 26.2% of the modified artifacts in the combined roof samples. Expedient knives represent 21.7%. Scrapers represent 11.1% and miscellaneous types represent 10.4%. These types are so abundant that their distributions in the samples can confidently be expected to represent their distributions in the complete roofs. None of the other types represents more than 10% of the modified artifacts in the combined roof sample. Most types represent less than 5%. Since the distributions of these rarer types of modified lithic artifacts in the samples were considered less likely to accurately represent their distributions in the complete roofs, these types were extracted from all of the excavated lithic samples from the roofs. Many of the selected types are thought to have been specialized tools so an accurate picture of their distributions was expected to be important in identifying the locations of activity areas in the roofs. The selected types are listed below:

- projectile points
- bifaces
- bifacial knives
- end scrapers
- key-shaped scrapers
- drills and perforators
- cores
- bipolar cores
- spall tools
- ground stone
- pipe fragments
- convergent knife-like bifaces
- pièces esquillées

Modified artifacts found in the floors and the roof samples from the three housepits were identified with one of five categories of material type: vitreous trachydacite (commonly called vitreous basalt), cherts and chalcedonies, obsidian, quartzite, and other. The latter category includes mostly ground stone; notably sandstone abraders and steatite pipe fragments. As with modified artifact types, it was expected that raw material types would occur in very similar proportions among modified artifacts on the floors and among modified artifacts in the reconstructed roofs. These proportions should be somewhat less similar among modified artifacts deposited in rooftop dumps and may be very dissimilar in rooftop activity areas.

Fragmentation and Wear of Modified Artifacts

In areas of a roof where the lithic assemblage was primarily derived from the floors and was deposited in the process of roof reconstruction, artifacts might be slightly more fragmented than modified artifacts on the floor due to breakage during redeposition. Depending on the kind and intensity of roof top activities, fragmentation and wear of modified artifacts may be more or less advanced in rooftop activity areas than in the floor deposits. Worn and broken artifacts from inside activities are especially likely to have been discarded in dumps. So modified artifacts which have been discarded in rooftop dumps should exhibit the most wear and resharpening and are most likely to be broken compared to those left on the floor, those redeposited in the roof during the reconstruction process, or those in rooftop activity areas.

Chipped stone artifacts other than cores and bipolar cores were examined under a 10× lens and classified as either relatively new (i.e., without visible evidence of wear after initial reduction or retouch), worn (i.e., with evidence of wear after initial retouch but no resharpening), resharpened (i.e., with evidence of resharpening), or exhausted (i.e., worn or broken to the point where there is no possibility of further resharpening). Modified artifacts other than cores and bipolar cores were also classified according to their degree of fragmentation (1 = whole, 2 = chipped, 3 = 1/2 to 3/4 of the original artifact, 4 = less than 1/2 of the original artifact, 5 = small fragment).

Debitage

Flakes found in the excavated housepits were classified according to:

1) Size: small flakes (< 2 cm. maximum dimension) vs. large
2) Material type: vitreous trachydacite (commonly called vitreous basalt); chert or chalcedony; obsidian; quartzite. (This category was employed only in the classification of debitage found in the roofs. Quartzite flakes found on the floors were included in the count of chert or chalcedony flakes.)
3) Flake type: primary (usable) flakes; secondary (minimally useful) flakes; billet flakes; bipolar flakes; shatter
4) Cortical surface: cortex present on > 30% of dorsal surface vs. less cortex.

While different modified artifact types may have had different use-lives and thus different discard rates, most debitage is waste from the moment it is manufactured. Debitage collected from the floor and deposited on the roof should, therefore, include the various types of flakes and the various material types in fairly similar proportions. The same is true of flakes with cortex. Generally, this should apply whether debitage was removed from the floor and redeposited in the roof in the reconstruction process or whether it was dumped on the roof while the house was occupied.

The distribution of large and small flakes may be more difficult to interpret. Large flakes are more conspicuous and, thus, more likely to have been removed from the floors and dumped on the roofs than small flakes. However, large primary and billet flakes might also have been introduced into rooftop activity areas as potential tool blanks. So it is unclear whether large flakes should be found in greater proportions in reconstructed roof, in rooftop activity areas, or in rooftop dumps.

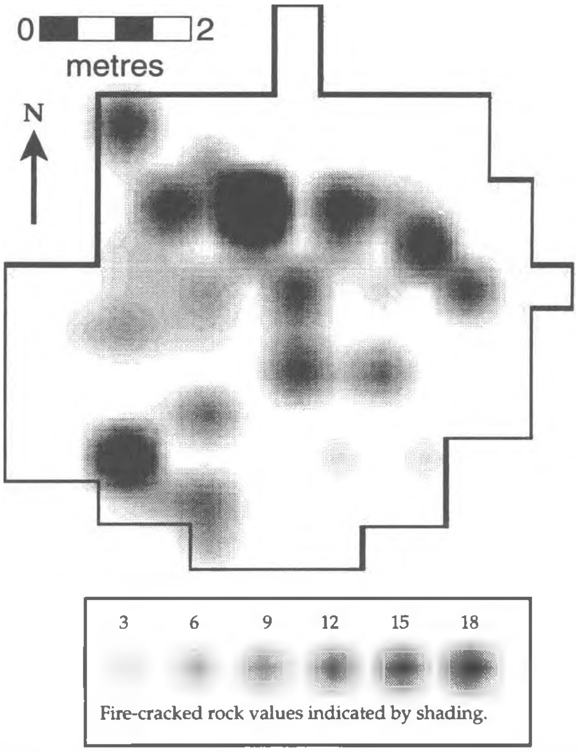

Figure 1. Distribution of FCR in the roof of HP 12 (complete sample).

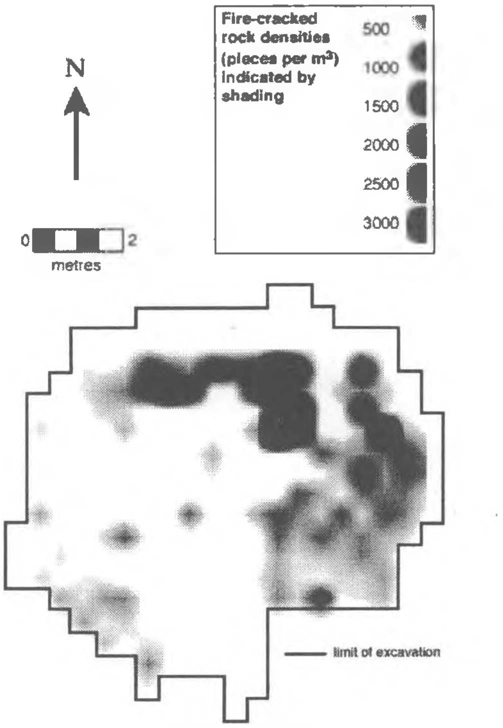

Figure 2. Fire-cracked rock density (pieces per m^3) distribution in roof strata in HP 3.

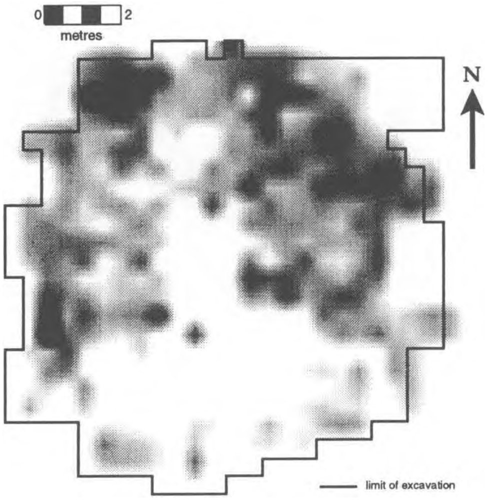

Figure 3. Fire-cracked rock densitiy distribution in all roof strata of HP 7.

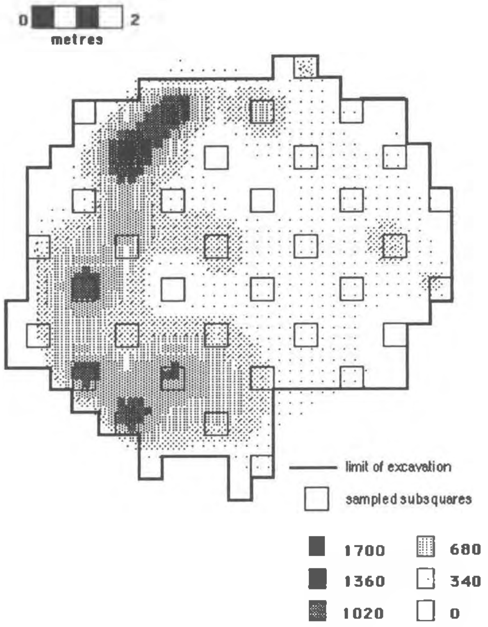

Figure 5. Debitage densities (flakes per cubic metre) in all roof strata of HP 3. Plotted densities are extrapolated from sample subsquares.

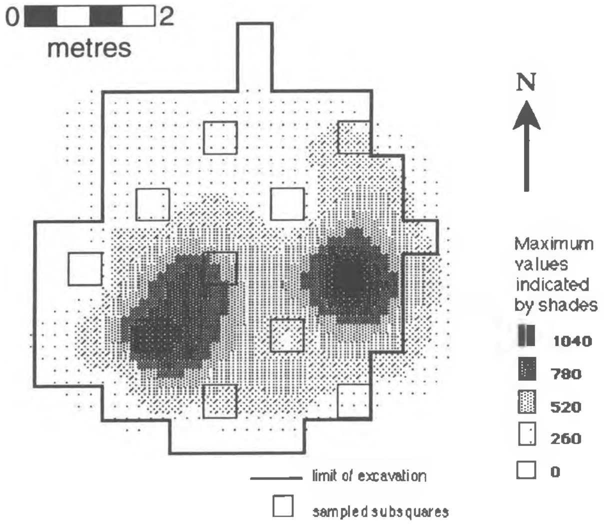

Figure 4. Debitage density in all roof strata of HP 12.

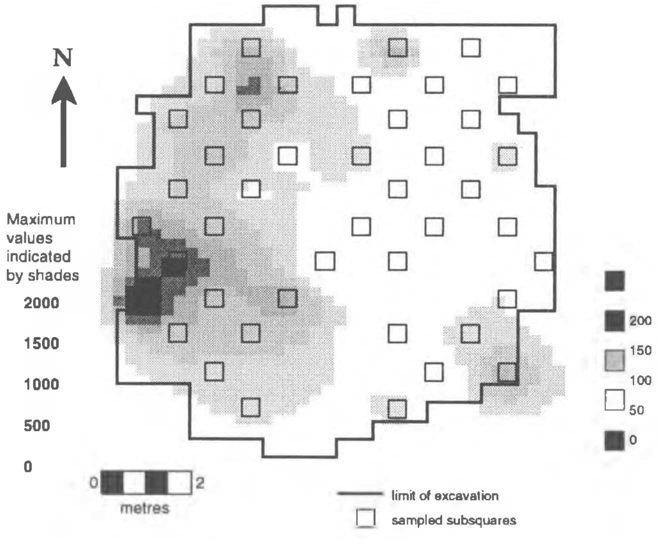

Figure 6. Debitage densities (flakes per cubic metre) in all roof strata of HP 7. Plotted densities are extrapolated from sample subsquares.

Definition of Sectors in the Roofs

After an initial examination of the data, the roofs of the three housepits were each divided into two sectors based on the density distributions of fire-cracked rock and debitage. The fire-cracked rock density distributions shown in Figures 1, 2, and 3 were based on complete samples of the excavated roofs. The density distributions for debitage and modified artifacts were based on much smaller samples. Debitage densities were calculated for each of the sampled roof units where thickness was recorded. Contour maps representing the distribution of debitage densities in each of the three roofs were interpolated from the sampled data. The sampled subsquares and the interpolated debitage density distributions are shown in Figures 4, 5, and 6.

The interpolated density distribution plots suggest that both debitage and modified artifacts occur in dense concentrations in restricted areas of the roofs of HP's 3 and 7. If artifacts were introduced into roof deposits primarily during pithouse reconstruction, i.e., as part of redeposited floor and rim deposits, then lithic artifacts should be more evenly distributed. Therefore, these concentrations were probably deposited as the result of dumping or specialized activities which occurred on the roofs during the period when the houses were last occupied.

Since the fire-cracked rock distributions are based on more complete data than the debitage distributions, they were given greater importance in defining sectors. Distribution maps based on the more complete fire-cracked rock data were compared to distribution maps generated from only the sampled subsquares as a check on the accuracy of interpolated distributions based on lithic artifact frequencies in the sampled subsquares. The interpolated distributions of fire-cracked rock correspond well to the actual distributions, which suggests that the interpolated distributions of all high frequency artifact classes are reasonably accurate.

The sectors were compared in terms of the characteristics which it was thought might distinguish between activity areas and dumps.

Fire-cracked rock is most densely distributed in the northeastern part of all three roofs. In all three housepit roofs, there is also a smaller concentration of fire-cracked rock in the southwest. Therefore, each roof was divided into a southwest (SW) sector and a northeast (NE) sector for analytical purposes.

In HP's 3 and 7, debitage is most densely distributed in the southwest sectors. So the defined sectors also separate the areas of greatest fire-cracked rock density from the areas of greatest debitage density. In HP 12 the defined sectors isolate two apparently distinct concentrations of debitage.

The following section summarizes the data and notes some of the most obvious patterns and interpretations. A full synthesis and interpretation is presented in the last section of this analysis.

Results

Housepit 12

HP 12 is the smallest of the three housepits in this analysis and is believed to have housed a simpler socioeconomic unit than either HP 3 or HP 7. As Figure 1 shows, fire-cracked rock is clearly more densely distributed in the northeast sector of HP 12 than in the southwest sector. Apart from that, frequencies of all types of lithic artifacts are fairly low, and variability in the density distributions is small within HP 12 (Table 1). There is no significant difference between the floor and the sampled roof in terms of fire-cracked rock density. There is no significant difference between the sectors of the sampled roof in terms of debitage density.

Debitage density in the floor deposits is twice as high as in the roof and, since the modified artifact densities are low in both strata, the tool/debitage ratio in the floor is lower than that in the roof. However, the roof sample is small and this difference may not be statistically significant.

Table 1. Lithic artifact densities in the the floor and the sampled roof of HP 12

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
Subsquares	12	12	116	24
Volume (litres)	763	883	1075	1645
Debitage	184	258	672	442
FCR	15	8	26	23
tools	20	19	38	39
flakes/litre	0.23	0.31	0.63	0.26
FCR/litre	0.01	0.02	0.02	0.01
tools/litre	0.03	0.02	0.04	0.02
tools/flakes	0.10	0.07	0.05	0.09

Modified Artifacts

The frequencies and proportions in which the various types of modified artifacts are represented in the floor and in the samples from the two sectors of the roof of HP 12 are shown in Table 2. The frequencies of the selected types which were extracted from the complete collection of excavated lithic samples for each sector are presented in Table 3. The total number of artifacts in the roof and in each of the sectors was estimated from the sample data. Table 3 also includes estimates of the proportions which the selected types represent of the total number of artifacts. These proportions permit comparison of the artifact assemblages from each of the three roofs in terms of the relative importance of the various modified artifact types.

Table 2. Modified artifact types in the floor and the two sectors of the sampled roof of HP 12.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
utilized flakes	6 30.0%	3 15.8%	14 (36.8%)	9 (23.1%)
expedient knives	4 20.0%	6 31.6%	6 (15.8%)	10 (25.6%)
scrapers	4 20.0%	3 15.8%	8 (21.1%)	7 (17.9%)
projectile points	0 (0.0%)	0 (0.0%)	2) (5.3%)	0 (0.0%)
notches	0 (0.0%)	2 10.5%	3 (7.9%)	2 (5.1%)
bifaces	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
bipolar cores	0 (0.0%)	1 5.3%	0 (0.0%)	1 (2.6%)
end scrapers	0 (0.0%)	0 (0.0%)	2 (5.3%)	0 (0.0%)
cores	0 (0.0%)	2 10.5%	0 (0.0%)	2 (5.1%)
piercers	0 (0.0%)	1 5.3%	0 (0.0%)	1 (2.6%)
spall tools	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
ground stone	1 5.0%	0 (0.0%)	0 (0.0%)	1 (2.6%)
drills & perforators	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
bifacial knives	0 (0.0%)	1 5.3%	0 (0.0%)	1 (2.6%)
hammerstones	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
key-shaped scrapers	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
ornaments	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
miscellaneous	5 25.0%	0 (0.0%)	3 (7.9%)	5 (12.8%)

The sampled portion of the HP 12 roof is chiefly distinguished from the floor by a relative scarcity of utilized flakes, by a relative abundance of expedient knives, and by the presence of two bifacial knives, two cores, a bipolar core, a piercer, and a piece of ground stone. Five bifaces, a key-shaped scraper, a spall tool, a ground stone abrader, and an ornament were found in the roof when all of the excavated roof material was searched. All of these types were absent in the floor. This may indicate that these types were rarely used inside this house but low frequency items may reflect chance associations as well.

Generally, the floor appears to be more similar to the southwest sector of the roof than to the northeast sector in terms of the types of modified artifacts represented. Utilized flakes are more abundant and expedient knives are rarer in the southwest sector than in the northeast sector. End scrapers and miscellaneous artifact types were found only on the floor and in the southwest sector. Key-shaped scrapers are present in the northeast sector but absent in the floor and in the southwest sector. Piercers are present in the sample from the northeast sector but absent in the floor and in the sample from the southwest sector. In terms of the distribution of modified artifact types, the only correspondences between the floor and the northeast sector of the roof are that both contain notches and both apparently lack ground stone tools.

Insofar as similarity with the floor assemblage is an indication that an area was used as a dump, the southwest sector appears more likely to have been used for this activity than the northeast sector on the basis of artifact type distributions.

Material Types

In HP 12, the floor is quite similar to the sampled subsquares from the roof in terms of the raw materials from which modified artifacts are made. There is also no significant difference between the two sectors of the roof in the distribution of raw material types (Table 4).

Wear

The proportion of the artifacts in the floor of HP 12 and in each sector of the roof which fell into each wear category is shown in Table 5. Most of the modified artifacts found on the floor exhibited very little wear while those in the roof tend to be more worn. There is no significant difference between the two sectors of the roof in terms of the wear states of modified artifacts.

Table 3. Frequencies of selected modified artifact types in all excavated subsquares from the floor and the two sectors of the roof of HP 12 with percentages of estimated total numbers of artifacts based on sample data.

	SW roof	NE roof	Floor	Roof
projectile points	2 (1.9%)	2 (3.1%)	2 (5.9%)	4 (2.4%)
bifaces	3 (2.9%)	2 (3.1%)	0 (0.0%)	5 (3.0%)
bipolar cores	3 (2.9%)	2 (3.1%)	0 (0.0%)	5 (3.0%)
pièces esquillées	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
end scrapers	1 (1.0%)	0 (0.0%)	1 (2.9%)	1 (0.6%)
cores	1 (1.0%)	2 (3.1%)	0 (0.0%)	3 (1.8%)
piercers	0 (0.0%)	1 (1.5%)	0 (0.0%)	1 (0.6%)
spall tools	1 (1.0%)	0 (0.0%)	0 (0.0%)	1 (0.6%)
ground stone	1 (1.0%)	0 (0.0%)	0 (0.0%)	1 (0.6%)
drills & perforators	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
bifacial knives	2 (1.9%)	1 (1.5%)	0 (0.0%)	3 (1.8%)
convergent knife-like bifaces	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
hammerstones	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
key-shaped scrapers	0 (0.0%)	1 (1.5%)	0 (0.0%)	1 (0.6%)
ornaments	1 (1.0%)	0 (0.0%)	0 (0.0%)	1 (0.6%)
pipe fragments	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
estimated total number of artifacts	**103**	**65**	**34**	**168**

Fragmentation

The proportion of the artifacts in each sector which fell into each fragmentation category in the floor and in each sector of the roof of HP 12 is shown in Table 6. Broken artifacts (as opposed to whole or chipped artifacts) are slightly more abundant in the roof as a whole than on the floor. Whole artifacts are very rare on the floor but chipped artifacts, which might have been stored as provisional discard items, are quite abundant. The northeast sector of the roof has a very high proportion of whole artifacts which would be anomalous if dumping occurred in the northeast sector and thus reinforces earlier inferences that it appears to be a special activity area.

Debitage

A summary of the variability in the distributions of the different classes of lithic debitage between the roof sectors and between the floor and the sampled roof of HP 12 is presented in Table 7. In every respect, the southwest sector of the roof is more similar to the floor than either is to the northeast sector, though some of the differences are small. The most notable differences are in the relative frequencies of large flakes (> 2 cm.) and of chert and chalcedony flakes, both of which are most abundant in the northeast sector. These distributions also suggest that the northeast sector is the most likely location for an activity area on this roof.

Several types of modified artifacts which were absent on the floor of HP 12 were present in the sampled roof, especially in the northeast sector. This suggests that the roof was used for activities which rarely occurred on the floor. The northeast sector of the roof differs most from the floor in the relative frequencies of the most common artifact types, in the extent to which modified artifacts are fragmented, and in the relative frequencies of large flakes and of chert and chalcedony flakes. Apart from the distribution of fire-cracked rock, the distribution of lithic artifacts in the roof of HP 12 suggests that the northeast sector of the roof is a more likely location for a specialized rooftop activity area than is the southwest sector.

This location may have been chosen for some activity for which the shade of the housepit was desirable, possibly for hide-working or butchering.

Housepit 3

Density Distributions

Housepit 3 is a medium sized housepit with some evidence for wealth and socioeconomic complexity. The roof of HP 3 was divided into a southwest sector and a northeast sector as described above. As can be seen in Figure 2, fire-cracked rock is most concentrated in the northeast sector, especially along the northern edge of the roof. Debitage densities are highest in the southwest sector. Mann-Whitney tests of the variability between the two sectors indicate that the probability that the samples from the two sectors were drawn from populations with the same distribution of debitage

Table 4. Frequencies and percentages of raw material types used in the manufacture of modified lithic artifacts from the floor and the two sectors of the sampled roof of HP 12.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
basalt	17 (85.0%)	17 (89.5%)	34 (89.5%)	34 (87.2%)
chert & chalcedony	2 (10.0%)	1 (5.3%)	3 (7.9%)	3 (7.7%)
obsidian	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
quartzite	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
sandstone	1 (5.0%)	0 (0.0%)	0 (0.0%)	1 (2.6%)
unknown	0 (0.0%)	1 (5.3%)	1 (2.6%)	1 (2.6%)

Table 5. Frequencies and percentages of modified chipped stone artifacts in different wear categories on the floor and in the two sectors of the sampled roof of HP 12. Percentages are based on the number of all chipped stone artifact types, excluding cores and bipolar cores, recovered from the floor excavation and the roof samples.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
new	1 (5.0%)	1 (6.7%)	32 (84.2%)	2 (5.7%)
worn	9 (45.0%)	7 (46.7%)	1 (2.6%)	– (45.7%)
sharpened	10 (50.0%)	7 (46.7%)	1 (5.3%)	– (48.6%)
exhausted	0 (0.0%)	0 (0.0%)	3 (7.9%)	0 (0.0%)

Table 6. Frequencies and percentages of modified chipped stone artifacts in different fragmentation states on the floor and in the two sectors of the sampled roof of HP 12. Percentages are base on the total number of chipped stone artifacts, excluding cores and bipolar cores, in the excavated floor and the sectors of the sampled roof.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
whole artifacts	8 (40.0%)	11 (73.3%)	2 (5.3%)	19 (54.3%)
chipped artifacts	2 (10.0%)	0 (0.0%)	22 (57.9%)	2 (5.7%)
1/2–3/4 of orig. artifact	3 (15.0%)	0 (0.0%)	14 (36.8%)	3 (8.6%)
< 1/2 of orig. artifact	2 (10.0%)	1 (6.7%)	0 (0.0%)	3 (8.6%)
small fragment	4 (20.0%)	3 (20.0%)	0 (0.0%)	7 (20.0%)
uncertain	1 (5.0%)	0 (0.0%)	0 (0.0%)	1 (2.9%)

densities is less than 0.05. The ratio of tools to debitage is somewhat higher in the northeast sector than it is in the southwest sector or in the floor (Table 8).

Modified Artifacts

The frequencies and proportions in which the various types of modified artifacts are represented in the floor and in the samples from the two sectors of the roof of HP 7 are shown in Table 9. The frequencies, in each sector, of the selected types which were extracted from all excavated roof deposits are presented in Table 10. The total number of artifacts in the roof and in each of the sectors was estimated from the sample data and Table 10 also includes the proportions which the selected types represent of the estimated total number of artifacts.

Utilized flakes, scrapers, expedient knives, projectile points, notches, and miscellaneous artifacts are the only categories which, individually, make-up more than 5% of the modified artifacts in the sample from the roof of HP 3. Together they account for 63% of the artifacts found in the roof and 67% of the artifacts found in the floor (see Table 9). The remaining types occur in such low frequencies that variability between the samples from the two sectors of the roof and between the floor and the sampled roof could easily be the result of stochastic variation or sampling error. Overall, scrapers represent a much smaller proportion of the artifacts found in the roof than on the floor. Expedient knives, utilized flakes, points, and notches are correspondingly more abundant, proportionately, in the roof and rarer on the floor.

Among the modified artifact types culled from the whole of the excavated roof, projectile points, bifaces, and bipolar cores, each represent a similar proportion of the modified artifacts in each of the two roof sectors and are much more abundant in the roof than in the floor. Pipe fragments, ornaments, pièces esquillées, and bifacial knives are present in both sectors of the roof but absent in the floor. The southwest sector of the roof also includes the only convergent knife-like biface in the entire housepit assemblage. Piercers, spall tools, and hammerstones are slightly more abundant in the floor than in the roof. The other selected types occur in fairly similar proportions in both the roof and the floor.

In the sampled subsquares, the northeast sector of the roof is most similar to the floor in that it is poorer in utilized flakes and expedient knives and richer in scrapers than the southwest sector.

Insofar as similarity with the floor assemblage is an indication that an area was used as a dump, the northeast sector of the sampled roof appears more likely to have been used for this activity than the southwest sector on the basis of artifact type distributions. However, the greatest differences are between the floor and the roof as a whole.

Wear

The proportions of modified artifacts which were new, worn, or sharpened in the floor and in each of the two sectors of the roof of HP 3 are shown in Table 11. In general, tools from the southwest sector exhibit slightly more wear than tools from the northeast sector. However, both of the roof sectors are more similar to each other in this respect than they are to the floor, where new tools are comparatively abundant and resharpened tools are comparatively rare. This is what one might expect from roof accumulations derived from dumping.

Fragmentation

The proportions of modified artifacts on the floor and in each of the two sectors of the roof of HP 3 which were in each of the five fragmentation states are shown in Table 12. Fragments smaller than 3/4 of the original artifact are considerably more abundant in the roof than in the floor. There is very little difference between the two sectors of the roof in terms of the relative frequencies of fragmented (as opposed to whole or chipped) artifacts (57.8% in the southwest vs. 55.3% in the northeast). The very smallest fragments are most abundant in the northeast sector but it is unclear how this should be interpreted. Overall, the fragmentation states of these modified artifacts are also consistent with the argument that the roof was used for dumping rather than special activities.

Debitage

The relative frequencies with which various types of debitage occurred in the floor of HP 3 and in the samples from the two sectors of the roof are presented in Table 13. The greatest difference between the floor and the sampled roof is in the relative frequencies of flakes with cortex, which are most abundant in the floor. In this respect, and in almost every other, debitage on the floor is more similar to the debitage in the sample from the northeast sector of the roof than it is to the debitage in the sample from the southwest sector of the roof. The only exception is in the relative frequencies of shatter which is more abundant in the northeast sector of the roof than in either the floor or the southwest sector. Most of the debitage differences between the two sectors of the roof are small but the consistently greater similarities between the floor and the northeast sector of the roof do suggest that the northeast sector is the most likely location for a rooftop dump used for the disposal of materials collected from the floor.

Table 7. Frequencies and percentages of lithic debitage in different categories on the floor and in the two sectors of the sampled roof of HP 12.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
total flakes	184	258	672	442
large flakes (> 2 cm)	45 (24.5%)	73 (28.3%)	175 (26.0%)	118 (26.7%)
chalcedony & chert flakes	5 (2.7%)	16 (6.2%)	16 (2.4%)	21 (4.8%)
quartzite flakes	0 (0.0%)	7 (2.7%)	(0.0%)	7 (1.6%)
obsidian flakes	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
billet flakes	6 (3.3%)	5 (1.9%)	28 (4.2%)	11 (2.5%)
flakes with cortex	10 (5.4%)	13 (5.0%)	36 (5.4%)	23 (5.2%)

Table 8. Lithic artifact densities in the floor and the two sectors of the sampled roof of HP 3.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
Subsquares	53	63	240	116
Volume (litres)	965.00	1342.50	2431.20	2307.50
Debitage	803	689	2146	1492
FCR	90	183	190	273
tools	89	100	276	189
flakes/litre	0.83	0.51	0.88	0.65
fcr/litre	0.09	0.14	0.08	0.12
tools/litre	0.09	0.07	0.11	0.08
tools/flakes	0.11	0.14	0.13	0.13

Synopsis

In HP 3 modified artifacts are more worn and more fragmented in the roof than in the floor, which suggests that lithic artifacts discarded in the course of activities on the floor of HP 3 were dumped on the roof. However, in terms of the proportions in which different types of modified artifacts and debitage occur, there are enough differences between the floor and the two sectors of the roof, to suggest that the roof was also used for activities other than dumping. The southwest sector of the roof differs most from the floor in these respects. So the southwest sector may have been preferred for rooftop activities.

Table 9. Modified artifact types in the floor and the two sectors of the sampled roof of HP 3.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
utilized flakes	23 (25.8%)	20 (20.0%)	43 (15.6%)	43 (22.8%)
expedient knives	22 (24.7%)	20 (20.0%)	40 (14.5%)	42 (22.2%)
scrapers	7 (7.9%)	11 (11.0%)	62 (22.5%)	18 (9.5%)
projectile points	5 (5.6%)	14 (14.0%)	23 (8.3%)	19 (10.1%)
notches	7 (7.9%)	10 (10.0%)	19 (6.9%)	17 (9.0%)
bifaces	2 (2.3%)	3 (3.0%)	6 (2.2%)	5 (2.6%)
bipolar cores	3 (3.4%)	4 (4.0%)	5 (1.8%)	7 (3.7%)
end scrapers	1 (1.1%)	3 (3.0%)	4 (1.5%)	4 (2.1%)
cores	1 (1.1%)	0 (0.0%)	3 (1.1%)	1 (0.5%)
piercers	1 (1.1%)	1 (1.0%)	8 (2.9%)	2 (1.1%)
spall tools	0 (0.0%)	0 (0.0%)	6 (2.2%)	0 (0.0%)
ground stone	0 (0.0%)	1 (1.0%)	6 (2.2%)	1 (0.5%)
drills & perforators	0 (0.0%)	0 (0.0%)	1 (0.4%)	0 (0.0%)
bifacial knives	1 (1.1%)	1 (1.0%)	4 (1.5%)	2 (1.1%)
hammerstones	0 (0.0%)	0 (0.0%)	5 (1.8%)	0 (0.0%)
key-shaped scrapers	0 (0.0%)	0 (0.0%)	1 (0.4%)	0 (0.0%)
ornaments	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
pipe fragments	1 (1.1%)	1 (1.0%)	0 (0.0%)	2 (1.1%)
miscellaneous	13 (14.6%)	11 (11.0%)	39 (14.1%)	24 (12.7%)
total	**89**	**100**	**276**	**189**

Housepit 7

Density Distributions

Housepit 7 is the largest housepit analyzed. Greater socioeconomic differentiation has been attributed to the group which inhabited this pithouse than to the groups which resided in the other two houses. Density figures for the various categories of lithic artifacts on the floor and in the samples from each of the two sectors of the roof are presented in Table 14.

Fire-cracked rock is clearly more densely distributed in the northeast sector of the roof of HP 7 than it is in the southwest sector (Fig. 3). Debitage densities are overwhelmingly higher in the sampled subsquares in the southwest sector. The probability that the samples from the two sectors were drawn from populations with the same distribution of debitage densities is less than 0.001. Modified artifact density is also higher in the southwest sector than in the northeast sector. The ratio of modified artifacts (tools) to flakes is highest in the floor. There is little difference in the tool:debitage ratio between the samples from the two sectors of the roof.

Modified Artifacts

The frequencies and proportions in which the various types of modified artifacts are represented in the floor and in the samples from the two sectors of the roof of HP 7 are shown in Table 15. The frequencies, in each sector, of the selected types which were extracted from all the excavated roof deposits are presented in Table 16. The total number of artifacts in the roof and in each of the sectors was estimated from the sample

Table 10. Frequencies of selected modified artifact types in all excavated subsquares from the floor and the two sectors of the roof of HP 3 with percentages of estimated total numbers of artifacts based on sample data.

	SW roof	NE roof	Floor	Roof
projectile points	34 (18.9%)	36 (18.8%)	23 (8.3%)	70 (18.8%)
bifaces	10 (5.6%)	11 (5.7%)	6 (2.2%)	21 (5.6%)
bipolar cores	15 (8.3%)	16 (8.3%)	5 (1.8%)	31 (8.3%)
pièces esquillées	1 (0.6%)	1 (0.5%)	0 (0.0%)	2 (0.5%)
end scrapers	3 (1.7%)	3 (1.6%)	4 (1.4%)	6 (1.6%)
cores	5 (2.8%)	2 (1.0%)	3 (1.1%)	7 (1.9%)
piercers	1 (0.6%)	2 (1.0%)	8 (2.9%)	3 (0.8%)
spall tools	2 (1.1%)	3 (1.6%)	6 (2.2%)	5 (1.3%)
ground stone	5 (2.8%)	4 (2.1%)	6 (2.2%)	9 (2.4%)
drills & perforators	0 (0.0%)	1 (0.5%)	1 (0.4%)	1 (0.3%)
bifacial knives	1 (0.6%)	2 (1.0%)	0 (0.0%)	3 (0.8%)
convergent knife-like bifaces	1 (0.6%)	0 (0.0%)	0 (0.0%)	1 (0.3%)
hammerstones	1 (0.6%)	1 (0.5%)	5 (1.8%)	2 (0.5%)
key-shaped scrapers	1 (0.6%)	2 (1.0%)	1 (0.4%)	3 (0.8%)
ornaments	0 (0.0%)	1 (0.5%)	0 (0.0%)	2 (0.5%)
pipe fragments	2 (1.1%)	4 (2.1%)	0 (0.0%)	6 (1.6%)
estimated total number of artifacts	**180**	**192**	**276**	**372**

data and Table 16 also includes the proportions which the selected types represent of the estimated total number of artifacts.

As in HP 3 and HP 12, the most frequently occurring modified artifact types in both the floor and the sample from the roof of HP 7 are utilized flakes, expedient knives, scrapers, and miscellaneous artifacts (see Table 15). Expedient knives are the most abundant type in both sectors of the roof and scrapers are correspondingly rare. In the southwest sector of the sampled roof, utilized flakes are also relatively rare. On the floor, all three types occur in fairly similar proportions. Notches are proportionately most abundant in the sample from the southwest roof sector and rarer in the sample from the northeast sector and the floor.

Of the selected types which were extracted from all excavated roof samples, bipolar cores, end scrapers, cores, piercers, and hammerstones are notably more abundant, proportionately, in the floor than in the roof. Projectile points are proportionately more abundant in the roof than in the floor. Pipes are absent in the floor but present in the roof. With selected types, the estimated proportionate differences between the floor and the roof tend to be small. Only in the cases of end scrapers and bipolar cores is the difference greater than 1%.

Within the roof, the differences between the proportions in which the selected types occur in the two sectors also tend to be small. The southwest sector is proportionately richer in projectile points, end scrapers, cores, key-shaped scrapers, piercers, drills and perforators, and bifacial knives. The northeast sector is richest in bifaces, bipolar cores, pièces esquillées, ground stone, and pipes. The northeast sector also contained the only convergent knife-like bifaces and the only hammerstone in the roof.

While modified artifact density in the southwest sector of the roof is greater than in the northeast sector, the roof deposits are considerably thicker in the northeast sector and the two sectors are quite similar in terms of the number of artifacts per unit area (3.8 artifacts per sampled subsquare in the southwest sector vs. 3.4 artifacts per sampled subsquare in the northeast). The excavated area in the northeast sector is also considerably greater than that in the southwest sector. Thus, the total estimated number of modified artifacts in the northeast sector is nearly twice that for the southwest sector (1330 vs. 686). Nearly twice as many modified artifacts of the selected types were found in the northeast sector as in the southwest sector (202 vs. 117). So, it is not surprising that almost all of the selected types occur in greater numbers in the northeast sector than in the southwest. The exceptions are bifacial knives

Table 11. Frequencies and percentages of modified chipped stone artifacts in different wear categories on the floor and in the two sectors of the sampled roof of HP 3. Percentages are based on the number of all chipped stone artifact types, excluding cores and bipolar cores, recovered from the floor excavation and the roof samples.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
new	17 (20.72%)	14 (14.9%)	46 (17.8%)	31 (17.4%)
worn	40 (47.6%)	47 (50.0%)	140 1(54.1%)	87 (48.9%)
sharpened	22 (26.2%)	29 (30.8%)	65 (25.1%)	51 (28.7%)
exhausted	1 (1.2%)	2 (2.1%)	4 (1.5%)	3 (1.7%)
uncertain	4 (4.8%)	1 (1.6%)	3 (1.2%)	5 (2.8%)

Table 12. Frequencies and percentages of modified chipped stone artifacts in different fragmentation states on the floor and in the two sectors of the sampled roof of HP 3. Percentages are base on the total number of chipped stone artifacts, excluding cores and bipolar cores, in the excavated floor and the sectors of the sampled roof.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
whole artifacts	43 (51.2%)	43 (45.7%)	152 1(58.5%)	86 (48.3%)
chipped artifacts	7 (8.3%)	7 (7.5%)	21 (8.1%)	14 (7.9%)
1/2-3/4 of orig. artifact	11 (13.1%)	19 (20.2%)	24 (9.2%)	32 (18.0%)
< 1/2 of orig. artifact	14 (16.7%)	9 (9.6%)	36 (13.9%)	23 (12.9%)
small fragment	7 (8.3%)	14 (14.9%)	25 (9.6%)	21 (11.8%)
uncertain	2 (2.4%)	2 (2.1%)	2 (0.8%)	4 (2.2%)

Table 13. Frequencies and percentages of lithic debitage in different categories on the floor and in the two sectors of the sampled roof of HP 3.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
total flakes	184	258	672	442
large flakes (> 2 cm)	45 (24.5%)	73 (28.3%)	175 (26.0%)	118 (26.7%)
chalcedony & chert flakes	5 (2.7%)	16 (6.2%)	16 (2.4%)	21 (4.8%)
quartzite flakes	0 (0.0%)	7 (2.7%)	(0.0%)	7 (1.6%)
obsidian flakes	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
billet flakes	6 (3.3%)	5 (1.9%)	28 (4.2%)	11 (2.5%)
flakes with cortex	10 (5.4%)	13 (5.0%)	36 (5.4%)	23 (5.2%)

Table 14. Lithic artifact densities in the floor and the two sectors of the sampled roof of HP 7.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
Subsquares	70	37	464	57
Volume (litres)	3140.8	2155.5	4347.5	5296.3
Debitage	2577	1622	5424	4199
FCR	355	1136	1393	1491
tools	265	125	885	390
flakes/litre	.82	0.75	1.03	0.93
fcr/litre	0.45	0.59	0.32	0.55
tools/litre	0.08	0.06	0.20	0.07
tools/flakes	0.10	0.08	0.20	0.09

Table 15. Modified artifact types in the floor and the two sectors of the sampled roof of HP 7.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
utilized flakes	66 (24.9%)	16 (12.8%)	188 (22.3%)	82 (21.0%)
expedient knives	74 (27.9%)	36 (28.8%)	164 (18.5%)	110 (28.2%)
scrapers	30 (11.3%)	14 (11.2%)	198 (22.7%)	44 (11.3%)
projectile points	15 (5.7%)	15 (12.0%)	49 (5.5%)	30 (7.7%)
notches	18 (6.8%)	7 (5.6%)	47 (5.3%)	25 (6.4%)
bifaces	8 (3.0%)	5 (4.0%)	26 (2.9%)	13 (3.3%)
bipolar cores	5 (1.9%)	3 (2.4%)	32 (3.6%)	8 (2.1%)
end scrapers	3 (1.1%)	6 (4.8%)	27 (3.0%)	9 (2.3%)
cores	7 (2.6%)	4 (3.2%)	19 (2.1%)	11 (2.8%)
piercers	3 (1.1%)	2 (1.6%)	13 (1.5%)	5 (1.3%)
spall tools	1 (0.4%)	0 (0.0%)	12 (1.4%)	1 (0.3%)
ground stone	1 (0.4%)	2 (1.6%)	10 (1.1%)	3 (0.8%)
drills & perforators	3 (1.1%)	3 (2.4%)	8 (0.9%)	6 (1.5%)
bifacial knives	3 (1.1%)	1 (0.8%)	3 (0.3%)	4 (1.0%)
hammerstones	0 (0.0%)	0 (0.0%)	8 (0.9%)	0 (0.0%)
key-shaped scrapers	3 (1.1%)	0 (0.0%)	6 (0.7%)	3 (0.8%)
ornaments	1 (0.4%)	0 (0.0%)	2 (0.2%)	1 (0.3%)
miscellaneous	25 (9.4%)	10 (8.0%)	72 (8.1%)	35 (9.0%)

and key-shaped scrapers. Both of these types make up a greater proportion of the estimated total number of modified artifacts in the southwest sector than in either the floor or the northeast sector. This may indicate that the southwest sector was the preferred location for some activity involving the use of bifaces and key-shaped scrapers. As argued in Volume I Chapter 12, and by Rousseau (1992), bifaces and key-shaped scrapers are tools generally associated with long-distance hunting. This suggests gearing-up and/or the repair and replacement of hunting tools as activities which may have occurred in the southwest sector of this roof.

The relative frequencies of utilized flakes in the two sectors of the roof suggests that the northeast sector is somewhat more similar to the floor than the southwest sector. Insofar as similarity to the floor can be taken as an indication of dumping, this distribution suggests that the northeast sector may have been used for this purpose. The modified artifact types which are proportionately most abundant in the southwest sector, notably key-shaped scrapers and bifacial knives, are likely to have been fairly highly curated types with specialized functions. This suggests that this sector is the more likely location for specialized activity areas. In this context it is also worth noting that bifaces in the early stages of reduction are rare in the southwest sector. Only 2 of the 21 Stage 2 and Stage 3 bifaces in the entire roof assemblage were found there. However, this sector does contain 7 of the 19 Stage 4 bifaces; 6 of them in a fairly tight group in the extreme southwest. Stage 4 bifaces are also likely to have been highly curated, specialized tools. By contrast, the bipolar cores which characterize the northeast sector are likely to have had a comparatively high discard rate and are, therefore, more likely to have been dumped as waste material rather than deposited in activity areas.

Wear

Compared to the floor, the roof of HP 7 is poor in new artifacts and rich in worn artifacts (Table 17). Sharpened artifacts occur in similar proportions in both strata. In the northeast sector of the roof a considerably greater proportion of the modified artifacts are worn and sharpened than in the southwest sector. This may indicate that dumping was more common in the northeast sector than in the southwest sector.

Fragmentation

In terms of the fragmentation states of modified artifacts (Table 18), the roof of HP 7 is distinguished from the floor by the scarcity of chipped artifacts. Broken, as opposed to chipped, artifacts are considerably more abundant in the roof than in the floor. This supports the argument that the roof was used as a dumping area. The smallest fragments are more common in the southwest sector of the roof than in the northeast sector.

Debitage

The relative frequencies with which various types of debitage occurred in the floor of HP 7 and in the samples from the two sectors of the roof are presented in Table 19. The most notable difference between the floor and the roof is in the relative frequency of billet flakes, which are rarer in the roof. The two sectors of the roof are quite similar in most respects. Obsidian is absent in the southwest sector but present in the northeast sector and on the floor. This suggests that the debitage in the northeast sector is more likely to have been collected from the floor. However, since obsidian flakes apparently occur in 7% of the subsquares in the roof, the probability that a sample of 23 subsquares would contain no obsidian flakes is fairly high (p = 0.182).

Table 16. Frequencies of selected modified artifact types in all excavated subsquares from the floor and the two sectors of the roof of HP 7 with percentages of estimated total numbers of artifacts based on sample data.

	SW roof	NE roof	Floor	Roof
projectile points	46 (6.7%)	72 (5.4%)	49 (5.5%)	118 (5.9%)
bifaces	14 (2.0%)	30 (2.3%)	26 (2.9%)	44 (2.2%)
bipolar cores	11 (1.6%)	29 (2.2%)	32 (3.6%)	40 (2.0%)
pièces esquillées	1 (0.1%)	2 (0.2%)	5 (0.6%)	3 (0.1%)
end scrapers	8 (1.2%)	10 (0.8%)	27 (3.1%)	18 (0.9%)
cores	10 (1.5%)	17 (1.3%)	19 (2.1%)	27 (1.3%)
piercers	4 (0.6%)	2 (0.2%)	13 (1.5%)	6 (0.3%)
spall tools	6 (0.9%)	11 (0.8%)	12 (1.4%)	17 (0.8%)
ground stone	1 (0.1%)	11 (0.8%)	10 (1.1%)	12 (0.6%)
drills & perforators	4 (0.6%)	5 (0.4%)	8 (0.9%)	9 (0.4%)
bifacial knives	6 (0.9%)	4 (0.3%)	3 (0.3%)	10 (0.5%)
convergent knife-like bifaces	0 (0.0%)	3 (0.2%)	0 (0.0%)	3 (0.1%)
hammerstones	0 (0.0%)	1 (0.1%)	8 (0.9%)	1 (< 0.1%)
key-shaped scrapers	6 (0.9%)	4 (0.3%)	6 (0.7%)	10 (0.5%)
ornaments	2 (0.3%)	1 (0.1%)	2 (0.2%)	3 (0.1%)
pipe fragments	1 (0.1%)	2 (0.2%)	0 (0.0%)	3 (0.1%)
estimated total number of artifacts	**686**	**1330**	**885**	**2016**

Table 17. Frequencies and percentages of modified chipped stone artifacts in different wear categories on the floor and in the two sectors of the sampled roof of HP 7. Percentages are based on the number of all chipped stone artifact types, excluding cores and bipolar cores, recovered from the floor excavation and the roof samples.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
new	106 (42.1%)	17 (14.7%)	303 (36.7%)	123 (33.4%)
worn	80 (31.8%)	55 (47.4%)	189 (22.9%)	135 (36.7%)
sharpened	34 (13.5%)	40 (34.5%)	223 (27.0%)	74 (20.1%)
exhausted	21 (8.3%)	1 (0.9%)	69 (7.9%)	22 (6.0%)
uncertain	11 (4.4%)	3 (2.6%)	41 (5.0%)	14 (3.8%)

Summary and Interpretation

Were lithic artifacts from the floors of these three housepits dumped on the roofs?

Several characteristics of the lithic assemblages in the roofs of the two largest housepits, HP's 3 and 7, suggest that lithic waste from the floors of these housepits was deposited on the roofs:

1) Fire-cracked rock is more densely distributed in the roofs than in the floors and is consistently concentrated in specific areas, most notably along the north and northeast edges of the roofs.
2) Despite the greater abundance of scrapers in the floors, a higher proportion of the modified artifacts in the roofs are extensively re-sharpened than in the floors. Relatively new tools are more abundant in the floors.
3) Whole and chipped tools are more abundant in the floors of these two housepits than in the roofs. Fragments of tools, especially the smallest fragments, are more common in the roofs.
4) The tool:debitage ratio is greater in the floors than in the roofs. It might be expected that a high proportion of the waste flakes generated at a pithouse would eventually be deposited in nearby dumps. On the other hand, a comparatively high proportion of modified artifacts would have been removed to other sites or deposited in the locations where they were used or stored. A high tool:debitage ratio may,

therefore, be characteristic of areas used for dumping.

5) Taken together, utilized flakes and expedient knives, which are likely to have been expediently used and to have had relatively high discard rates, are more abundant in the roofs of these two housepits than in the floors. The relative abundance of projectile points in both roofs is somewhat surprising. A high discard rate for points is one possible explanation. Another is that an unusually high proportion of points, which were presumably used in outdoor activities, were deposited in outdoor use contexts.

   Scrapers, which are more likely to have been stored for repeated use and to have had relatively low discard rates, are more abundant in the floors than in the roofs. Some of the rarer tool types which are also likely to have had relatively low discard rates also appear to be proportionately less abundant in the roofs than in the floors. Spall tools, drills and perforators, hammerstones, and key-shaped scrapers are all proportionately more abundant in both floors than they are estimated to be in the corresponding roofs. (Bifacial knives and end scrapers, however, appear to be most abundant in the roofs).

6) With the exception of a single ornament, six pipe fragments, and two pièces esquillées in the sample from the roof of HP 3 and three pipe fragments in the roof of HP 7, all of the artifact types which are represented in either roof are represented in the respective floors. It appears that smoking may have been an exclusively outdoor activity. Apart from that, it seems that if some parts of the roofs of HP 3 and HP 7 were used for activities which did not occur on the floors of those housepits, those activities must have involved the same tool types which were also used on the floors. By contrast, the floor of HP 12 lacks several (albeit rare) tool types which are present in the roof. This suggests that one part of the roof of HP 12 was used for activities which may not have occurred on the floors.

It is difficult to account for most of these characteristics without concluding that worn and broken tools as well as waste flakes and fire-cracked rock were removed from the floors and discarded on the roofs of HP's 3 and 7.

In HP 12, on the other hand, many of the differences between the roofs and the floors in the two larger housepits are reversed. There, the tool:debitage ratio is higher in the roof than in the floor. Utilized flakes are considerably more abundant in the floor than in the roof. Several types which are present in the roof are absent in the floor.

Table 18. Frequencies and percentages of modified chipped stone artifacts in different fragmentation states on the floor and in the two sectors of the sampled roof of HP 7. Percentages are base on the total number of chipped stone artifacts, excluding cores and bipolar cores, in the excavated floor and the sectors of the sampled roof.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
whole artifacts	155 (61.5%)	77 (66.4%)	328 (39.8%)	232 (63.0%)
chipped artifacts	30 (11.9%)	4 (3.5%)	371 (45.0%)	34 (9.2%)
1/2–3/4 of orig. artifact	24 (9.5%)	17 (14.7%)	75 (9.1%)	41 (11.1%)
< 1/2 of orig. artifact	18 (7.1%)	9 (7.8%)	25 (3.0%)	27 (7.3%)
small fragment	24 (9.5%)	6 (5.2%)	10 (1.2%)	30 (8.1%)
uncertain	1 (0.4%)	3 (2.6%)	16 (1.9%)	4 (1.1%)

Table 19. Frequencies and percentages of lithic debitage in different categories on the floor and in the two sectors of the sampled roof of HP 7. Data are incomplete for some categories and percentages are based on the total number of flakes for which data were recorded.

	SW roof (sample)	NE roof (sample)	Floor (complete)	Roof (sample)
large flakes (> 2 cm)	301 (32.0%)	489 (30.8%)	1232 (27.5%)	790 (31.3%)
chalcedony & chert flakes	88 (9.4%)	123 (7.8%)	395 (8.8%)	211 (8.3%)
quartzite flakes	12 (1.3%)	23 (1.5%)		35 (1.4%)
obsidian flakes	0 (0.0%)	4 (0.3%)	19 (0.4%)	4 (0.2%)
billet flakes	29 (3.1%)	39 (2.5%)	420 (9.4%)	68 (2.7%)
flakes with cortex	45 (4.8%)	65 (4.1%)	228 (5.1%)	110 (4.4%)

In other respects, HP 12 does bear a weak resemblance to HP's 3 and 7. Scrapers *are* slightly more abundant in the floor of HP 12 than in the roof sample but the difference between the roof and the floor is much smaller than in either of the larger housepits and too small to be statistically significant. As in HP's 3 and 7, a greater proportion of modified artifacts *are* whole or chipped in the floor of HP 12 than in the roof but, here too, the difference is small (2.5% difference) compared to the differences between the floors and the roofs of the larger housepits (12.6% difference in HP 7 and 10.4% difference in HP 3).

The only pattern which is clearly consistent between HP 12 and the two larger housepits is in the heavier wear states among the modified artifacts in the different strata. New artifacts are more abundant in the floors of all three of the housepits than in any of the corresponding roofs. Extensively sharpened artifacts are more abundant in the roofs than in the floors. In fact, the differences between floor and roof in this respect are extreme in HP 12 where 91.43% of artifacts in the floor exhibit no wear and 50% of the artifacts in the roof have been extensively re-sharpened.

Apart from greater stochastic variation due to smaller sample size, there are at least two possible reasons why rooftop activities, as opposed to rooftop dumping, may have been more important in the formation of the lithic assemblage from the roof HP 12 than was the case in the roofs of the two larger houses. First, because HP 12 is so much smaller, there may simply not have been enough indoor space for some of the activities which occurred inside the larger houses. These activities may, of necessity, have been moved to the roofs. As was suggested above, the fact that many modified artifact types which are present in the roof sample are absent in the floor may indicate that the roof was used for some activities that did not occur on the floor.

Second, HP 12 appears to have had few internal posts to support the roof. Only one posthole was identified in the floor of HP 12. The entrance to this housepit may, therefore, have been at the the side of the roof rather than through the smokehole in the center of the roof. Such entryways can be seen in photographs of some smaller earth-banked winter lodges lacking internal posts (Alexander 1992: Plate 3.3) and have been documented in HP 90 at Keatley Creek. If lithic waste were removed from the floor through a doorway in the rim, it would be distributed in a very different pattern than if it were thrown down from the center of the roof. Debitage and modified artifacts might simply be thrown through the door onto the ground. Fire-cracked rock may have been piled on the roof, away from the door, because it would be more likely to become an obstacle around the doorway. It may also have been a useful addition to roof soil.

Did any activities other than dumping occur on the roofs?

Housepit 12

As noted in the previous section, the diversity of modified artifact types in the roof of HP 12, their relatively low degree of fragmentation, and the relatively high tool:debitage ratio suggest that some activities occurred on the roof of that house which did not occur on the floor. In the two larger houses, on the other hand, the roof assemblages, in general, are characterized by properties attributed to the dumping of lithic refuse. While these observations are indicative of the processes which were dominant in the formation of each roof assemblage as a whole, they do not preclude the possibilty that some areas in any of the roofs of the larger housepits were used as activity areas or that some part of the roof of HP 12 was used as a dump.

Evidence of dumping in the roof of HP 12 and, indeed, in all three roofs can be seen in the uneven distribution of fire-cracked rock. Fire-cracked rock was almost certainly deposited in the roofs as refuse which originated on the floors. Its patterned distribution indicates that it was most probably removed from the floors and deliberately deposited on the northern parts of the roofs while the houses were occupied. If it had been incorporated into the roofs during the process of reroofing it seems unlikely that its distribution would be so patterned and so different from the distribution of debitage (Figs. 1–6), or that the patterning would be so consistent between housepits.

In the roof of HP 12, the northeast sector has the most whole artifacts, the greatest modified artifact diversity, and the greatest fire-cracked rock density. This may indicate that, at least in HP 12, some outdoor activities occurred in the same area where fire-cracked rock and other lithic waste was dumped.

The southwest sector of the roof of HP 12 is more similar to the floor than to the northeast sector in terms of: modified artifact diversity; the proportions in which different modified artifact types, different material types, and different fragmentation states are represented among modified artifacts; and the proportions in which various flake types and material types are represented in debitage. Only the distribution of wear states clearly departs from this pattern. Relatively unused artifacts are much more common in the floor than in either sector of the roof. On the whole, though, the southwest sector of this roof is similar enough to the floor, in most respects, to suggest that this part of the roof was rarely used as an activity area. The lithic assemblage in the southwest sector of the roof is more characteristic of artifacts which originated on the floor. Either they were discarded and removed from the floor during the period when the house was occupied or they were scraped from an abandoned floor and redeposited on the roof during the process of roof reconstruction. The apparent concentration of lithic artifacts in limited areas within the southwest sector suggests that at least some of those artifacts were dumped on the roof rather than mixed into roof soils during the process of reconstruction.

Housepit 3

In HP 3, the northeast sector of the roof has been identified as the most probable location for a rooftop dump both because of the northerly concentration of fire-cracked rock and because the northeast sector is most similar to the floor in many respects. The proportions in which the various types of flakes, including flakes with cortex, and the different raw material types occur in the debitage in the northeast sector are more similar to the proportions in which they occur on the floor than to the proportions in which they occur in the southwest sector. The same can be said of material types among modified artifacts. The proportions of utilized flakes, expedient knives, and scrapers among modified artifacts on the floor are more similar to those in the northeast sector than those in the southwest sector.

A greater proportion of the modified artifacts in the northeast sector are fragmented (as opposed to whole or chipped) and a greater proportion are re-sharpened than on the floor. The differences between the floor and the northeast sector in both respects are probably due to selective discard of re-sharpened and broken artifacts in the northeast sector of the roof. However, even higher proportions of the modified artifacts in the southwest sector of the roof are fragmented and re-sharpened. Also, the tool:-debitage ratio is less in the southwest sector than in either the northeast sector or the floor. These distributions are not consistent with what would be expected if the southwest sector had been reserved exclusively for some activity other than dumping. Rather, they suggest that dumping was not restricted to the northeast sector. The southwest sector may have served both as an activity area and as a dump.

The southwest sector is distinguished from the northeast chiefly by a relative abundance of utilized flakes and by relative scarcities of scrapers, and notches. A low discard rate has been attributed to scrapers and there is no obvious reason to suppose that the discard rate for notches would be especially high. So it is not surprising that these types should be scarce in an area used only for dumping. Conversely, given the high discard rate attributed to utilized flakes, they might be expected to occur in high proportions in areas used as dumps. It is not clear, though, why utilized flakes should be considerably more abundant in the southwest sector than in the northeast sector if the only activity which occurred in both sectors was dumping. There may have been some reason that utilized flakes were preferentially discarded in the southwest sector, but it seems equally likely that the higher proportion of utilized flakes among the modified artifacts in the southwest sector is the result of some additional activity in that sector which involved the use of this modified artifact type. To summarize, the distributions of lithic artifacts in the roof sample suggest that, in HP 3, unlike HP 12, dumping occurred in both sectors of the roof and that additional roof-top activities enriched the southwest sector in certain tool types (utilized flakes).

Housepit 7

While neither sector of the roof of HP 7 was clearly more similar to the floor, the distribution of fire-cracked rock, the distributions of modified artifact types, the high proportions of worn and extensively re-sharpened artifacts, and the high proportion of fragmented artifacts in the northeast sector identified this sector as the more probable location for a dump on the roof of this housepit. As in HP 3, whole and chipped artifacts are more abundant in the floor than in either sector of the roof and the southwest sector does contain a concentration of fire-cracked rock. So it seems likely that dumping also contributed to the formation of the assemblage in the southwest sector of the roof.

As in HP 3 (and HP 12), the southwest sector of the roof of HP 7 is characterized by a high proportion of utilized flakes. This similarity between the housepits lends some support to the argument that similar activities occurred in the southwest sectors of these roofs. The southwest sector of the roof of HP 7 is also comparatively rich in Stage 4 bifaces, bifacial knives, and key-shaped scrapers, which may also indicate the occurrence of some special activities in this zone.

What activities, other than dumping, may have occurred on the roofs?

The distributions of modified artifact types are really the only clues that the lithic assemblages provide as to the nature of whatever activities may have occurred on the roofs of these three pithouses. These data allow considerable latitude for speculation, but I will propose some possible interpretations.

Utilized flakes are the modified artifact type which are most clearly characteristic of the southwest sectors of both of the two larger housepits (HP's 3 and 7). These are such general purpose tools that they may have been deposited in the course of any number of activities. Given the apparent association of dense clusters of utilized flakes with high densities of fire-cracked rock in the southwest sectors of the roofs of both HP 3 and HP 7, the preparation of foodstuffs is one possibility. Manufacturing processes involving plant fibers or dressed skins are another.

Most of the more specialized artifact types for which complete samples were collected occur in the roofs of these two HP's, (and in the southwest sectors) in sufficient numbers to suggest that activities associated with these artifact types are at least as likely to have occurred on the roofs as on the floors. Hammerstones are one possible exception. The scarcity of hammerstones in the two roofs may indicate that activities involving the early stages of lithic reduction were not common on the roofs or it may indicate that these tools were stored elsewhere.

Pipe fragments are absent in the floors but present in both roofs, especially in the northeast sectors. This may indicate that smoking was primarily an outdoor activity.

None of the more specialized types for which a complete roof inventory was obtained is consistently associated with either the southwest or the northeast sector in both HP 3 and HP 7. In HP 3 most of these types tend to be fairly evenly distributed between the two sectors. The southwest sector of HP 7 is distinguished by an abundance of key-shaped scrapers and bifacial knives. Key-shaped scrapers have been identified with the preparation of wooden shafts (Rousseau, 1992). Bifacial knives are robust tools with relatively acute cutting edges suited to sawing or slicing and may have been associated with woodworking or heavy butchering (see Vol. I, Chap. 12).

What factors may have determined which areas on a roof were selected for which activities?

Whatever activities, other than dumping, may have occurred on the roofs of these three housepits, both the distributions of fire-cracked rock and the distributions of modified artifacts suggest that orientation to the sun or to the compass played some role in determining which areas on a roof were used for which activities. However, apart from the disposal of fire-cracked rock, dumping of lithic artifacts does not seem to have been restricted to one sector or another.

Rather it appears that while fire-cracked rock was preferentially dumped in the northern parts of the roofs of all three housepits, dumping of debitage and modified lithic artifacts was not restricted to either sector (Figs. 4–6). Thus dumping was not restricted to the northern parts of the roofs simply because the ladders were laid against the north side of the smokehole. Only fire-cracked rock appears to have been selectively dumped to the north, either because it served some purpose there or because it would have interfered with some activity in the southern areas. Certainly, fire-cracked rock is bulkier and more obtrusive than other kinds of lithic debris.

However, insofar as there are some indications in the lithic assemblages of activities other than dumping on the roofs, it does not appear that, when locations were selected for activities involving the use of stone tools, areas where fire-cracked rock had been dumped were necessarily avoided. In fact, the apparent close association of fire-cracked rock with utilized flakes in the southwest sectors of the three roofs suggests that the dumping of fire-cracked rock may have been associated with some activity there. Perhaps fire-cracked rock was dumped in designated outside activity areas so that lithic elements could be sorted for recycling and use.

Instead of being excluded from activity areas, fire-cracked rock may have been discarded where there was least foot traffic on the roof or even where it served some positive purpose. It is possible, for example, that fire-cracked rock served to bulk up the roof covering in the northern parts of the roofs or to help keep insulation in place.

On the other hand, there are some possible rooftop activities, or inactivities, which need not have involved the deposition of any lithic artifacts. Dumps of fire-cracked rock might have been especially inconvenient in rooftop areas set aside for basking in the warmth of a winter's afternoon sun.

The choice of locations for different activities on the pithouse roofs was probably influenced by other factors, besides orientation to the sun. Wind direction or proximity to water or fuel are possibilities. Orientation to the river or the mountains may have had some symbolic significance. At any rate, it is remarkable that orientation of lithic artifact distributions is so similar in all three housepits.

The aim of this paper was to investigate the processes by which lithic artifacts were introduced into housepit roof deposits. Some of these artifacts undoubtedly derive from the incorporation of floor deposits in roof soils during reroofing events. This process probably accounts for background distributions of fire-cracked rock, debitage, and modified artifacts throughout the roof deposits. However, it can be concluded, on the basis of the distinctive characteristics of concentrations of lithic artifacts in the roofs, that the roofs of these three housepits were used both for dumping and for some other activities. We cannot say with certainty, at this point, what those activities were but there are indications that similar locations on the roofs were chosen for similar activities in all three houses.

These three housepits hardly represent an adequate sample of the more than one hundred housepits at the site. Overall though, the results of this preliminary analysis certainly suggest that there are patterns in the distributions in the housepit roofs which are worthy of future investigation.

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Chapter 15

An Analysis of Lithic Artifacts from the Rim Deposits at HP 7

William C. Prentiss

Introduction

The goal of this report is to summarize the current data on lithic artifacts in the rims of HP 7 at the Keatley Creek Site. I then assess these data for their potential to answer a number of significant questions pertaining to the formation of the rim deposits. First, I evaluate temporal resolution in the rim deposits based on the distribution of temporally diagnostic artifacts. I follow this with an assessment of temporal variation in other lithic artifact types. Second, I evaluate spatial variation in rim lithic debitage, tool, and core assemblages. Here, I am primarily interested in differences or similarities between excavated units on the rim and how this might reflect variation in activities on the roof and rims or in practices which produced the build-up of sediments in these areas such as pre-winter occupation roof/floor excavation and dumping on the rim. Finally, I compare the overall distribution of floor and rim lithic debitage, tool, and cores to examine the idea that rim deposits are made up primarily of redeposited floor and roof materials. In the analysis of floor deposits in housepits, it was particularly important to determine if there were any biases in the representation of specific tool types or tool states due to their use outside versus inside the structure or due to selective discard of some types onto the rim middens. Therefore, this detailed analysis was undertaken.

As this report represents an initial assessment of the rim data, I also make recommendations regarding sources of error which may confound certain interpretations. I make reference to several key terms: random and systematic error, and reliability and validity. Random and systematic error are classified under the general term, measurement error (see Amick et al. 1989 for a discussion of the relationship between measuring instruments and measurement error with special reference to lithic studies). A measuring instrument is a device or procedure which provides measurements (such as a lithic tool typology). Measurement error is defined as the difference between some theoretically true score (or measurement unaffected by error) and an actual observed score (see Nance 1987 on true score theory). Random errors are truly random. They are as likely to contain negative deviations as positive deviations from the true value. Random error is produced by limits in measuring instrument precision as well as actual errors by the operator. Systematic errors are directional. In other words, they produce predictable deviations from true scores. They can be the result of idiosyncratic tendencies of the instrument operator and bias in instrument design.

Reliability studies attempt to assess the replicability or the consistency of measurements. Reliability studies are concerned with random error. An instrument might be considered to be reliable if it has very little random error. Validity studies attempt to identify sources of systematic error. An instrument might be considered valid if it has low systematic error. Thus, it would measure what it is intended to measure (Nance 1987).

Excavations of the HP 7 rim deposits were accomplished between the years of 1986 and 1989. Discussions of rim sediments and stratigraphy may be found in Volume I, Chapter 17 and Volume III, Chapter 6. I rely upon these reports and the original field notes of the excavators to identify sedimentary units belonging to the rim (as opposed to the roof, floor, or other deposit types). The lithic artifacts excavated from these sedimentary units are the focus of this report. Identification and coding of lithic tool, core, and flake types has been accomplished by a number of different analyses. Two possibly significant sources of measurement error may exist in the data set used in this study. First, variation between analysts may introduce substantial variation in artifact classifications (Nance 1987; J. Nance, personnal communication) thus lowering the reliability of the study (Carmines and Zeller 1979; Nance 1987). Fortunately, some of these reliability problems may have been mitigated through supervision and review of all analytical results by B. Hayden. However, the problem of data reliability has not been quantitatively assessed. Thus, in this report, I attempt to identify potential sources of error variability in the data. The second potential source of error may be that of data gaps or missing samples of artifacts. With much assistance from J. Spafford, I have attempted to assemble complete data sets for each of the excavation units considered. However, there remains the possibility that some data may be missing as both temporally diagnostic and exotic raw material artifacts have been removed, coded, and entered into different data sets at different times throughout the last five years. This possible source of systematic error is more difficult to recognize.

In this report, I make no attempt to explore the interesting, but complex taphonomic problems of housepit rim formation. Lithic assemblages found in rim deposits may have been affected by such processes as weathering, trampling, human and non-human size-sorting agents, and scavenging. These are problems which will require far more extensive consideration than is possible here. They are also problems which may well affect the reliability and validity of the conclusions attempted in this report.

Methods

In this report I do not consider raw material variation or taphonomic variables such as staining, weathering and breakage. Nor do I consider data from deposits designated as roof, floor, post-hole, pit or surface. Quantification does not extend beyond type frequencies, percentages, means, standard deviations and the coefficient of variation (CV) statistic. Coefficients of variation are used to identify variation within assemblages of artifacts. This information is important for attempting to identify the source of that variation, whether archaeological or error related.

The artifact and flake typology followed is described in Volume III, Chapter 1. For analytical purposes this lengthy list has been collapsed into a more concise set of types:

Type 1	Miscellaneous (types 1, 2, 4, 135, 182, 171, 143, 148)
Type 2	Middle Period Projectile Points Shuswap Phase Projectile Points Plateau Phase Projectile Points
Type 3	Kamloops Phase Projectile Points
Type 4	Acute edge angle flake tools (minimal retouch) (types 70, 170-172, 140, 180, 142)
Type 5	Obtuse edge angle flake tools (minimal retouch) (types 161, 162, 150, 141, 156, 163, 164, 165, 154)
Type 6	Bifaces (types 131, 192, 193, 130, 134, 138)
Type 7	Spall Tools (types 183, 184)
Type 8	Obtuse edge angle tools (heavy retouch) (types 155, 150, 141, 156, 163, 164, 165)
Type 9	Piercing and Boring Tools (types 151, 152, 132, 133, 153)
Type 10	Bipolar Cores (types 146, 145)
Type 11	Other Cores (type 186)
Type 12	Groundstone (types 200–15)
Type 13	Microblade Cores (types 147–149)

Categorizations of minimal versus heavy retouch are based upon visual recognition and categorization of edge wear states based upon a scale developed by Hayden and Spafford.

Data Base

To facilitate a discussion of the lithic artifacts from the HP 7 rim, I first discuss the nature of the data base. For each excavation square, I consider excavation strategies, degree of stratigraphic complexity and our ability to recognize rim deposits versus those of the roof, floor, slopewash, or other sources. These considerations will provide the context for archaeological interpretations.

Trench 1 of Square AA was excavated in natural statigraphic levels and contains 15 levels within Stratum XIII (rim). Rim deposits appear to have been easily recognized by the excavator. An earlier occupation extends below the rim in this area which is not considered in this study. All tool, core, and debitage data have been incorporated in this analysis.

Two trenches were excavated in Square D. There are tool and core data available from Trench 1 from 1986, however, no debitage data are recorded in the database. Rim deposits were recognized readily by the excavators.

Two trenches were excavated in Square K. Stratigraphic designations in this square are quite complex and rather confusing. Trench 1 appears to contain 15 natural levels identified as rim deposits. Trench 2 contains 20 natural levels identified as rim deposits. I have attempted to place them in relative stratigraphic order for purposes of this study, but further work may be necessary. One problem appears to be that of relative comparability of stratigraphy between the two trenches designated and organized differently by different excavators. Tool, core, and debitage data are available for all identified levels.

Field notes from Square L identify excavation of one trench containing six natural levels and a second trench with eight natural levels attributable to rim deposits. Profile maps indicate the presence of two additional designations within the rim deposits (XIIIC and XIIID) which are not described in the field notes. No artifacts are available for these stratigraphic units. Data regarding tools and cores and debitage however, are available for the noted 14 levels of Trenches 1 and 2. Excavators note no problems in recognizing rim deposits.

The identification of rim deposits in Squares S and T appears to be somewhat problematic as these deposits have apparently been affected by slopewash from the east. Each contains five natural levels presumed to be rim-related. Tool, core, and debitage data are available for all.

Tool and core data are available from 15 natural rim deposit levels of one test trench (Trench 2) in Square N. All level designations are clearly rim deposits with the exception of two. Levels XIIIE-1 and XIIIF-1 may represent pit fill associated with a pit located below the rim deposits.

Tool, core, and debitage data are available for two trenches from Square M. Trench 1 was excavated in arbitrary 10 cm levels. The artifact assemblages are clearly mixed with two or more natural stratigraphic units contributing artifact samples to single collection bags. This may have severe implications for statements on choronological resolution. Within Trench 1, all arbitrary levels indicate rim with the exception of the bottom four, which according to the excavator, represent a pit below the rim. Trench 2 produced 14 natural levels representing rim deposits. The bottom three designations (XIIIF1-3) are not classic rim sediments, but contain high quantities of churned till materials. These may represent the early stages of housepit excavation and thus could be identified as the initial rim from the house. They may also be the result of adjacent pit excavation. Further consideration will be necessary to resolve this problem.

Square O was excavated in subsquares, of which six contain rim deposits with tool, core, and debitage data. Natural level designations range from 4, in subsquare 4, to 10 in subsquare 11. Rim deposits appear to have been easily identified by the excavators.

Chronological Resolution

Considering the tool and core data presented in Tables 1–9, I first assess variability in temporally diagnostic artifacts. If there is high chronological resolution, early period artifacts will be found in lower stratigraphic contexts while later period materials will be found primarily in upper stratigraphic contexts. Building upon this I assess variation in overall tool, core, and debitage assemblage data.

Temporally diagnostic artifacts are found in Squares AA, K and D, located on the south and south-west sides of HP 7. In Square AA, five Shuswap projectile points are found in the lowest levels (XIIIC6 and XIIIF3) while one Kamloops point is situated in an upper level (XIIIB-1). Two Plateau points were found in what appear to be middle levels of Square D (Levels 8 and 9). Square K contains a wide variety of diagnostic artifacts including Plateau points found in the upper and lower middle levels (XIII-4 and XIIIB6-1 respectively) of Trench 1. One key-shaped formed uniface is located in the middle of the Trench 1 sequence (XIII-8). In Trench 2, one Kamloops and one Plateau point are found in an upper level sequence (levels XIIIA4 and XIIIB1-2). No temporally diagnostic artifacts are found in Square L.

Moving to the east side of HP 7, Square T contains one key-shaped formed uniface. This artifact is located in what appears to be a middle level (2A) of the rim/slopewash deposits found in this area.

Square N, located on the north side of the house, contains one Kamloops point, found in an upper level (XIIIA2). In Trench 1 of Square M a Plateau point is found stratigraphically above four Kamloops points (one is a preform). This may be the result of mechanical mixing from arbitrary level excavations. Trench 2 of Square M contains one Kamloops point in the upper middle portion of the stratigraphic profile (XIIIB4). One Shuswap point is found in the basal zone of subsquare 4 in Square O. No other temporally diagnostic artifacts are found in Square O.

Table 1. Square AA Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
T1 XIIIA1		2	2			1									
XIIIB1	1	3	2								1				1
2	2	2	4												
3	5	5	3	3			4								
4	4	4	5			1	2			1					
5		4	1												
XIIIC1		9	4				2								
2		8	3												
3	2	8	2				1	1		1					
4	3	4	6	1			2			1					
5		4		1			1								
6	8	17	9	3			5	1					2		
XIIIF1	1	9	7			1	1								
2	9	7	6	2		1									
3	11	9	10	3		6	3		1	1			3		

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

Table 2. Square L Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
T1 XIII-2	1		1												
3															
4															
5															
6															
7															
XIIIA1	5	7	11												
2	1	9	5	1			1		1						
3	2	6	3					1							
XIIIB1	6	6	3			1									
2		3	2	1		1									
3															
XIIIB2-1		2	5	1				1							
2															

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

Table 3. Square S Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
1A			1												
1B		2	3	1	1										
2B	2	5	1					1							
2C								1							
3A		2	1												

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

Table 4. Square T Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
1A		1	1												
1B	1	3	3												
1C		1													
2A	1	2	1											1*	
5A	2	4	1				2								

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

* Key shaped formed uniface

Table 5. Square K Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
T1 XIII-2	1														
3															
4	1		1			1	1	1						1	
5	1	4	6	3		1									
6	2	9	5	1		2	1								
7	1	4	5	2		1	1								
8	5	9	13	5		4	1	1						1*	
9	1			1					1						
XIIIA-4		2				1	1								
5		1													
XIIIB6-1		3	1			1	1								
2														1	
XIIIB7	1	2													
XIIIB8		1	3	1		1	1								
XIIIB9															
T2															
XIIIA1	3	5	6	1		3								1	1
A2	1	3	1	1											
A3			3				1								
A4		2	1			2					1	1			
XIIIB1-2	4	5	8	2				1	1			1			
XIIIB2-1						1									
B3-1	1	2	2	1		2	1		1						
B4-1		1	1			3	1								
B4-2		2	1			1		1							
T2 C2-1				1		1		1							
C3-1															
C4-1	1	1				1			1						
C5-1															
C6-1		2													
C7-1		7	1			4									
C8-1															
C9-1			1			1									
C10-1	1	2				1									
C11-1						3			2						
XIIID-1		4	1			3									

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

* Key shaped formed uniface

Table 6. Square M Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
T1 2		5	7	1		1	1	1							
3		2	1			1								1	
4	1	7	1	1		3	1	1		1					1*
5	1	3	4			5									
6	1	5	3			1	2								3
7		1						1							
8	2	1	1			1									
9			1				1								
10	1	2						1		1					
11															
12															
13															
14															
T2 A1		2					1								
A2	3	1		1			1								
B1		3				4		1							
B2	1	4	2	1		1		1							
B3		2	1	2				2							
B4	1	7	2	1			4	1							1
B5			1			1									
C1		1	2	1											
C2		1	1			1		1							
C3	1	1													
C6		1													
F1		1				2									
F2	1					1									
F3	3	6	2			1			1						

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

*Kamloops point preform

Table 7. Square N Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
T2 XIIIA1		3	1	1		1									
A2		4	2			1									1
A3		1	1												
B1-1		2	1			1		1		1					
B1-2			1												
B2		3	1			2	1								
B2-1						1									
B2-2	1	1	2			2		1							
C1-1															
C2-1			2					1							
C3-1															
C4-1		3	3												
D-1	2	3													
E-1															
F-1							1	3							

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

Table 8. Square D Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
T2 XIIIB1		1				1									
B2		2	1						1						
B3	1	3				1			1						
B4	1	9	4			2		2			1				
B5	1	4	4	1		2	2	1	1						
C1-1						2									
2-1	1	2	1	1		1									
3-1															
4-1															
5-1															
6-1															
7-1		1													
8-1															
9-1															
D-1		1	2			1			2						
D-2	1	4				2		2	1						
D-3		1				1									
D-4		3	1			4									
D-5		4				1									
1986															
Trench															
XIII-6	2	10	1					2							
7		4													
8	1	4	2					1						1	
9		5	1	1				3						1	
10	2	3	2					1							

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

In general, these data indicate a fair degree of chronological resolution. In squares excavated in natural levels, late period artifacts such as Kamloops points occur relatively high in stratigraphic sequences. Moving backwards in time, Plateau Horizon artifacts occur typically in the middle portions of the rim stratigraphy, while even earlier Shuswap Horizon and Middle Period artifacts occur at the bottoms of the profiles. Identification of chronological resolution does not mean that there is an understanding of integrity, or the number of agents which played a role in producing the observed archaeological patterns (Binford 1981). A complete analysis aimed at understanding the integrity of the rim deposits is beyond the scope of this study. However, I provide some preliminary statements in this direction through a consideration of overall artifact assemblage variability throughout the rims, both stratigraphically and horizontally.

Stratigraphic Variability

To study stratigraphic variability by excavation unit, I converted tool and core assemblages with more than 15 artifacts from raw data to percentages (Table 10). This process unfortunately removed the majority of artifacts from consideration leaving artifact assemblages from 21 stratigraphic levels in five excavation squares (AA, L, K, M, and D). This process, however, provides at least a standardized set of artifact distributions for comparison where sample sizes are large enough to more likely reflect actual variability rather than idiosyncratic sampling. Artifact category 1 contains miscellaneous artifacts ranging from severely broken tools to resharpening flakes. I consider variation in category 1 between levels and units to be the result of the nature of this category rather than any true reflection of variation in processes producing the archaeological record. Thus, I do not consider it further. Future researchers might consider the artifact types from this category independently. I assess debitage assemblage variability peripherally through an examination of raw data frequencies. Only those assemblages where acceptable numbers of tools and cores have been identified are considered (i.e., Squares AA, L, K, M, and D).

Square AA produced eight assemblages large enough for consideration in this analysis (Table 10), thus providing the best sequence of lithic artifacts from the

Table 9. Square O Tool Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
8 XIII F2-111	3				1										
3-1	1	1													
3-2		7				1									
3-3															
3-4	1	3													
4-1															
4-2		1													
4 F3-1															
4-1		1													
4-2		1	1												
4-3	1	2	2						1				1		
11 D-1		1													
D-2		1	1												
D-3		1				1									
E-1			1												
F-1		2				1									
F-2			1								1				
F-3	1	1	1				1								
F-4		1	1												
F-5		2													
F-6															
F-7/8		4				2									
F-9		1													
12 D-1		1													
D-2		1	1												
E-1															
F-1															
F13F1	1	3				1									
F-2		3				1									
F-3									1						
F-4			1												
F-5															
F-6		2					1								
F3-7		3	2	1			1								
F-10		1	1												
15															
XIIIA-1	1														
D1-2		1				1									
D1-3			1												
D-2		1													
F-1						1									
F-2		1													
F-3	1	2	1			1									
16															
XIIIA-1		1	1												
D1-1		1													
D2-1		3	1												
D2-2	1	1	2												
E-1		3				1		1							
F-1															
F-3															
F-4		2				1									

1 = Misc, 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period Points, Shu = Shuswap Points, Pla = Plateau Points, Kam = Kamloops Points.

HP 7 rim. Artifacts in categories 4 and 5 are most common throughout the sequence indicating that discard of minimally modified flake tools may have been relatively consistent through time. Although level XIIIB3 contains several bifaces, bifaces are most common in the lower levels. Likewise, heavily modified, obtuse edge-angle flake tools occur more commonly in the lower levels. Boring and piercing tools occur consistently throughout. Other artifact types occur too infrequently for further consideration. Overall density in debitage increases in the lower levels. Especially notable are increases in billet flakes in these levels.

The primary difference in artifact frequencies from Square L is in terms of density. Tools and cores are far more common in the upper levels than in the lower ones, where modified artifacts are almost nonexistant. Debitage patterning is similar with few flakes in the lower levels and dramatic increases in the upper levels.

Patterning in Square K is difficult to evaluate due to its complex stratigraphy. Tool and core density is far greater in the middle to upper levels than in the lower levels. If projectile points are any indication of the period of occupation which produced the middle and upper-middle deposits, then they are primarily attributable to the Plateau Horizon. This is consistent with radiocarbon dates discussed in Volume I, Chapter 2. Minimally modified flake tools, bifaces and heavily modified flake tools are common in these levels. Flakes are also most dense in the middle to upper middle levels, with especially high numbers of billet flakes.

Only three levels from Square M are represented by percentage data (Table 10). I, therefore, make statements regarding assemblage variability in this square from a consideration of both the raw (Table 6) and percentage data. I rely on Trench 2 data only as there are clearly validity problems associated with Trench 1 due to excavation in arbitrary 10 cm levels. This type of validity problem is known as criterion-related validity (Nance 1987). In this case it would be impossible to make accurate statements about stratigraphic variability as mixing of stratigraphically distinct assemblages has occurred during excavation. Minimally modified acute edge-angle flake tools are consistent throughout the stratigraphic sequence of Trench 2. The middle to upper levels contain minimally modified obtuse edge-angled flake tools and bifaces, which are not commonly found in the lower levels. Heavily modified obtuse edge-angled flake tools occur throughout the sequence while piercing and boring tools and bipolar cores cluster in the middle to upper levels. The middle to upper levels of Trench 2 contain far higher densities of flakes than the lower levels. Billet flakes are not particularly numerous in any levels.

Raw (Table 8) and percentage data (Table 10) from Square D indicate two general clusterings of tools and cores: one in the upper levels and one in the extreme lower levels. There appear to be no real differences between the two, however. Both contain numerous flake tools of all types, a limited number of cores and very few of any other tool types. Flakes are also clustered in the upper and lower levels. There do not appear to be any real differences between the two. Billet flakes are relatively uncommon throughout.

Two major trends are apparent from this rather cursory examination of stratigraphic variability in rim lithic assemblages. First, on the south and southwest sides of the house, bifaces and heavily worked obtuse edge-angle flake tools are far more common in the lower to middle levels than in the upper levels. Other flake tools and piercing/boring tools are common throughout the stratigraphic sequences. Second, on the north side of the house bifaces are most common in the middle levels while piercing/boring tools are the most common in the upper levels. There is little stratigraphic variation in any of the flake tool categories.

If the lower levels of the rim are primarily attributable to Middle period and Shuswap Horizon occupations, the middle levels to Plateau Horizon occupations, and the upper levels to Kamloops Horizon occupations, then it is possible to note a general decrease through time in biface and intense flake tool resharpening and reuse. There may also be a parallel increase in specialized flake tool use as indicated by increased numbers of piercing/boring tools on the north side of the house. If not attributable to sampling bias, this may be indicative of possible shifts in mobility and general economy of the housepit occupants through time.

Spatial Variability

In order to begin evaluating spatial differences in the formation of the rim lithic assemblages I compare mean tool and core percentage data for rim Squares AA, L, K, M and D (Table 11, Figs. 1–3). I also calculate the coefficient of variation for each mean score to provide some assessment of variability in each tool and core category for the rim strata represented (Table 11). Raw data for the calculation of the mean and CV scores is provided in Table 10.

Before discussing the mean percentage data, I note that the CV scores are distributed in almost direct correspondence to sample size. Low sample sizes generally have CV scores higher than 10 and are the result of bimodal distributions or at least some form of unrecognized sub-variation. It is clear that there is substantial variation in the representation of all tool classes between levels in the rim of HP 7. Archaeological variability as well as sources of error may have contributed to this total variability.

As I do not think artifact category 1 represents anything meaningful archaeologically, I initiate my discussion with categories 4 and 5 (Fig. 1), or respectively, minimally modified acute and obtuse edge-angle flake tools. Mean scores for each category are fairly consistent across the five excavation squares. Category 6 (bifaces) means are consistently low across all five excavation squares (Fig. 1). Category 8 parallels that of 5 in the number of potential tool types contained. Means are consistently low with the exception of Square D, which contains a somewhat higher score. Distributions of categories 9 and 10 (piercing/boring tools and bipolar cores—Fig. 2) are quite similar. Both have high mean scores in Squares M and D. Category 9 tools also score somewhat highly in Square AA. All other artifact types occur very infrequently across all squares (Figs. 2 and 3).

It is not possible at this point to remove the confounding effects of random error from this analysis. However, assuming that random error is present to some degree and assuming knowledge of some of its sources (excavation strategies and intra- and inter-observer error) it is possible to cautiously draw some limited conclusions on archaeological spatial variability. It seems clear that there is no substantial typological variability between the five squares. The same basic processes seem to have produced these lithic

Table 10. Percentage Tool Data

	1	4	5	6	8	9	10	11	12	13	MP	Shu	Pla	Kam
AA														
T1														
XIIIB1	25	25	15	15		20								
XIIIB4	23.5	23.5	29.4		5.9	11.8			5.9					
XIIIC3	13.3	53.3	13.3			6.7	6.7		6.7					
XIIIC4	17.6	23.5	35.3	5.9		11.8			5.9					
XIIIC6	18.2	38.6	20.5	6.8		11.4	2.3					4.5		
XIIIF1	5.3	47.4	36.8		5.3	5.3								
XIIIF2	36	28	24	8	4									
XIIIF3	23.4	19.1	21.3	6.4	12.8	6.4		2.1	2.1			6.4		
L														
XIIIA1	45.4	30.4	47.8											
XIIIA2	5.6	50	27.8	5.6		5.6		5.6						
XIIIB1	37.5	37.5	18.8		6.3									
K														
T1														
XIII-5	6.7	26.7	20	6.7										
XIII-6	10	45	25	5	10	5								
XIII-8	12.8	23.1	33.3	12.8	10.3	2.6	2.6						2.6	
T2													5.0	5.0
XIIIA-1	15	25	30	5	15									
XIIIB1-2	18.2	22.7	36.4	9.1			4.5	4.5			4.5			
M														
T1														
2		31.2	43.8	6.3	6.3	6.3	6.3							
4	5.9	41.2	5.9		17.6	5.9	5.9		5.9					5.9
T2														
B4	5.9	41.2	11.8	5.9		23.5	5.9							5.9
D														
T2														
B4	5.3	47.4	21.1		10.5		10.5							
B5	6.3	25	25	6.3	12.5	12.5	6.3	6.3						

(levels with >15 artifacts) 1 = misc., 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores.

assemblages. Although typological variation is minimal, artifact density is not. Lithic artifacts in Square AA are far more common than in any other square. It is still unclear, however, whether this derives from differences in actual stone tool production, use and discard on the roof and rim, or floor and roof cleanout procedures resulting in extra-large accumulations on the southwest side of the house. Any attempt at addressing this problem requires a comparison of rim and floor data.

Floor and Rim Comparison

Tool, core, and debitage data are used to facilitate a comparison between the rim and floor data sets. Mean scores from Table 11 are used to produce means for the entire rim across each artifact category. These means were then compared to the percentage scores for each artifact category from the floor (Table 12, Fig. 4). Lithic samples from the rim and floor are compared by first summing the total number of flakes in each type and size class and converting these data to percentages (Table 13). These are compared graphically in Figures 5–8.

With the exception of category 1, which has been disregarded throughout this report for reasons of excess random error, there is an extremely high level of consistency across all artifact categories between the floor and the rim. Artifact category 8 (obtuse edge angle tools) is not considered in this analysis as these data are not available for the floor. Thus, in Figure 4, rim categories 5 and 8 have been collapsed together.

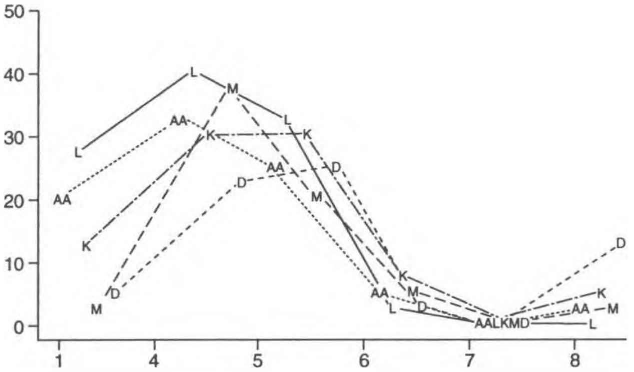

Figure 1. Comparison of rim squares (classes 1–8). (1 = Misc., 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools [heavy retouch], 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period points, Shu = Shuswap points, Pla = Plateau points, Kam = Kamloops points).

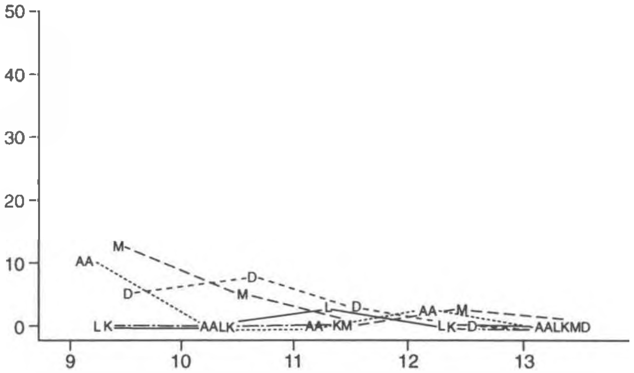

Figure 2. Comparison of rim squares (classes 9–13). (1 = Misc., 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools [heavy retouch], 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period points, Shu = Shuswap points, Pla = Plateau points, Kam = Kamloops points).

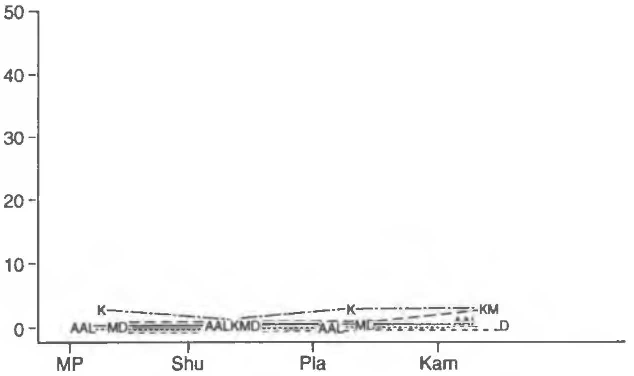

Figure 3. Comparison of rim squares (temporally diagnostic types). (1 = Misc., 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools [heavy retouch], 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period points, Shu = Shuswap points, Pla = Plateau points, Kam = Kamloops points).

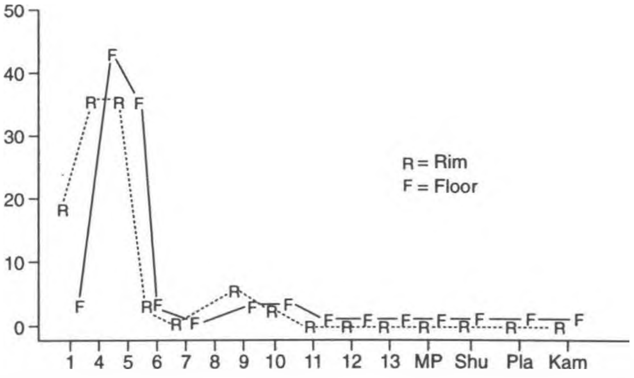

Figure 4. Mean rim and floor data relationship. (1 = Misc., 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools [heavy retouch], 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores, MP = Middle Period points, Shu = Shuswap points, Pla = Plateau points, Kam = Kamloops points).

Table 11. Rim Summary Statistics

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
AA															
Mean Rim	20.3	32.3	24.5	5.3	0.0	3.5	9.2	1.1	0.3	2.6	0.0	0.0	1.4	0.0	0.0
SD	9.0	12.6	8.7	5.2	0.0	4.5	6.0	2.4	0.7	3.1	0.0	0.0	2.6	0.0	0.0
CV	44.3	39.0	35.5	98.1	0.0	128.6	65.2	218.1	63.6	119.1	0.0	0.0	185.7	0.0	0.0
L															
Mean Rim	29.5	39.3	31.5	1.9	0.0	2.1	1.9	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0
SD	21.1	9.9	14.8	3.2	0.0	3.6	3.2	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
CV	71.5	25.2	47.0	168.4	0.0	171.4	168.4	0.0	105.3	0.0	0.0	0.0	0.0	0.0	0.0
K															
Mean Rim	12.5	28.5	28.9	7.7	0.0	7.1	1.5	1.4	1.9	0.0	0.0	.9	0.0	1.5	1.0
SD	4.4	9.4	6.5	3.3	0.0	6.7	2.2	2.1	2.0	0.0	0.0	2.1	0.0	2.2	2.2
CV	35.2	33	22.5	42.9	0.0	94.4	146.7	150.0	222.2	0.0	0.0	233.3	0.0	146.7	220.0
M															
Mean Rim	3.9	37.8	20.5	4.1	0.0	4.6	11.9	6.0	0.0	2.0	0.0	0.0	0.0	0.0	3.9
SD	3.4	5.8	20.4	3.5	0.0	4.1	10.0	0.2	0.0	3.4	0.0	0.0	0.0	0.0	3.4
CV	87.2	15.3	99.5	85.4	0.0	89.1	84.0	3.3	0.0	170.0	0.0	0.0	0.0	0.0	87.2
D															
Mean Rim	5.8	21	23.1	3.2	0.0	11.5	6.3	8.4	3.2	0.0	0.0	0.0	0.0	0.0	0.0
SD	0.7	19.8	2.8	4.4	0.0	1.4	8.8	3.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0
CV	12.1	94.3	12.1	137.5	0.0	12.2	139.7	35.7	140.6	0.0	0.0	0.0	0.0	0.0	0.0

1 = Misc., 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores.

Debitage percentages are almost identical between the floor and the rim in all size categories except for the largest (Figs. 5–8). In size category 4 (>5cm), there appear to be some important differences between the two. The rim contains far more primary flakes and far fewer secondary and bipolar flakes and spalls. Since the frequencies of all other classes of flakes are almost identical between the rim and the floor and since this is the largest size class of flakes, thereby best suited for use as tools, I argue that this distribution disparity is monitoring some specific behaviors on the part of the prehistoric inhabitants of HP 7.

In general, tool, core, and flake data from the rim and floor indicates such substantial similarity that it is hard not to imagine that they are the result of the same processes. I conclude that indeed much of the floor materials are being removed and placed on to the rim. Given relative spatial and stratigraphic consistency in assemblage composition the process of removing the old floor materials and placing them on to the rim appears to have been repeated through time. There does not appear to be any indication of different activities on the rim compared to the floor, at least given this level of resolution. The greater density of artifacts on the southwest side of the house may still represent work by house inhabitants on the roof and rim. If this is the case then, activities themselves may not have been significantly different from those conducted regularly on the inside.

Large bipolar flakes and spalls on the floor may well represent potential tools to be collected and used before floor cleanup and disposal on to the rim. Thus, these flake types may have been regularly collected for later use, rather than discarded on the rim. At housepit abandonment, they were no longer needed and were subsequently left *in situ*. We can view secondary flakes as more common on the floor than rim due to the intense trampling which may have occurred in this location. High numbers of large primary flakes on the rim may reflect less intensive flake culling/scavenging activities in these areas than in those occurring on the floor. Another possibility is that some large primary flakes may have been placed on the rim in anticipation of future use and thus could be seen as site furniture in Binford's terms (1979).

Table 12. Floor Percentage Tool Data and Mean Rim Percentage Data

	1	4	5	6	7	8	9	10	11	12	13	MP	Shu	Pla	Kam
Mean Rim	16	33.6	25.8	5.0	0.0	5.5	6.4	2.4	.9	1.3	0.0	.2	.5	.4	.8
Floor Total	6.9	40.0	33.7	3.0	1.1		2.3	3.8	1.6	2.0	0.0	.1	1.0	1.0	3.3

1 = Misc., 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools (heavy retouch), 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores.

Table 13. Total Floor and Rim Lithic Sample Data

	Pri.	Sec.	Bi	RBi	BP	Shat	MB	Spa
Floor								
Size 1		391	52			6		
%		87.1	11.6			1.3		
Size 2		2,580	296	1	25	60		
%		87.1	10	0.1	0.8	2		
Size 3	487	631	109	4	24	37	1	
%	37.7	48.8	8.4	0.3	1.9	2.9	0.1	
Size 4	10	3			1	2		
%	62.5	18.8			6.2	12.5		
Rim								
Size 1		328	87	4	1	23	1	1
%		73.7	19.6	0.9	0.2	5.2	0.2	0.2
Size 2		5,051	1,314	108	34	101	31	3
%		77.2	20.1	1.7	0.5	1.5	0.5	0.1
Size 3	1,221	681	431	53	42	63	14	2
%	48.7	27.2	17.2	2.1	1.7	2.5	0.6	0.1
Size 4	12	1						
%	92.3	7.7						

1 = Misc., 4 = acute edge angle flake tools, 5 = obtuse edge angle flake tools, 6 = bifaces, 7 = spall tools, 8 = obtuse edge angle tools [heavy retouch], 9 = piercing and boring tools, 10 = bipolar cores, 11 = all other cores, 12 = groundstone, 13 = microblade cores.

Conclusions

In this report I have explored spatial and stratigraphic lithic artifact data from the rim of HP 7 in order to first assess chronological resolution in the rim deposits and, second, to assess occupational variability. I have also made a comparison between the rim and floor data in an attempt to determine the origin of the rim assemblages. As this report does not deal in depth with all data and attempts little statistical analysis, I view all findings as preliminary in an ongoing series of investigations into the formation of the HP 7 rim lithic assemblages.

A number of conclusions were drawn during the course of this study. First, I concluded that chronological resolution was relatively good. Kamloops Horizon artifacts were found in the upper levels, Plateau Horizon in the middle levels and Shuswap and Middle Period materials in the bottom. I also noted that having identified some resolution did not mean that we had any understanding of integrity.

A second group of conclusions centered around issues of integrity. I argued that, stratigraphically, bifaces and heavily modified obtuse edge-angled flake tools were found more commonly in the lower to middle levels, while more specialized flake tools such as piercers and borers became somewhat more common in upper levels. This illustrated to me that some different processes resulted in stratigraphic inter-assemblage variability. We may be monitoring organizationally different strategies of residential and logistical mobility and lithic technological organization. Chatters (1989) has noted that during the Pithouse I period on the Columbia Plateau (4,440–3,770 BP), mobility and technological organization was quite different compared to the later period (3,300 BP to historic). This poses a research problem which future researchers may wish to consider.

Little variability is present in rim spatial organization with the exception of artifact density. Square

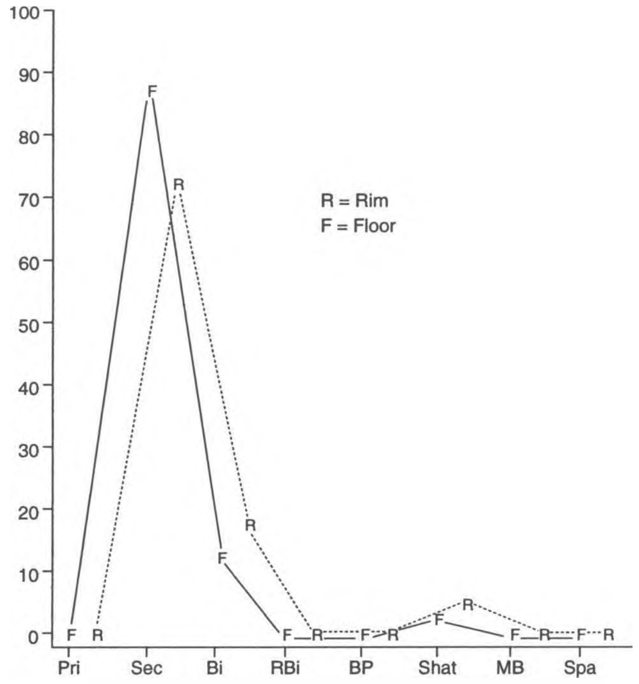

Figure 5. Comparison of rim and floor lithic sample data—size category 1. (Pri = primary flakes, Sec = secondary flakes, Bi = billet flakes, RBi = r billet flakes, BP = bipolar flakes, Shat = shatter, MB = microblades, Spa = Spalls).

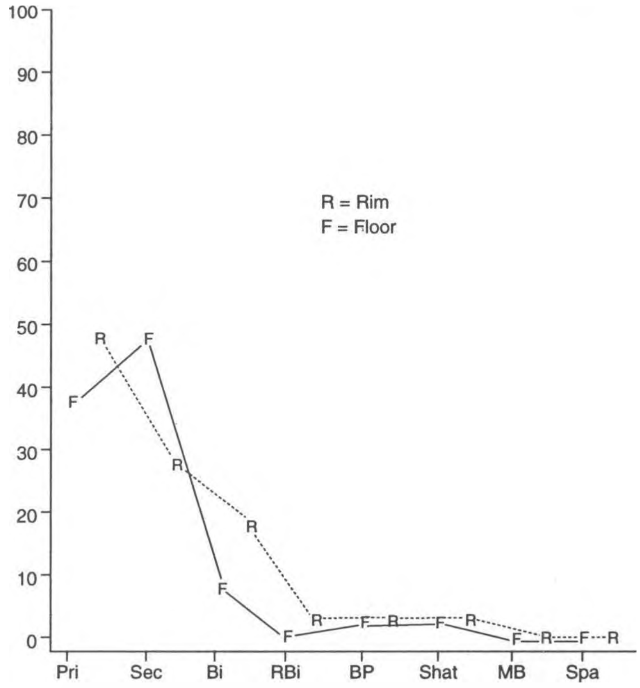

Figure 7. Comparison of rim and floor lithic sample data—size category 3. (Pri = primary flakes, Sec = secondary flakes, Bi = billet flakes, RBi = r billet flakes, BP = bipolar flakes, Shat = shatter, MB = microblades, Spa = Spalls).

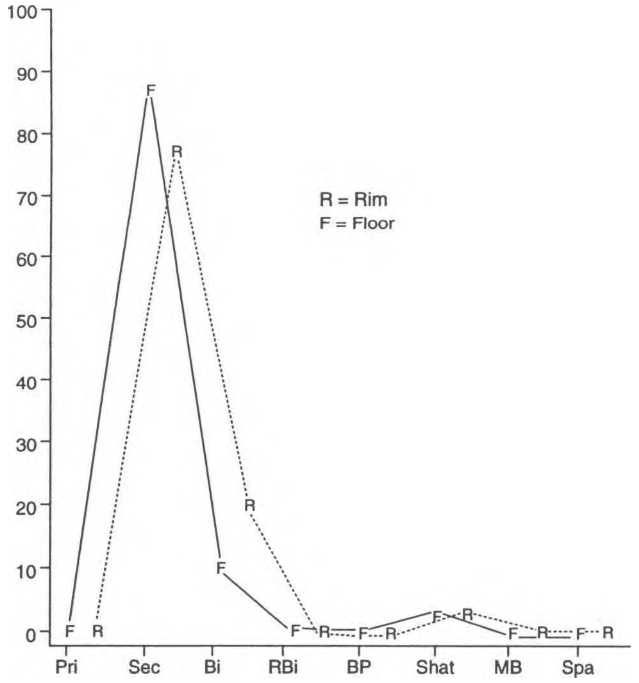

Figure 6. Comparison of rim and floor lithic sample data—size category 2. (Pri = primary flakes, Sec = secondary flakes, Bi = billet flakes, RBi = r billet flakes, BP = bipolar flakes, Shat = shatter, MB = microblades, Spa = Spalls).

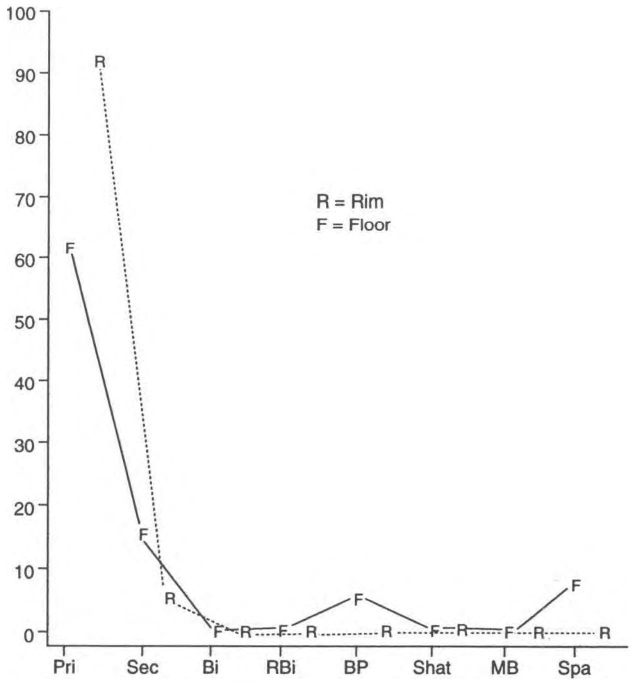

Figure 8. Comparison of rim and floor lithic sample data—size category 4. (Pri = primary flakes, Sec = secondary flakes, Bi = billet flakes, RBi = r billet flakes, BP = bipolar flakes, Shat = shatter, MB = microblades, Spa = Spalls).

AA is far more dense in lithic artifacts than any other excavation square. It has not been determined as to whether this is due to outside activity focus in this area or some other process of rim formation.

Finally, it is clear that the overwhelming majority of rim lithic materials derive from the interior floors of the housepit. Relative frequency profiles of tool, core, and debitage data are almost identical between the rim and the floor. Some limited variability exists in a few flake types which may be attributable to specific behaviors of the inhabitants over time.

In general, this study provides indications of, first, some shifts in artifact use and discard over time, and second, the derivation of rim lithics from excavated and redeposited floor sediments. Many details associated with these conclusions have not been explored. First, research is required into the presence and effects of random error on these conclusions. Reliability research should focus on both the reliability of inter-observer classification, as well as on possible sampling error in the excavation strategies. Should it be possible to obtain reliability coefficients, then researchers could correct data distributions for attenuation problems associated with excess random error (if present—see Nance 1987).

Second, research into the integrity of the rim deposits should continue with a detailed consideration of taphonomic conditions. Clearly, purposeful human behavior alone is not the cause of assemblage variability. There may have been a variety of processes in action including trampling, size-sorting, scavenging and intensive weathering.

Third, cultural organizational variability could be further examined stratigraphically and horizontally. There are differences between the lower and upper lithic assemblages found in the rim deposits. These could well be informing us of organizational differences in housepit occupation. Likewise, spatial variability around the rim could be informing us of differences in the spatial organization of work and artifact discard. Research should move beyond the coarse grained approach taken here to examine these problems in greater depth.

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Chapter 16

Classification and Distribution of Debitage at the Keatley Creek Housepit Village

Edward F. Bakewell

Introduction

The general aim of this study is to examine some problems involving lithic source discrimination, especially of highly siliceous, chert-like rocks. In general, the accurate and reliable identification of different lithic sources can be important in demonstrating differential access to various lithic sources on the part of different bands or subgroups within communities, in demonstrating exchange relationships between prehistoric groups or subgroups, or in helping to date specific deposits such as storage pits if the relative importance of various lithic sources changes over time. Being able to accurately distinguish different lithic sources can, therefore, be an essential part of reconstructing past social and economic organization at sites such as Keatley Creek.

The specific goal of this chapter is to identify and discriminate the types of stone used for tools prehistorically at the Keatley Creek site. The method introduced in this analysis is a new approach to the problem. Many recent studies of archaeological lithics, especially cherts (e.g., Hoard et al. 1993), begin sourcing studies with sampling of known lithic source areas, incorporating quantitative analyses of trace element compositions. Statistical techniques such as discriminant analysis, are then utilized to define multi-dimensional fields characteristic of a particular source. Archaeological specimens of site lithics are subsequently analyzed and compared to the statistically defined fields and by statistical association, and are attributed to some source with some degree of confidence.

One problem with this approach is that no criteria are developed for classifying either the source areas or the site lithics. Instead, lithics and source materials are grouped by discriminant functions, which will change with the addition of any new source region in subsequent analyses. In fact, any new data will result in the permutation of previous discriminant functions to some degree.

Cherts, chalcedonies, and the like, which have proven difficult to source or characterize using standard trace element techniques (Leudtke 1978), require definition in another dimension besides chemistry for confident grouping, classification, and sourcing. Petrographic analysis of thin sections provides that dimension.

As an alternative approach, one can begin the analysis with site lithics, determine their petrographic and geochemical characteristics, and use this information to model possible geological sources. Using this approach, classes of material are defined by distinctions that reflect petrography, geochemistry, and source; not those that depend upon statistical algorithms and sampling. With such information in hand, field sourcing surveys become more focused, and the literature and previous research of others becomes more helpful.

I stress the use of both petrographic and geochemical characteristics, because petrography can distinguish important textural variation imperceptible by chemical analysis alone. But petrography, as the interpretation of optical phenomena, is ultimately subjective, and quantitative expressions of compositional characteristics aid in providing more objective criteria frequently required to ascertain petrogenetic similarities and differences.

The geochemical approach favored in this study also deviates from standard archaeometric practice. Whereas trace element analysis has been generally employed in attempts to discriminate chert types, I advocate instead, major and minor element analysis (i.e., Si, Al, Fe, Mg, Ca, Na, K, Ti, Mn, P). The reason for my preference is rooted in geochemical theory. Some differences in elemental composition are stochastic (e.g., variation in Fe concentration due to bacterial activity). Elements which reflect stochastic processes are useless in a lithic sourcing analysis because the observed values for those variables will be random and unpredictable. Many trace elements are concentrated by biogenic activity and diagenetic (post-depositional) changes by processes which are, for all practical purposes, stochastic.

In other cases, elemental compositions inhere from mineralogy (e.g., the *ratio* of Ca to P in apatite). In this case, the calcium and phosporus have a stoichiometric relationship, i.e., one dictated by elemental ratios in the chemical formula for apatite. Most rocks are composed chiefly of just a few major rock-forming minerals, which in turn are composed primarily of major elements. The weathering of rock to a sediment, due to sedimentary processes or diagenesis, is most expressively recorded by the major element flux. Elsewhere (Bakewell 1995), I have shown that cherts from different regions can be characterized by the patterning of major elements in the accessory sediments, which reflects differences in the mineralogy of those sediments. The important difference is that stoichiometric relationships are predictable.

The statistical procedures which I advocate to describe the geochemical characteristics of materials from different sources isolate stoichiometric relationships between elements. The methods are simple, bivariate, exploratory, rather than confirmatory, and measure correlation between elements. They reveal the patterned co-occurrence of elements reflective of the presence of specific minerals or combinations of minerals. Multivariate alternatives to this bivariate approach are normally weakened by correlated variables (see Tabachnick and Fidell 1989:92 for one discussion), but stoichiometric parameters in minerals ensure that high correlations will be present and meaningful in most geochemical data.

Multivariate analyses also require normal data distributions. But, because sedimentary regimes interface with highly stochastic processes (e.g., weather and biosphere), sedimentary rocks such as chert usually exhibit marked heterogeneity, characteristically skewed to low elemental concentrations, but punctuated with higher values, more typical of a Poisson distribution. As clastic components in a sediment vary, e.g., by locally induced contamination or dilution, then elemental concentrations will vary as well. The usual solution to these problems in trace element analysis is to minimize the range of values by data transforms to achieve normal distributions even though such transformations exaggerate expressions of central tendency. When pattern recognition, not quantification, is the goal, broad-ranging values are useful, underscoring relationships characteristic of a particular sedimentary source. Pattern recognition, both petrographic and geochemical, is the key to the discrimination and modeling of source types. Petrographic patterns are discernable whenever textural elements, microfossils, or mineral phases are repetitiously associated in a lithic fabric.

Table 1. Keatley Site and Source Volcanics, Major and Minor Elements (elements reported in Wt.%)

Element	CC-4	CC-7	CC-9	MC-1	MC-2	KB-1	KB-2	KB-3	KB-4
SiO_2	66.29	70.56	65.73	69.37	68.91	68.30	68. -	65.20	69.00
TiO_2	0.49	0.36	0.53	0.42	0.42	0.41	0.38	0.67	0.35
Al_2O_3	15.17	15.16	15.35	15.57	15.57	14.90	15.10	15.90	15.20
Fe_2O_3	3.86	2.64	4.02	2.63	2.63	3.45	2.73	4.08	2.67
MnO	0.03	0.05	0.06	0.04	0.04	0.07	0.06	0.06	0.06
MgO	1.09	1.08	2.01	1.10	1.10	1.79	1.20	1.96	1.14
CaO	3.21	2.42	3.54	2.88	2.87	3.55	2.88	4.06	2.91
Na_2O	3.88	4.18	3.28	4.61	4.55	3.73	4.36	4.58	4.25
K_2O	3.33	3.87	4.05	3.52	3.31	3.24	3.75	2.84	3.81
P_2O_5	0.21	0.14	0.25	0.10	0.10	0.15	0.13	0.28	0.13
LOI	1.09	0.36	0.93	0.38	0.38	0.46	0.50	0.35	0.45
Total	98.85	101.09	99.98	100.82	99.95	100.00	99.90	100.00	100.00

Notes: CC-4, 7, 9: Cache Creek cobbles; MC-1, 2: Medicine Creek pebbles; KB-1, 2, 3, 4: Keatley Creek debitage.

Table 2. Keatley Site and Source Volcanics Trace Elements (elements reported in ppm)

Element	CC-4	CC-7	CC-9	MC-1	KB-1	KB-2	KB-3	KB-4
Zr	189	197	172	158	176	203	191	197
Zn	60	54	67	61	65	63	74	67
Y	9	8	9	3	8	8	7	8
Cr	47	23	53	8	69	28	34	69
Nb	7	8	13	<1	4	8	6	6
V	80	48	91	51	67	48	82	67
Be	1.3	1.8	1.4	1.0	1.8	1.8	3.6	1.8
Ba	1,181	1,264	1,160	1,260	1,193	1,304	1,163	1,254
Ni	14	8	23	<1	23	8	15	23
Li	15	25	9	18	20	26	21	25
Sr	466	398	475	498	438	414	639	396
Cu	58	37	57	70	56	37	75	36
Sc	9	5	9	3	7	5	6	7

Notes: CC-4, 7, 9: Cache Creek cobbles; MC-1, 2: Medicine Creek pebbles; KB-1, 2, 3, 4: Keatley Creek debitage.

Table 3. Classifications for Keatley Site and Source Materials (elements recorded in Wt.%)

Sample	SiO_2	$Na_2O + K_2O$	Material Classification
Cache Creek (CC-4)	66.3	7.21	Trachydacite
Cache Creek (CC-7)	70.6	8.05	Rhyolite
Cache Creek (CC-9)	65.7	7.33	Trachydacite
Medicine Creek (MC-1)	69.4	8.13	Rhyolite
Medicine Creek (MC-2)	68.9	9.86	Trachydacite
Keatley Lithic (KB-1)	67.7	7.95	Trachydacite
Keatley Lithic (KB-2)	67.9	9.03	Trachydacite
Keatley Lithic (KB-3)	61.5	8.46	Trachydacite
Keatley Lithic (KB-4)	67.1	8.77	Trachydacite

Notes: CC-4, 7, 9: Cache Creek cobbles; MC-1, 2: Medicine Creek pebbles; KB-1, 2, 3, 4: Keatley Creek debitage.

Geochemical patterns are observed as *ratios* between constituent elements.

I will show that proceeding from site to source in the train of analysis may yield unexpected benefits, even if the source areas are not immediately located. After modeling lithic source types of debitage from the Keatley Creek housepit village, intrasite frequency distributions for these types will be plotted for three major housepit dwellings. Results of this analysis may aid in understanding the selective distribution and utilization of lithic resources in complex hunter-gatherer societies of the Canadian Plateau.

Background

The majority of the debitage studied from the Keatley Creek site comes from HP's 1, 5, and 7, located respectively near the western, southern, and eastern perimeters of the site at distances of 120–200 m from each other. Debitage at the site may be broadly divided into two categories: basaltic, and other. The basaltic component, described as "fine-grained basalts" comprises 70–90% of excavated lithic materials. The remaining "exotic cherts and chalcedonies" are of special interest, since preliminary investigations suggested a biased distribution of varieties of this material between major housepit sites in the village. The initial task was to segregate the non-basaltic component into types of stone reflecting potentially different sources. The initial sorting criteria had to be related to macroscopic traits discernible without the aid of sophisticated techniques since it would be impossible to apply detailed tests to all of the artifacts. The first step was to construct a preliminary classification from color and textural elements (e.g., grain size). Samples of these classes were then examined petrographically and geochemically. Where petrography and chemistry suggested common petrogenesis, preliminary classes were combined or split to form "types" of chert. Finally, the distribution of these refined and tested chert types was examined with regard to their occurrence in HP's 1, 5, and 7.

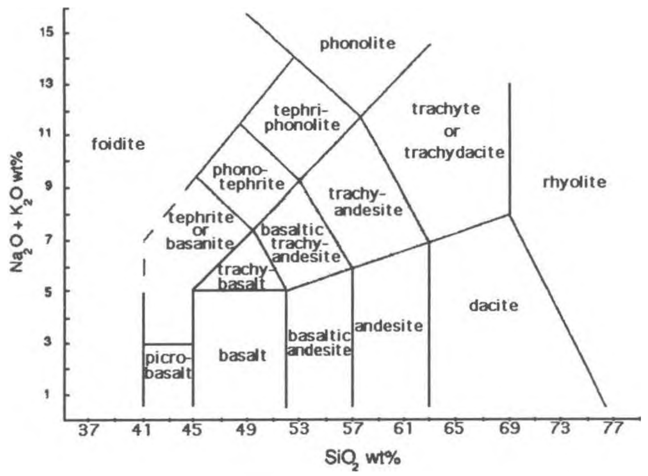


Figure 1. I.U.G.S. classification (after LeMaitre 1989).

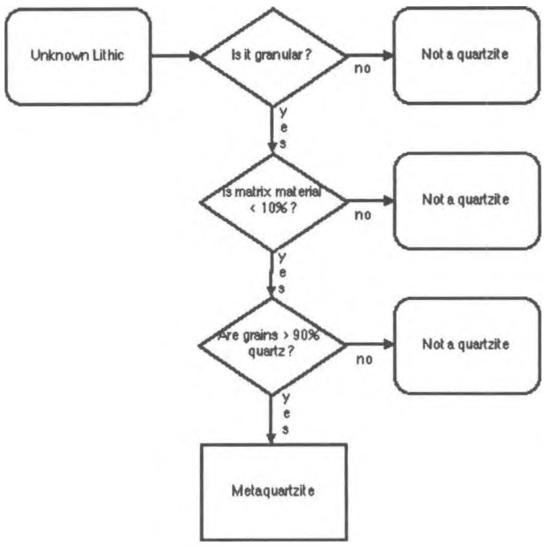


Figure 2. Quartzite type/variety criteria.

The Keatley Trachydacites

Before proceeding with an investigation of the non-basaltic debitage, the characteristics of the major, basaltic component will be briefly described. The traditional field practice of assigning fine-grained igneous rocks with a mafic (dark-gray to black) color index to the basalt category has resulted in the common description of dark, vitreous, igneous toolstone in Interior and Coastal British Columbia as basalt. However, where geochemical analyses have been performed on archaeological basalts in the Pacific Northwest (Bakewell 1991; Reid and Bakewell 1993; Bakewell and Irving 1993), no basalts have been identified. Classification of extrusive igneous rocks is based on geochemical criteria (Fig. 1), criteria which cannot be recognized in the field. The term "basaltic" is a perfectly acceptable descriptor if the definition is limited to mean "looks like basalt." However, until such time as geochemical and petrographic analyses become common practice, field classifications used to describe debitage materials in archaeological reports will remain *ad hoc* characterizations useful only in conveying a general image of the appearance of the stone.

The Keatley "basalts" are more accurately classified as trachytes, specifically trachydacites. The classification depends on total alkali vs. silica content, according to the fields illustrated in Figure 1. This really is an important distinction when questions of sourcing, intersite comparisons, or material science are considered. The archaeological sources of the Keatley trachytes are well known (Vol. I, Chap. 11). Large cobbles of the material

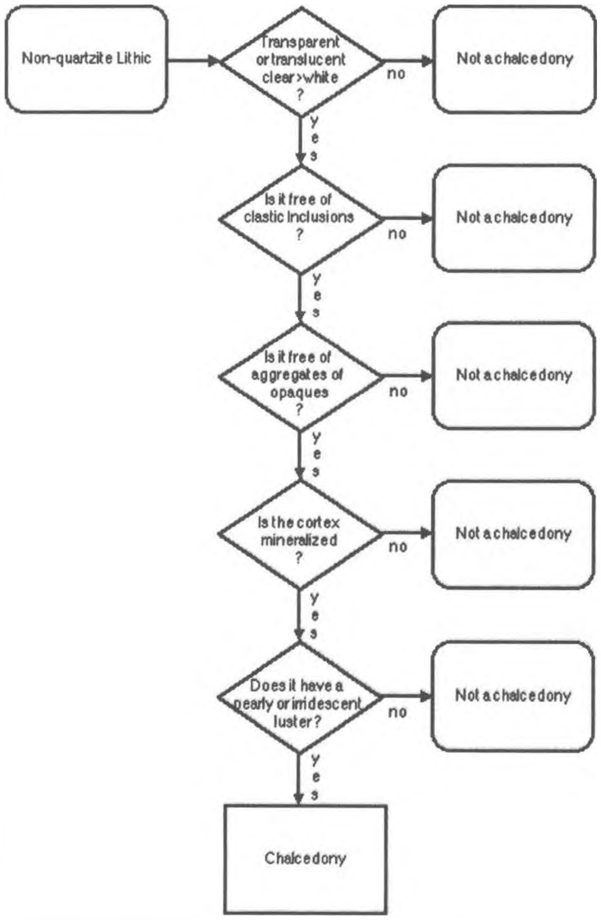


Figure 3. Chalcedony type/variety criteria.

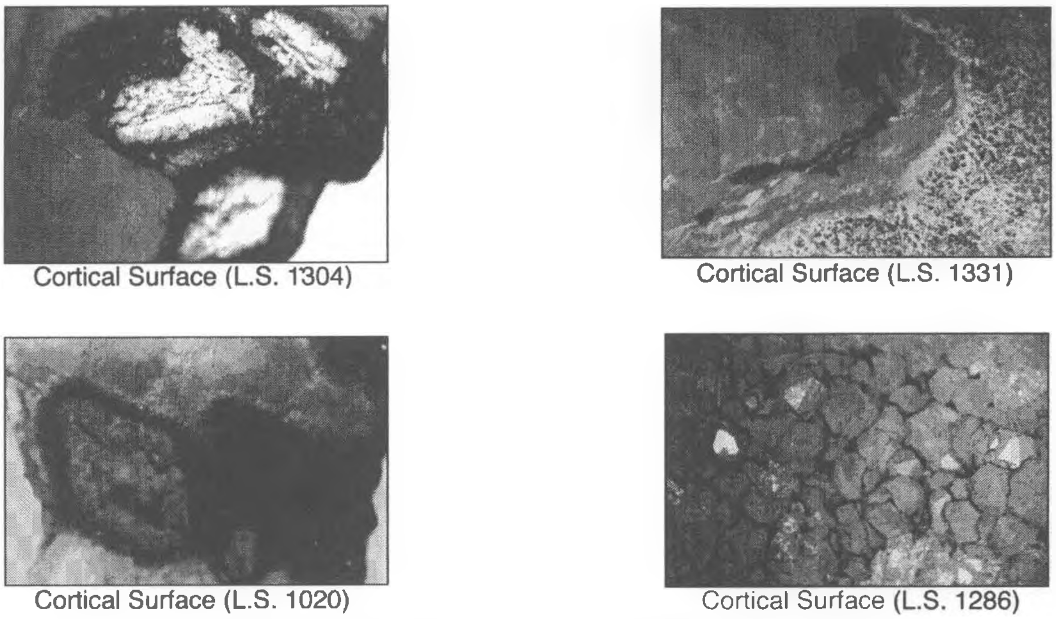
may be obtained at Cache Creek, about 35 air km from the Keatley Creek site. Smaller patinated pebbles, of the same sort of material, occur in the Medicine Creek highlands in Hat Creek Valley, about 20 air km from the site. This material is commonly referred to in the archaeological literature as "Cache Creek Basalt" and was considered to originate in geological sources of Kamloops Group or Chilcotin Group basalts (Richards 1988:14) whence it became incorporated into glacial deposits whose erosion created the concentrations of cobbles that formed prehistoric sources. In fact, the geochemistry of Cache Creek, Medicine Creek, and Keatley site lithics (Tables 1 and 2) does not remotely resemble anything in the Kamloops Group (Ewing 1981) or the Chilcotin Group (Bevier 1982). Richards' source attributions suggest that this "Cache Creek Basalt" originates in a diffuse geological source that covers an area in excess of 10,000 km^2 (Richards 1988:12, Fig. 2), when actually, the probable geological source is the nearby Trachyte Hills, a far smaller area through which Medicine Creek flows, included in the boundaries of Richards' map, but excluded as a possible source region because it does not constitute part of the Kamloops or Chilcotin Groups. I highlight Richards' study to emphasize the point that geochemical analyses are crucial in classifying fine-grained igneous rocks (e.g., Table 3). Material classification was important in Richards' study *Microwear Patterns on Experimental Basalt Tools,* with an entire chapter devoted to the "Geology and Petrography of Cache Creek Basalt," yet the materials were inaccurately described. Extensive petrographic analyses of thin sections were reported, including photomicrographs ostensibly showing olivine. While I have not had the opportunity to examine those thin sections, or sections of "basalt" reported in other studies of area toolstone (e.g., Magne 1979), thin sections of cobbles from the same sources (e.g., CC-4, 7, 9 of this report) show no olivine. In fact, it would be most unusual to find olivine in a rock with nearly 70% SiO_2. I suspect that the thin section analysis was biased by the investigator's assumption that the sample was basalt, an *a priori* conclusion induced by field characterizations. Other textural features observed in the current study, flow-banding and rounded, resorbed plagioclase crystals, were not reported by Magne or Richards. Petrographic features of lithics from the Keatley Creek assemblage match those of samples from Cache Creek and Medicine Creek sources. The materials are highly vitrophyric, with very few phenocrysts (usually total less than 5%), and are dominated by plagioclase with traces of pyroxenes and occasional quartz. In all, ten thin sections were examined from ten cobbles of dark gray-black material from Cache Creek. In addition, four thin sections were made of material from four Medicine Creek pebbles, and thin sections were made from four lithics from the Keatley Creek assemblage. Petrographic examinations of the thin sections were used to select the most optically diverse specimens from the source area materials for chemical analyses (i.e., CC-4, 7, 9 and MC-1,2). All four specimens from the archaeological assemblage were analyzed. Most geochemical analyses were completed for major and minor elements (Table 1) and trace elements (Table 2) using inductively-coupled plasma spectrometry (ICP) (Thompson and Walsh 1983).

Table 4. Keatley Creek Amygdaloidal Trachydacite Major and Minor Elements (Wt.%)

Element	Sample Number AB-1
SiO_2	67.4*
TiO_2	0.27
Al_2O_3	14.1
Fe_2O_3	3.00
MnO	0.04
MgO	1.51
CaO	2.97
Na_2O	4.69
K_2O	3.34*
P_2O_5	0.11
LOI	nd
Total	(97.43)

Table 5. Keatley Creek Amygdaloidal Trachydacite Trace Elements (ppm)

Element	Sample Number AB-1
Zr	145
Zn	62
Y	7.3
Cr	40
Nb	n.d.
V	67
Be	4.1
Ba	1130
Ni	27
Li	36
Sr	397
Cu	67
Sc	5.8
As	<3
Mo	2
Ag	<.1
Cd	<1
Sn	<10
Sb	<5
Sb	<5
Pb	<2
Bi	5



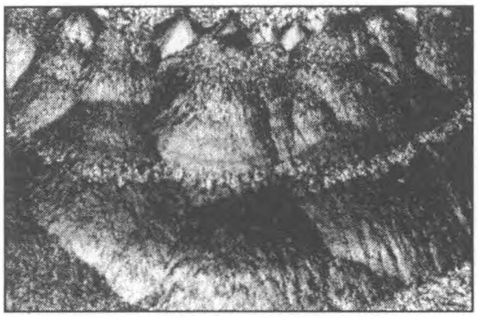
Cortical Surface (L.S. 1304)

Cortical Surface (L.S. 1331)

Cortical Surface (L.S. 1020)

Cortical Surface (L.S. 1286)

Cortical Features of Keatley Chalcedony (Width of field: 10 mm.)



Chalcedonic Texture 1B2(D) Crossed Nichols (Width of Field: 3 mm)

Figure 4. Cortical/textural features of Keatley chalcedony (width of field 10 mm).

Where major elements were determined by ICP analysis, Lithium Metaborate fusions were performed (source samples). XRF analyses generated the major element data for site lithics. Table 3 lists the International Union of Geophysical Sciences classification for the samples. Most are trachydacites, but slight differences require classification of one sample as rhyolite and another as dacite, since compositions straddle the trachyte, rhyolite and dacite fields (Fig. 1). The important point is that this material is quite distinctive. Because of the high total alkali content, if this toolstone occurs as a component in assemblages from other Plateau sites, it would be fairly easy to identify. Minor variations in alkali and silica suggest that two or more outcrops contribute cobbles to the fluvial sources. Although coarse-grained cobbles are present in the fluvial sources, selection for fine-grained, vitrophyric material is obvious in the assemblage. The trachydacites are generally easy to distinguish from the "exotic cherts and chalcedonies" although examination of the latter materials disclosed that a small quantity of amygdaloidal trachydacite was considered a variety of "exotic chert" by Gargett in a previous study (Hayden and Gargett 1989). This is easy to excuse, since the amygdules (vesicles filled with secondary minerals) are rare, and give the trachytes in which they occur a distinctively different appearance. Geochemical analysis (Tables 4 and 5) discloses the conformity of this amygdaloidal variety with previously described trachydacites. Note that characterization of fine-grained igneous rocks requires different methods than those advocated for modeling cherts in this study.

Keatley Cherts and Chalcedonies

The other major division in chipped stone debitage at the Keatley Creek site, referred to as "exotic cherts and chalcedonies" in previous studies (Hayden and Gargett 1989), while comprising the minor component, embraces a bewildering array of colors and textures. Using color and texture as discriminants, Gargett visually divided the materials in this component into more than 32 varieties. Since some of the materials which Gargett identified were recombined for curation it was not possible to systematically examine each of his proposed varieties. In addition, new materials were excavated subsequent to Gargett's study.

Classification by color and texture is very subjective and extremely susceptible to interpretive differences. For these reasons, early in this study it was decided that the best results could be obtained by a completely independent evaluation of the variability in the assemblage. Classes described by Gargett and divisions suggested by UBC geologist Ted Danner, who also examined specimens from the collection, will not be discussed in this study. More than 2,000 pieces of debitage are included in this analysis. Colors and textures are frequently gradational, and a wide array of thermal alterations and hydration effects exists in the materials, further confounding attempts to establish classes based solely upon visual criteria. The goal is to create classes of material robustly defined by petrographic and geochemical criteria, yet useful in identifying large numbers of artifacts because they are linked to combinations of color and texture observable without instruments more sophisticated than a binocular microscope. Creating such classes entailed prelim-

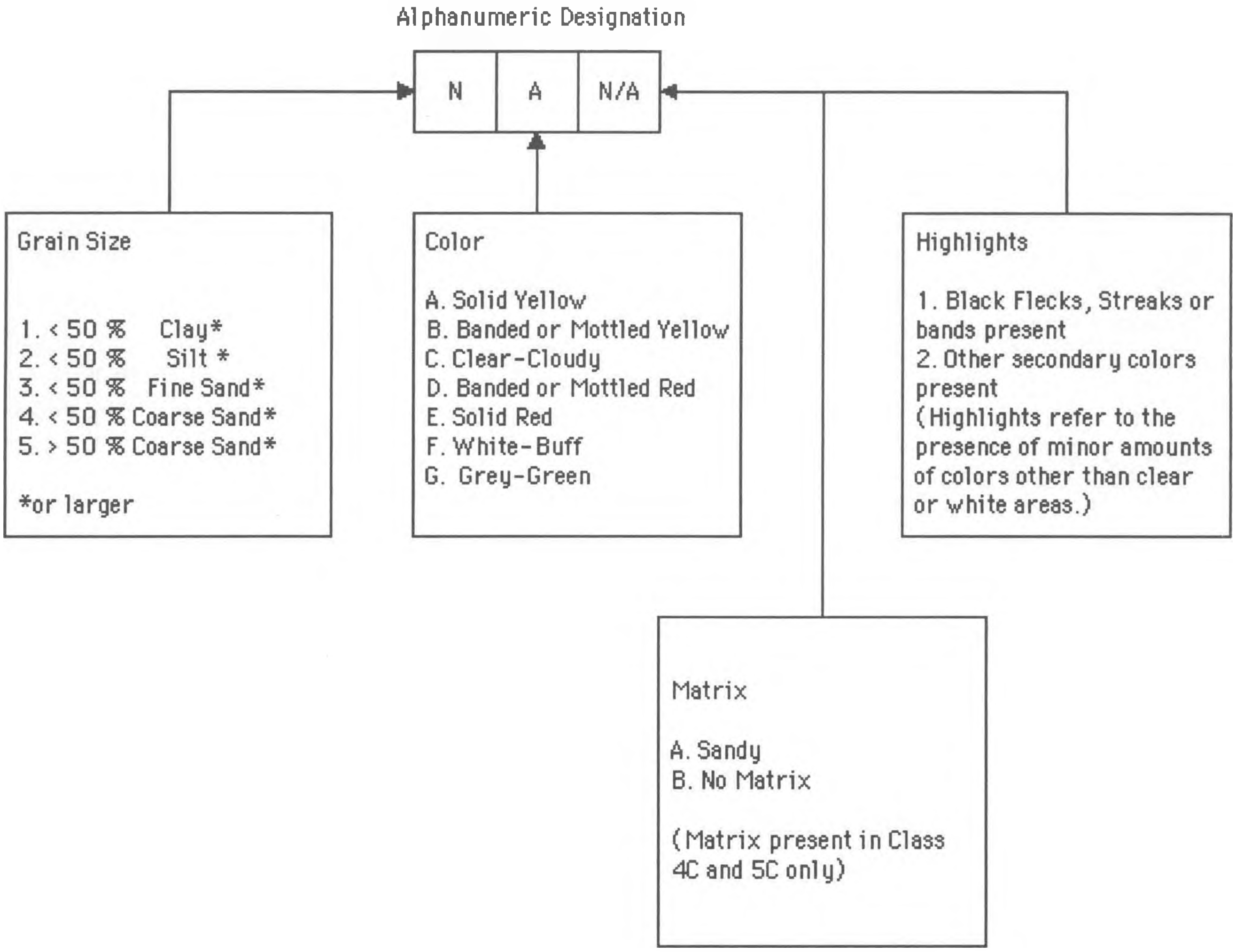
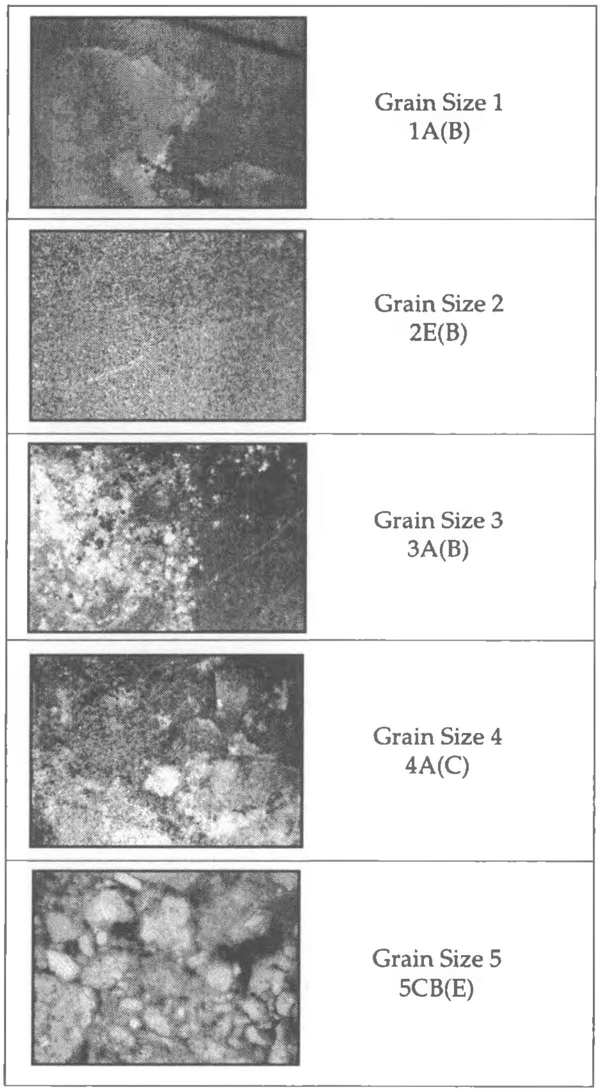


Figure 5. Keatley chert preliminary class criteria

Table 6. Classification by Color and Grain Size

	Grain Size				
	1	2	3	4	5
Color	<50% Clay or larger	<50% Silt or larger	<50% Fine Sand Element	<50% Sample Number AB-1	>50%
	or larger	Coarse Sand	Coarse Sand		
Yellow	1A	2A	3A	4A	5A
Banded (Yellow and Black)	1B1	2B1	3B1	4B1	
Banded (Yellow and Other)	1B2				
White-Buff	1C		3C	4CA (Sandy) 4CB (Plain)	5CA (Sandy) 5CB (Plain)
Banded (Red and Black)	1D1	2D1	3D1	4D1	
Banded (Red and Other)	1D2				
Red	1E	2E	3E	4E	5E
Clear-Cloudy	1F				
Gray-Green	1G	2G	3G		


Grain Size 1
1A(B)

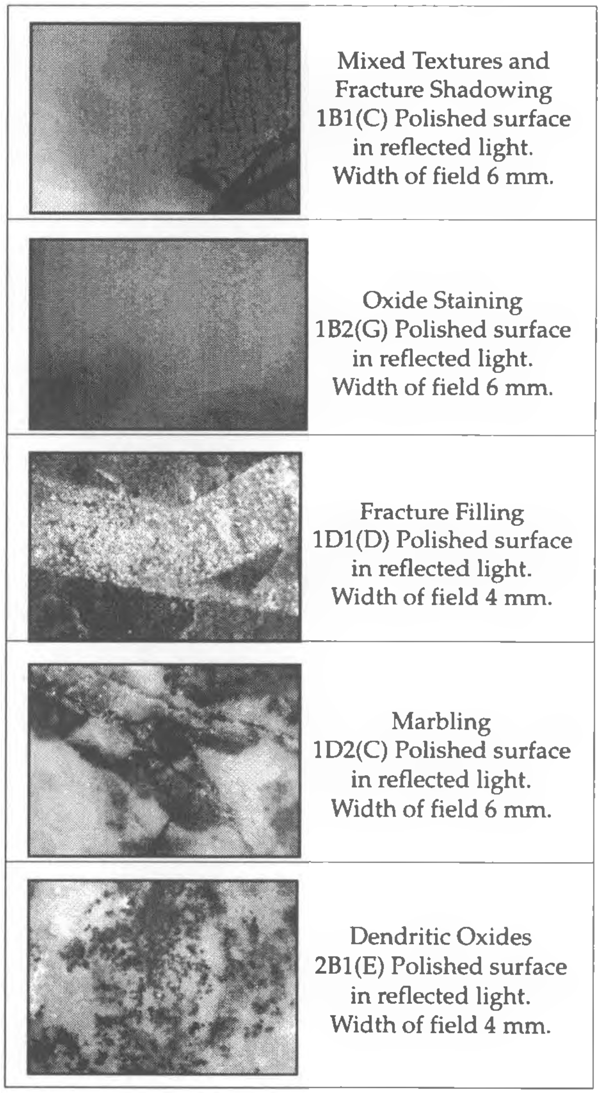
Grain Size 2
2E(B)

Grain Size 3
3A(B)

Grain Size 4
4A(C)

Grain Size 5
5CB(E)

Figure 6. Grain size distribution in the Keatley chert (width of field 6 mm, polished surfaces in reflected light).


Mixed Textures and Fracture Shadowing
1B1(C) Polished surface in reflected light.
Width of field 6 mm.

Oxide Staining
1B2(G) Polished surface in reflected light.
Width of field 6 mm.

Fracture Filling
1D1(D) Polished surface in reflected light.
Width of field 4 mm.

Marbling
1D2(C) Polished surface in reflected light.
Width of field 6 mm.

Dendritic Oxides
2B1(E) Polished surface in reflected light.
Width of field 4 mm.

Figure 7. Banding and highlighting in the Keatley chert.

inary definition by color and texture, subsequent sampling of preliminary groups for petrographic and geochemical characteristics, association of observed petrographic and geochemical attributes with corresponding suites of color and texture, and finally, a redefinition of types in terms of aggregates of color and texture associated with petrographic and geochemical criteria.

Sorting the Stone

In this section, the methods, criteria and problems associated with preliminary definition by color and texture are discussed. Visual criteria such as these are the least reliable discriminants in most cases, but for some classes of material, color and texture may be sufficiently diagnostic. The attribute combinations used to construct the preliminary classes are strictly defined, since the final types depend upon visual criteria for identification.

The first division extracts quartzites from the assemblage. The criteria used to define quartzites may be organized and illustrated by means of a decision tree (Fig. 2). The first requirement to be satisfied is the presence of a granular texture, an observation which can generally be confirmed by tactile as well as visual means. This criterion excludes all microcrystalline and cryptocrystalline materials. The second condition assumes the presence of less than 10% matrix material (clay, silt, etc.). This requirement excludes wacke sandstones from the type. The third condition assures that the grains are greater than 90% quartz, excluding other arkoses and arenites from the type. Quartz grains are typically clear and unweathered, the color in quartzites resulting largely from characteristics of the cement joining the grains and minor interstitial components. The final criterion, flattened or recrystallized grains, is not applied in this analysis since the distinction it makes is irrelevant to the primary research objective (differentiation of chert types). In addition, recrystallization is difficult to recognize without thin section analysis. It is, however, included to illustrate an important point. The term "quartzite" represents another of those field generalizations which can encompass two very different rocks, metamorphic varieties (metaquartzites) and sedimentary varieties (quartzarenites or orthoquartzites). Both varieties of material exist in the Keatley assemblage. No attempt will be made to isolate or analyze the distributional characteristics of these varieties and all quartzites will be considered as one type.

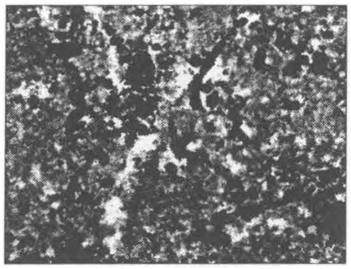
Table 7. Occurrences of Relict Carbonate Textures in Reddish and Yellowish Varieties of the Keatley Chert

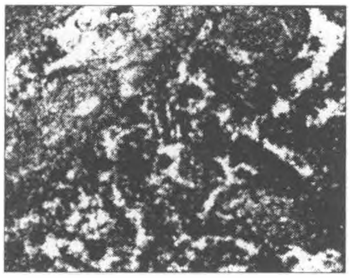
		Relict Carbonate Textural Features					
Class	**n**	**Algal**	**Pelloidal**	**Fossil**	**Dolomitic**	**Dissolved**	**Other**
1A	6	2	3	2	1		
1E	3	3	2	2			
2A	4	2		2	1		
2E	5	1	2	3			
3A	9	2	6				3
3E	4	1	1	2	1		1
4A	2	2	2				
4E	3	3		1			
1B1	3	2	1	1			1
1D1	3	1	1	3			
1B2	7	1		1			5
1D2	4	1	3	1	1		
2B1	3	2	2	1		1	
2D1	2	1	1	1		1	
3B1	4	1	1	3			
3D1	1	1	1				
4B1	1			1			
4D1	4	2	2	3		3	
Total	68	28	28	27	4	5	10

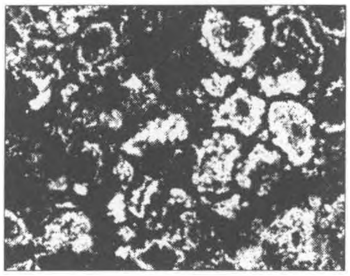
Other: 3A: Samples E and H are argillites; Sample I is an altered tuff 3E:
Sample B is a volcanoclastic chert 1B1:
Sample B is an altered tuff 1B2:
Samples A, B, F, G are altered tuff; Sample D is a chalcedony

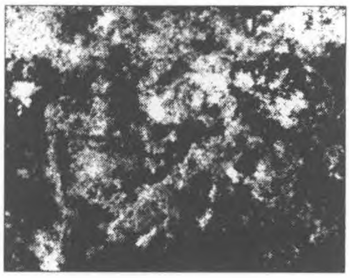
The second division isolates a chalcedony type from remaining debitage. The decision tree in Figure 3 illustrates the application of criteria to debitage after quartzite identification. First, transparent or translucent, clear to white debitage is selected for inspection. No chalcedonies of other colors exist in the Keatley assemblage in any significant quantity. Unusual and rare specimens of materials are excluded from this analysis. The second and third criteria, absence of clastic and globular inclusions (globules are crystalline aggregates of opaques which appear as dark, rounded specks or spots), separate chalcedony from cryptocrystalline materials of similar appearance. The fourth criterion refers to characteristics of the cortical surface, where such a surface is present. The chalcedonic material appears to have formed in a manner which resulted in heavily mineralized cortical surfaces (Fig. 4). Mineralization of these cortical surfaces may be very fine-grained (e.g., Fig. 4, L.S.1331, right side of image), and in such cases is of a brownish hue. Other crystals are pinkish (Fig. 4, L.S. 1020), white (Fig. 4, L.S. 1304) or clear (Fig. 4, L.S. 1286). The fifth criterion refers to a characteristic luster or sheen present in the material. Finally, although the attribute is not widely represented in Keatley chalcedonies, some laminar varieties (flowstone) are present. Distributional summaries treat both nodular and laminar varieties as one type.

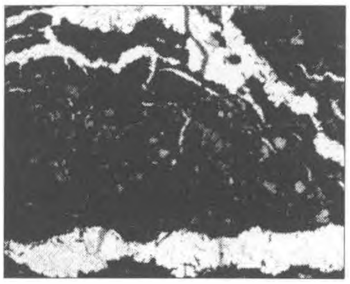
Only about 13% of the "chert" debitage could be relegated to quartzite or chalcedony types by application of these criteria. Sorting the remaining 87% presented one of the most difficult and challenging aspects of the study. No natural characteristics existed which allowed for clear distinction of material types in the remainder of the sample, because the attributes (e.g., color and grain size) were continuously variable and seemed randomly associated. The remaining debitage was therefore sorted by color and textural character-


3A(A) Pelloidal texture, dense organics. Width of field 3 mm.


2E(A) Vuggy pelloidal texture. Width of field 3 mm


4A(A) Algal texture. Width of field 3 mm.


3B1(B) Fossiliferous (Bryazoan) Width of field 3 mm.


2E(C) Fossiliferous, Dolomitic Width of field 3 mm.

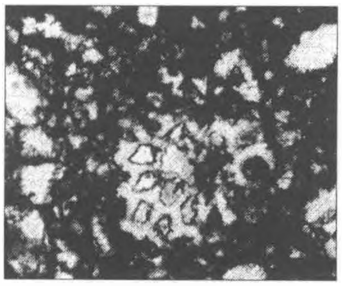

3B1(B) Fossiliferous (Bryazoan) Width of field 3 mm.

Figure 8. Relic carbonate texture in the Keatley jasperoid.

Table 8. Petrographic Features of Keatley Pisolite Facies (c.f. Figure 12)

Sample	Pisolitic Floatstone	Floatstone Rudstone	Rudstone	Botryoidal	Opalized	Hydrated
3C(A)	x				x	
3C(B)				x	x	
4CA(A)		x			x	x
4CA(B)		x			x	
4CA(C)		x			x	
4CA(D)		x			x	
4CA(F)			x		x	
4CB(A)		x			x	
4CB(B)		x			x	
4CB(C)	x					
4CB(D)	x					
5CA(A)			x		x	
5CA(B)	x					x
5CA(C)				x	x	
5CB(A)		x			x	
5CB(C)	x					
5CB(E)			x		x	
5CB(F)			x			
5CB(G)			x			
5CB(H)		x			x	
5CB(I)	x					
5E(A)			x			
5E(B)		x				
5E(C)				x	x	
5E(D)			x			
5E(E)			x			
5E(F)		x				x
5E(G)	x					
Totals (28)	7	10	8	3	15	3

Table 9. Petrographic Varieties in the Gray Chert

Sample	Argillite	Schist	Altered Tuff	Jasperoid	Chert	Marl
1G(A)				x		
1G(B)				x		
1G(C)			x			
1G(D)						x
1G(E)			x			
2G(A)				x		
2G(B)				x		
2G(C)					x	
2G(D)			x			
2G(E)			x			
2G(F)		x				
2G(G)			x			
3G(A)	x					
3G(B)	x					
3G(C)			x			
Totals (15)	2	1	6	4	1	1

istics into a number of groups corresponding to arbitrary distinctions depicted in Figure 5. The classes received alphanumeric designations. The first discriminant is grain size. Grain size refers to the dominant particle size, where 1 = dominantly cryptocrystalline (less than 50% clay-sized or larger particles), 2 = microcrystalline (greater than or equal to 50% clay-sized, 3 = silty, 4 = fine sand, and 5 = coarse sand (Fig. 6). The second discriminant is color and patterning. Patterning is described as solid or banded/mottled. Banding and mottling was found to arise from a variety of causes (Fig. 7) resulting in mixed textures where grain size varieties are abruptly conjoined by tectonic or diagenetic processes or secondary mineralization. Highlighting, a third discriminant, usually resulted from oxide staining and secondary mineralization. The net result of the application of the visual criteria described in Figure 5 was the segregation of a number of varieties (Table 6). Residual debitage which could not be described by the criteria outlined in Figure 5 (there were very few pieces) were considered "exotics" and will be described at a later time. Careful inspection of Table 6 will show that some patterning exists. Solid reddish and yellowish materials all exhibit gradation in grain-size and are paralleled by reddish and yellowish banded or mottled varieties. Gray-Green materials do not have banded or mottled counterparts. Clear-Cloudy and White-Buff color varieties do not exhibit an unbroken gradational grain-size change, but occur in sandy textures only after a gap at grain-size 2. This patterning is symptomatic of similarities and differences observable at the level of thin section or geochemical analysis.

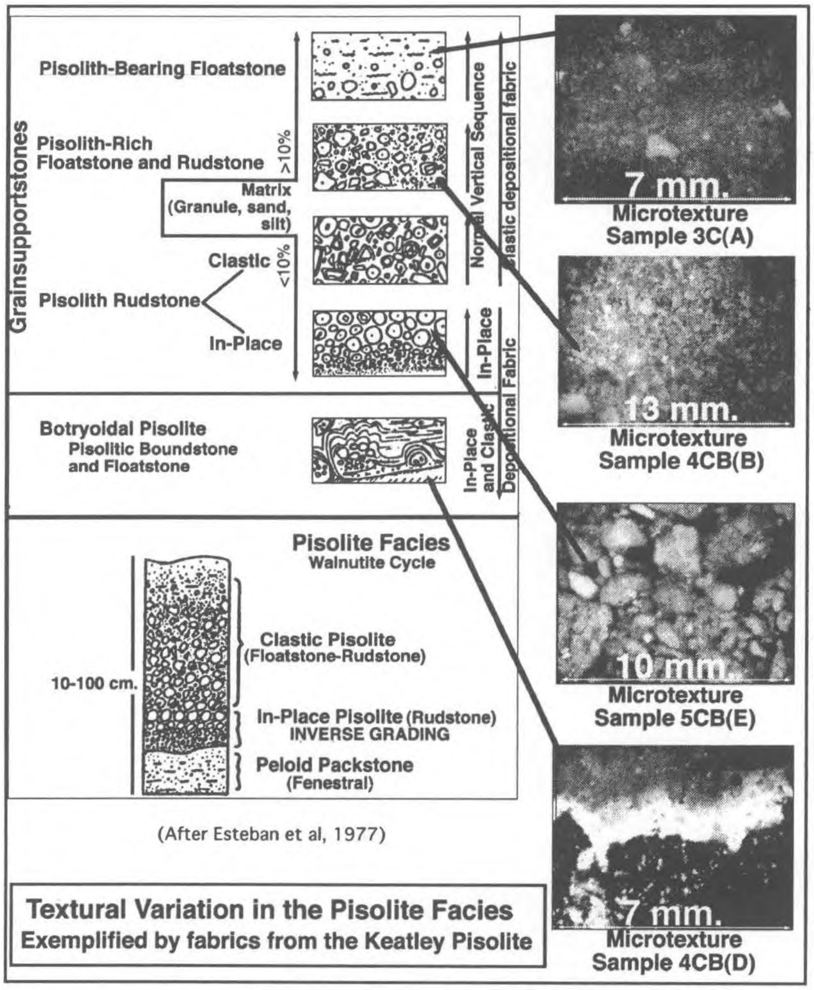


Figure 9. Pisolitic textures in the Keatley chert.

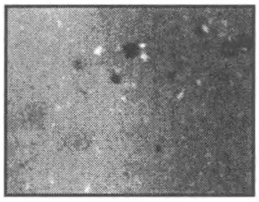
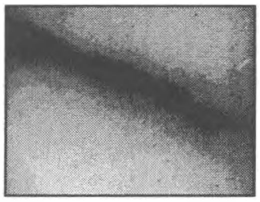
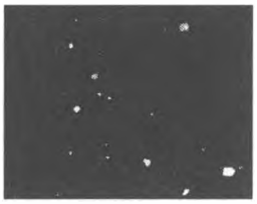
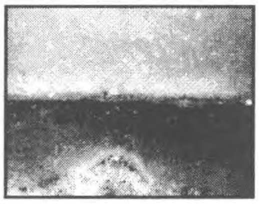
 **1F(A) Aggregates of opaques in the Keatley Tuff** **(Width of field 3 mm)**	 **1C(B) Collapse structure in the Keatley Tuff** **(Width of field 3 mm)**
 **1F(B) Clastic inclusions in the Keatley Tuff** **(Enhanced Contrast) (Width of Field 3 mm)**	 **1F(C) Layering in the Keatley Tuff** **(Width of Field 7 mm)**

Figure 10. Petrographic characteristics of the Keatley tuff.

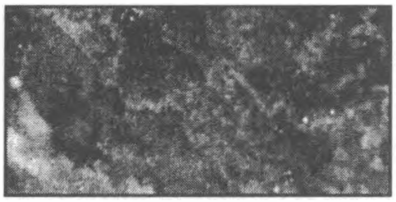
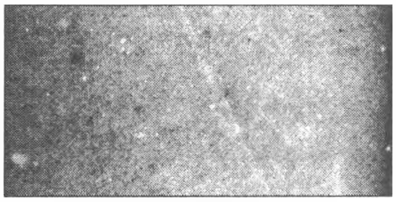
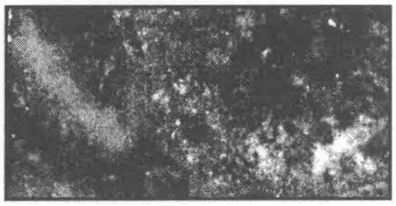
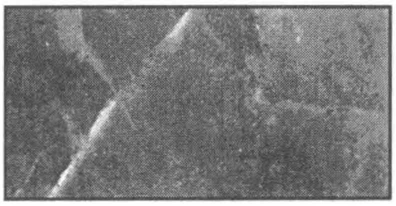
 2G(A) Jasperoid Reflected Light (Width of Field 7 mm)	 2G(F) Schist Reflected Light (Width of Field 10 mm)
 2G(C) Radiolarian Chert Reflected Light (Width of Field 7 mm)	 2G(D) Altered Crystal Vitric Tuff Reflected Light (Width of Field 7 mm)
 1G(B) Jasperoid (Enhanced) Reflected Light (Width of Field 7 mm)	 1G(A) Jasperoid Reflected Light (Width of Field 7 mm)

Figure 11. Petrographic textures in the Keatley gray chert.

Table 10. Distribution of Types by Housepit: Raw Counts

HP	Jasperoid	Pisolite	Tuff	Chalcedony	Quartzite	Totals
1	61	325	74	6	7	473
5	115	82	28	93	13	331
7	561	155	218	37	85	1056
All	737	562	320	136	105	1860

Table 11. Distribution of Types in Housepit 1: Raw Counts

Unit	J	P	T	C	Q	Totals
Roof	10	28	6	1	2	47
Rim	40	247	41	5	0	333
Floor	9	12	5	0	1	27
All*	59	287	52	6	3	407
Rim Sq. XF	17	168	16	2	0	203
Sq. XF Lvl. 1	9	37	6	1	0	53
Sq. XF Lvl. 2	3	29	1	0	0	33
Sq. XF Lvl. 3	5	102	9	1	0	117

Level 1= Excavation Levels 1-3 J=Jasperoid P=Pisolite T=Tuff; Level 2= Excavation Levels 4-6 C=Chalcedony Q=Quartzite; Level 3= Excavation Levels 7-9; * Excludes “surface” and “other” strata

Table 12. Distribution of Types in Housepit 5: Raw Counts

Unit	J	P	T	C	Q	Totals
Roof	30	16	1	6	7	60
Rim	69	45	13	70	1	198
Floor	3	2	0	2	2	9
All*	102	63	14	78	10	267
Rim Sq. XF	19	2	1	1	0	23
Rim Sq. E	11	7	2	25	0	45
Rim Sq. F	38	36	10	44	1	129
Sq. F Lvl. 1	15	11	2	9	0	37
Sq. F Lvl. 2	18	15	2	8	0	43
Sq. F Lvl. 3	5	10	6	27	1	49

Level 1= Strata VIIIA and VIIIB J=Jasperoid P=Pisolite T=Tuff; Level 2= Strata VIIID,E,F,I,G C=Chalcedony Q=Quartzite; Level 3= Stratum VIIIH; * Excludes “surface” and “other” strata

Petrographic Analyses of the Keatley Chert

Having separated the “cherts” by the criteria specified in the preceding section, samples were taken from each group for petrographic and geochemical analysis. The sampling process was not random. The first objective in the petrographic analysis was to describe features of the chert best observable in thin section. For that reason, samples representative of the most divergent hues and textures found within each group were selected for analysis. This explains why, in some varieties (e.g., 1C and 1F), very few specimens were selected for petrographic and geochemical analyses (everything looked the same), while in others with very few members (e.g., 1G, 2G, 3G) many samples were taken (everything looked different). It was hoped that this sampling strategy would produce the most diverse set of petrographic and geochemical characteristics.

Sedimentary rocks are extremely scale sensitive. At the outcrop scale, one may find a fairly complete suite of petrographic features. As the metric scale of analysis decreases, variability in petrographic (and geochemical) characteristics between samples increases. The debitage flakes analyzed from the Keatley Creek site usually consisted of less than a cubic centimeter of material. When a geologist examines thin sections of samples from an outcrop, he compiles a list of attributes that characterize the material. In examining a collection of flakes from cultural contexts, the assumption of a single origin for all items cannot be reasonably made.

Table 13. Distribution of Types In Housepit 7: Raw Counts

Unit	J	P	T	C	Q	Totals
Roof	20	6	2	1	3	32
Rim	487	116	82	33	70	788
Floor	1	1	1	0	1	4
All*	508	123	85	34	74	824
Rim Sq. AA	239	61	48	27	13	388
Sq. AA Lvl 1	32	4	5	9	4	54
Sq. AA Lvl 2	110	49	31	10	8	208
Sq. AA Lvl 3	97	8	12	8	1	126
Rim Sq. XD	14	0	0	0	0	14
Rim Sq. D	59	6	7	1	5	78
Rim Sq. K	89	22	10	2	27	150
Rim Sq. L	28	4	5	1	1	39
Rim Sq. M	30	17	6	2	13	68
Rim Sq. N	14	5	5	0	11	35
Rim Sq. O	14	1	1	0	0	16
DKL Trench 1	26	5	0	1	4	36
DKL Trench 2	148	26	21	3	29	227
DKL T2 Lvl 1	91	16	12	3	13	135
DKL T2 Lvl 2	57	10	9	0	16	92
MNO Trench 2	41	9	8	1	16	75
MNO T2 Lvl 1	10	6	3	1	14	34
MNO T2 Lvl 2	17	2	4	0	2	25
MNO T2 Lvl 3	14	1	1	0	0	16

Level 1= Strata XIIIA and XIIIB; J=Jasperoid P=Pisolite T=Tuff Level 2= Strata XIIIC and XIII; C=Chalcedony Q=Quartzite Level 3= Stratum XIIIF; * Excludes "surface" and "other" strata

In debitage analyses, sets of petrographic attributes must be enumerated by thin section and similar sets combined only when theory allows such combinations. The products of this process are synthetic descriptions, aggregates of textural and mineralogical attributes found in several samples that might be considered characteristic of a "type" of rock, one of hypothetically common origin and formation. Where geochemical analyses allow, such attribute combinations are used to reorganize varieties formed in the initial sorting process into the types analyzed for distributional characteristics later in the study.

The first set of features defines the petrographic attribute called in this study "Relict Carbonate Texture" (Fig. 8). Use of the word "relict," in this case, signifies a siliceous replacement of the original minerals. In the process of silicification, much of the fine detail originally present in the carbonate rock has been lost. In many cases, the best evidence of carbonate texture is presented only by "ghosts" (morphological outlines) of carbonate species in a dissolution texture. However, in some thin sections, remarkably well preserved forms of calcareous algae, bryozoans, echinoderm fragments, crinoid stem, and brachiopod spines are present, frequently with pelloidal masses. These fossils and textures can easily be attributed to a shallow carbonate environment conducive to the deposition of a biopelmicrite (limestone) or biopelsparite (coarse limestone). Siliceous replacement of rhombahedral authigenic carbonates (e.g., dolomite) occurs in many thin sections. Thin sections with relict carbonate texture also exhibit a finely dispersed suspension of phosphatic or organic particles which results in a murky appearance in plane polarized view. Relict carbonate texture dominates the reddish and yellowish lithics, both banded and solid (Table 7). On the basis of this petrographic evidence, the bulk of the reddish and yellowish debitage can be classified as "jasperoid," a dense, chert-like siliceous rock in which cryptocrystalline quartz has replaced the carbonate minerals.

The second major textural suite is actually a special case of relict carbonate texture, "Relict Pisolitic Texture." This texture results from the inclusion and aggregation of pisolites, rounded to sub-rounded, usually coated grains, in a carbonate matrix of varying concentration (Fig. 9). As in the previous case, much of the structure in the pisolites has been lost, although frequently, the coating of grains characteristic of pisolites may still be seen. This material contains a lot of opaline silica. The pisolites themselves are usually opaline. Matrix material is usually replaced by cryptocrystalline quartz, but occasionally by chalcedony. The glassy nature of the material makes it extremely susceptible to hydration (e.g., Fig. 4, cortical surface). The pisolitic texture is reasonably easy to discern (except in some occurrences of pisolitic floatstone and botryoidal pisolite) and has been commonly referred to as "Speckled Chert" by those

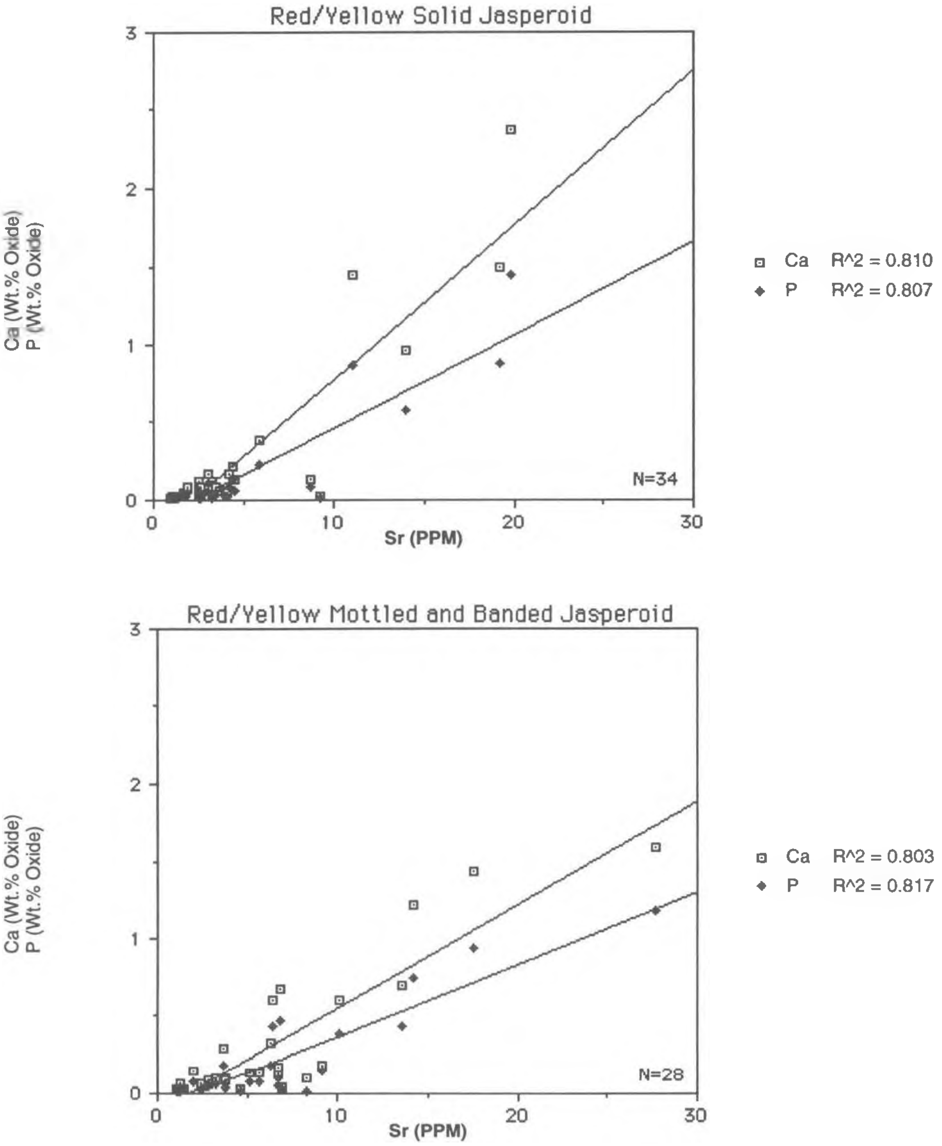


Figure 12. Ca and P vs. Sr in the Keatley jasperoid.

familiar with the Keatley Creek materials. Samples from provisional classes 3C, 4CA, 4CB, 5CA, 5CB, and 5E consist nearly entirely of pisolite (Table 8).

The third suite of petrographic features describes the "Keatley Tuff," an altered vitric tuff. Materials of this type are usually considered pyroclastic igneous rocks. At Keatley Creek, clear-cloudy varieties (1F) of this material look similar to the chalcedony. One obvious petrographic difference is that no chalcedonic quartz was observed in any of the thin sections of vitric tuff examined, although it would not be unusual to find some chalcedonic quartz in an altered vitric tuff. The majority of the rock consists of cryptocrystalline quartz and zeolite minerals, products of the alteration of volcanic glass. Occasional ghosts of crystal shards are present, where phenocrysts have been replaced by quartz, but outlines of the original euhedral mineral (a feldspar or amphibole) may be discerned. A suite of textural features (globular inclusions, collapse structures, angular clastic inclusions, and layering) may be observed in this material (Fig. 10). Provisional classes 1B2, 1C, and 1F appear to consist almost entirely of altered tuff.

The only remaining varieties not yet characterized by some set of common petrographic features are the gray-green lithics of provisional classes 1G, 2G, and 3G.

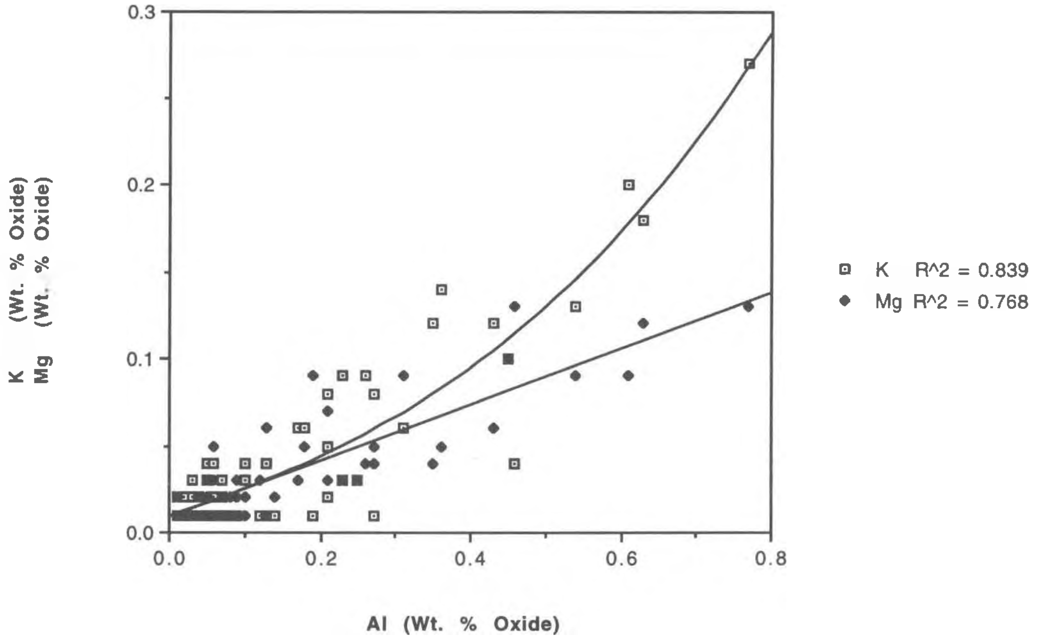


Figure 13. K and Mg vs. Al in the Keatley jasperoid.

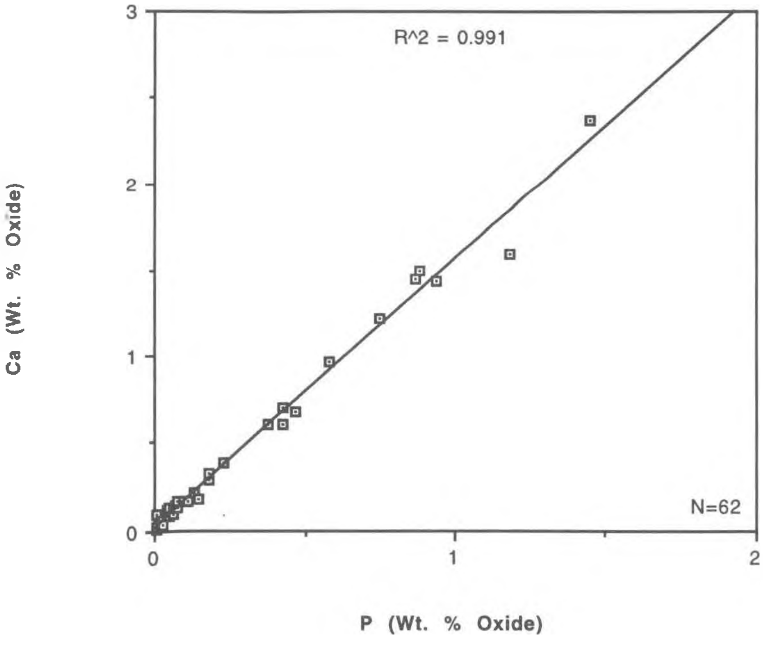


Figure 14. Ca vs. P in the Keatley jasperoid.

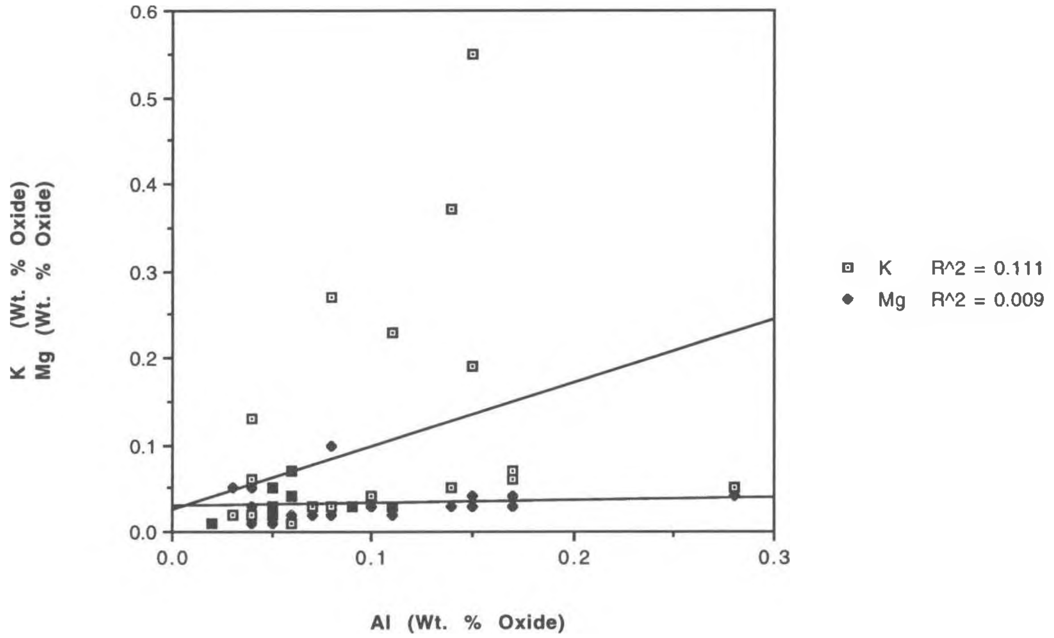


Figure 15. K and Mg vs. Al in the Keatley pisolite.

The diversity present in this group does not allow for the formation of any common set of petrographic characteristics. Many different kinds of material are present within these provisional classes (Table 9, Fig. 11). The most abundant variety is a tuffaceous material which shares geochemical and petrographic characteristics with the Keatley Tuff, allowing for the expansion of that type to include gray, as well as clear-cloudy and white-buff members. The gray-green materials also include some jasperoid (silicified limestone) which can be included as a minor constituent of the Jasperoid type. Other gray materials include distinctively rare (in this assemblage) varieties such as argillite, marl (a mixed siliciclastic and carbonate rock), a silicified schist and a radiolarian chert.

Geochemical Patterns in the Keatley Chert

By this time, it may have become apparent that, aside from two isolated occurrences (one piece of volcanoclastic chert in variety 3E and one piece of radiolarian chert in the gray materials), there are no true cherts in the Keatley Creek assemblage. Petrographic evidence indicates a preponderance of silicified carbonates (jasperoid and pisolite), a chalcedony, altered vitric tuff, and quartzite. Petrographic criteria alone could be used to construct class definitions at this point, but the petrographic observations made in this study are subjective. Interpretations of thin section texture and mineralogy can be disputed (just as I have questioned Richard's report of olivine in Cache Creek "basalts"). Therefore, petrographic class distinctions made in this study are contrasted with geochemical evidence. Geochemical patterns in the Keatley Creek "cherts" are examined to determine whether petrographic patterns and chemical anaylses can be harmoniously integrated as type criteria. The proposed groupings are then evaluated using discriminant analysis techniques based on geochemical data.

Only those samples for which thin sections existed were quantitatively analyzed. This procedure provides an opportunity to directly compare analytical results with petrographic observations. Geochemical analyses were all performed by ICP analysis. The analyses were originally conceived as trace element studies, since that seemed to present (from reviews of the available literature) the most promise of success. Therefore, metaborate fusions were not performed as part of the

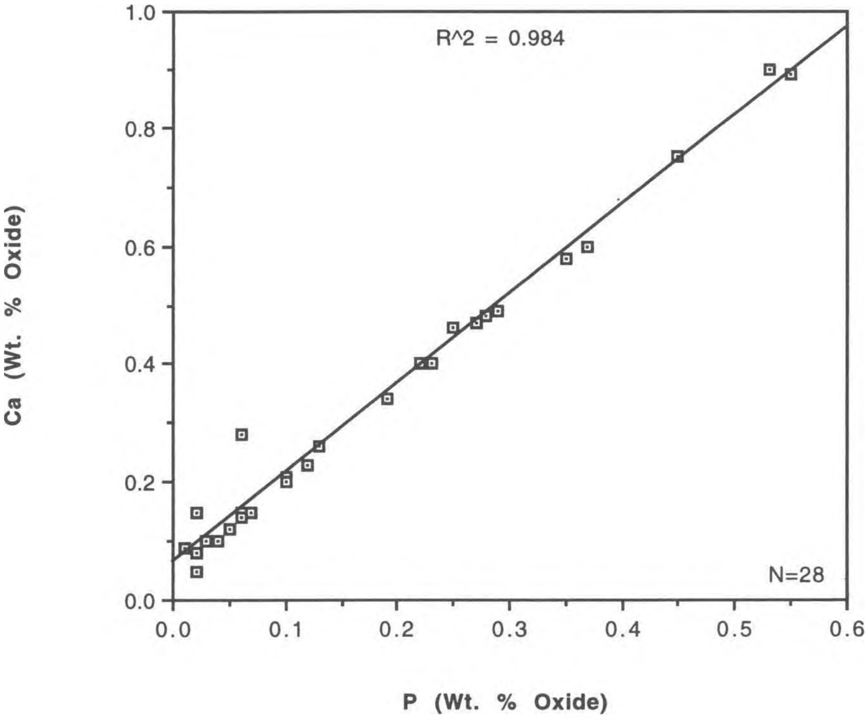


Figure 16. Ca vs. P in the Keatley pisolite.

process. As a result, there may have been some undissolved materials, and the concentrations of major elements may be slightly higher than reported. Nevertheless, the data seem to provide strong discriminatory patterning for each of the proposed types.

In the petrographic analyses, textural observations resulted in an interpretation that all of the reddish and yellowish materials, both solid and banded or mottled, were essentially similar, i.e., jasperoid, and potentially attributable to the same kind of source. If this was true, then some patterning should exist in the geochemistry to support merging the two varieties. There is such evidence, and one example is the patterning of Ca and P with Sr (Fig. 12). Correlation levels are equivalent, the range of compositional values is similar, and the patterns are strongly similar. Strong correlation of K and Mg with Al also exists in both banded and solid materials, as is shown in a combined plot (Fig. 13). A near perfect correlation between Ca and P is also evident (Fig. 14), but this is not unique to the jasperoid material. The Keatley Pisolite, described next, was also originaly a carbonate sediment, and shares some characteristics with the Keatley Jasperoid.

The Keatley pisolite is, as I mentioned in the section on petrography, fairly easy to distinguish macroscopically, because of the speckled appearance of the material. Both the pisolite and the jasperoid are both replacement textures of carbonate sediment. It is interesting to note, however, that the association of K and Mg with Al, clearly does not occur in the pisolite (Fig. 15 vs. Fig. 13). This and other geochemical distinctions support petrographic evidence for separating this material from the jasperoid. A very different physical environment is required for the formation of a pisolite, and it is likely to represent a different toolstone source. What they do share is the very high correlation between Ca and P (Fig. 16), a relationship which probably results from apatite which was not dissolved during diagenesis when the carbonate minerals were replaced by silica. Apatite is *seventeen orders of magnitude* less soluble than calcite in aqueous solution at 25°C. Solubility differences in minerals (e.g., the phosphates hypothesized in this case and the sulphates in the next example) may result in residual minerals that resist diagenetic changes, providing stoichiometric variables for type discrimination.

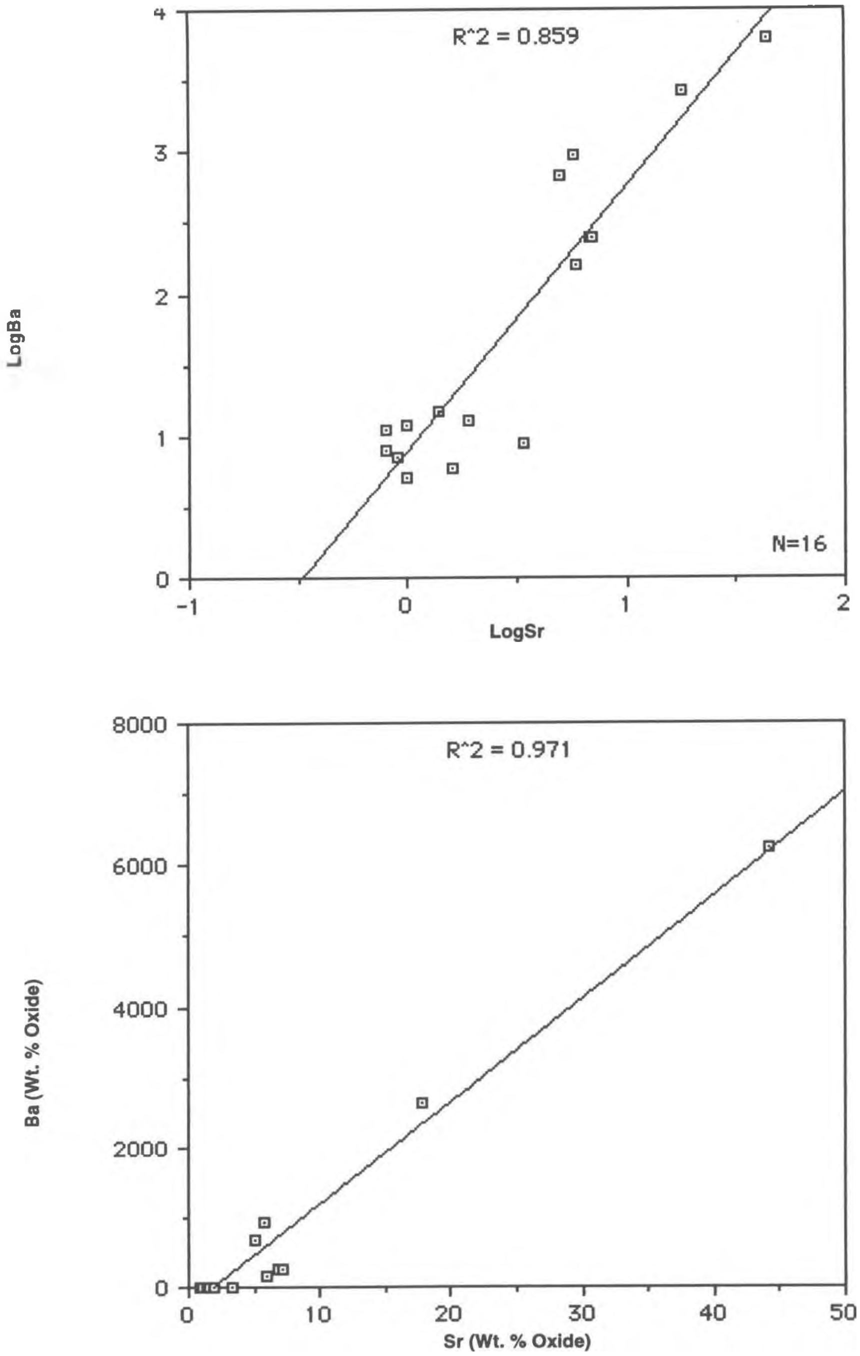
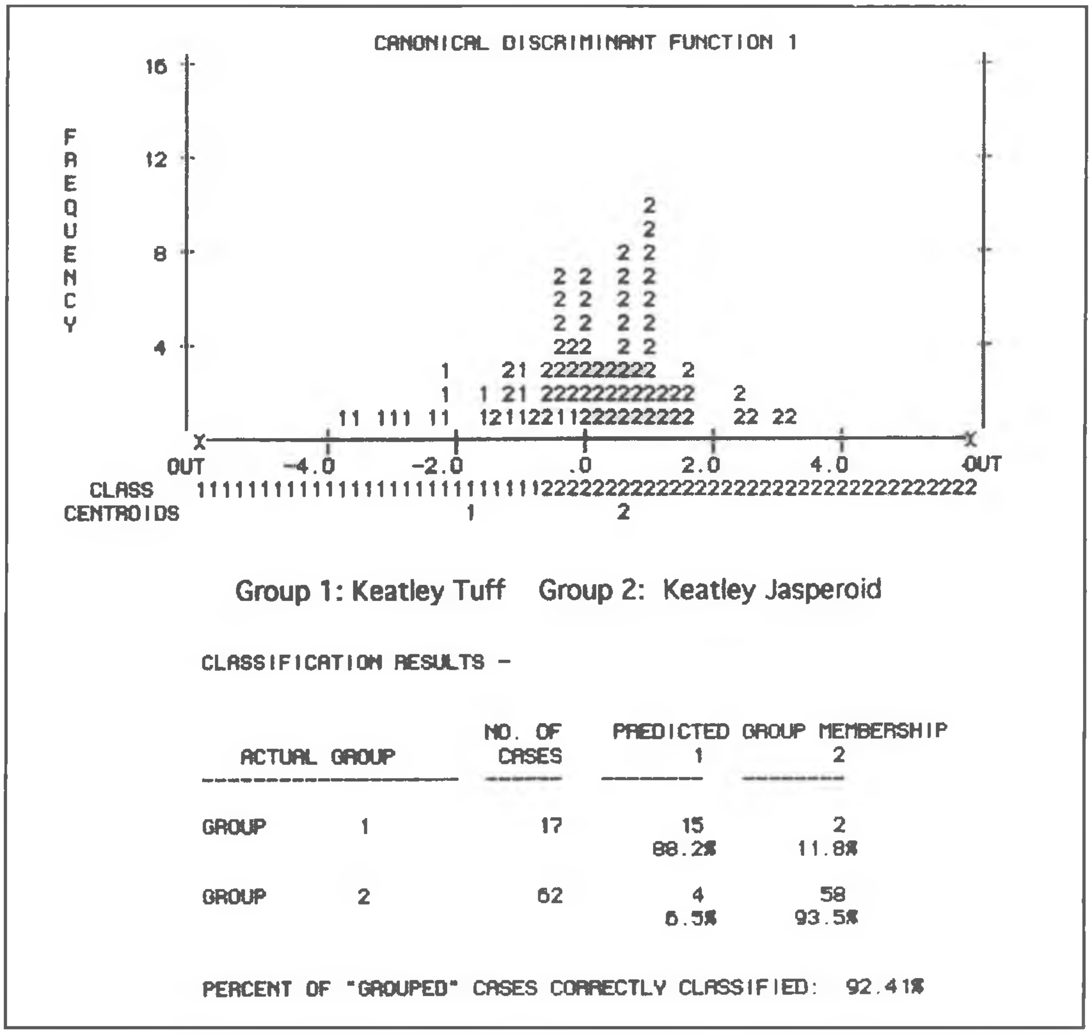


Figure 17. Ba vs. Sr in the Keatley tuff.

Besides quartzite and chalcedony, which were not modeled geochemically, the only remaining "type" is the altered vitric tuff. The sole reliable signature I could find for this material is a fairly strong correlation between Ba and Sr. The correlation apparently exists over a tremendous range of Barium/Strontium values. Indeed, since some might claim the correlation exists due to the extreme and median values, I plotted the logarithmic transforms as well, and the relationship seems to hold (Fig. 17).



Group 1: Keatley Tuff   Group 2: Keatley Jasperoid

```
CLASSIFICATION RESULTS -

                           NO. OF    PREDICTED GROUP MEMBERSHIP
    ACTUAL GROUP           CASES          1             2
----------------------     ------    --------      --------

GROUP        1               17          15             2
                                       88.2%         11.8%

GROUP        2               62           4            58
                                        6.5%         93.5%

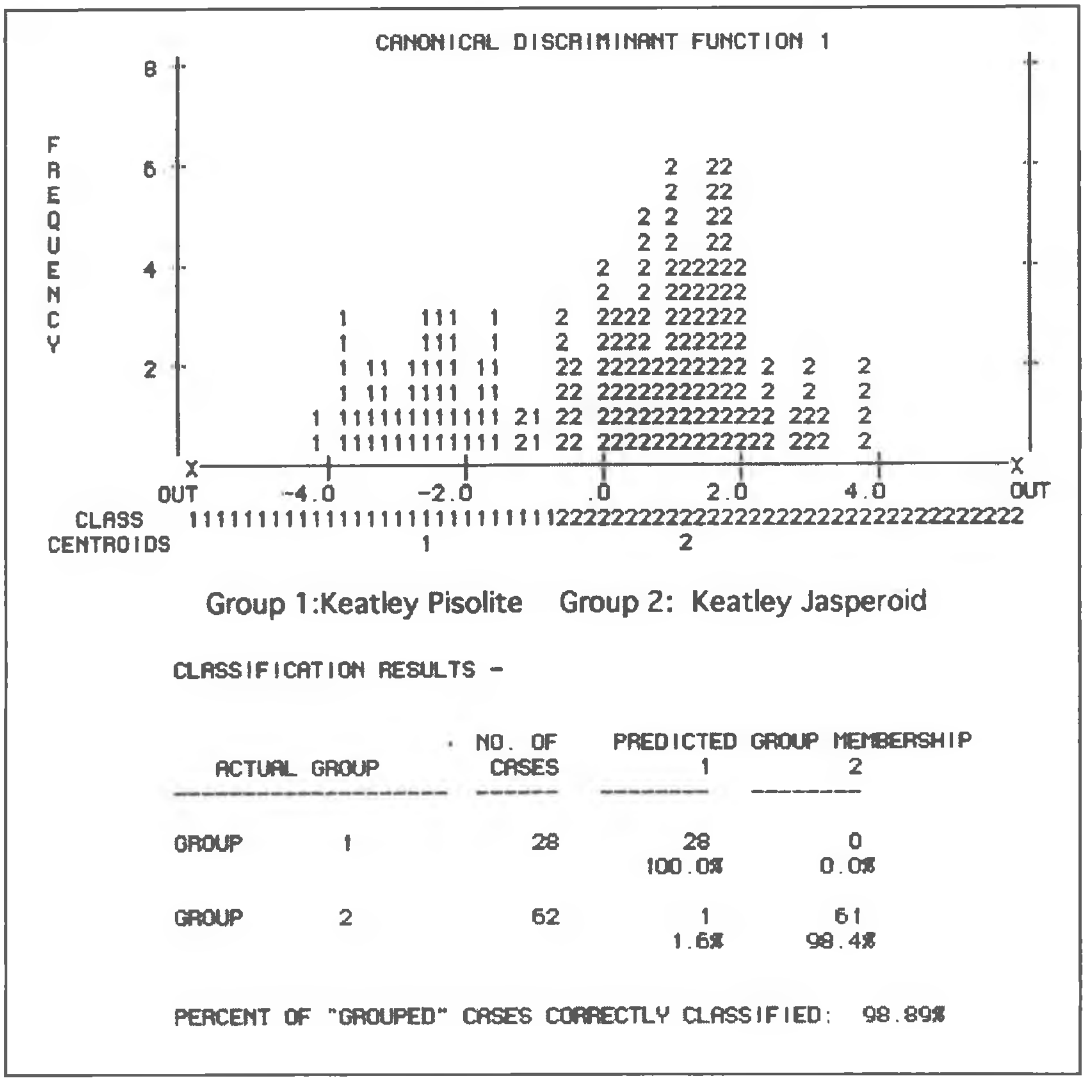
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED:  92.41%
```

Figure 18. Tuff vs. jasperoid discriminant analysis.

Barium/Strontium patterning in this material emphasizes the interpretive problems inherent in sampling Poisson distributions. Few cases will be found where the rock will be so rich in barite/celestite ($BaSO_4$/$SrSO_4$) as to yield compositions reflective of the higher values. Data transforms are appropriate devices for exploring relationships in such circumstances. In any event, the tuff simply does not have any of the geochemical characteristics of the two previously described materials.

Finally, I present the results of the discriminant analysis which was run using geochemical values (with log transforms to satisfy normality requirements) for the major and minor elements (*all* of them, rather than a selected few). The goal is to test whether materials classified as the Keatley Tuff, Keatley Jasperoid, and Keatley Pisolite can be distinguished using summary values for the major and minor element data, as well as ratio analysis.

In the first analysis, which compares the tuff to the jasperoid (Fig. 18), the discriminant function predicted group memberships in 92.4% of the cases, with 88.2% of the tuff and 93.5% of the jasperoid "correctly" classified. In the second analysis, pisolite was compared to jasperoid (Fig. 19), and 98.9% of the group members were correctly predicted, with 100% of the pisolite and 98.4% of the jasperoid cases correctly classified. The third analysis combines all three types (Fig. 20) and



Group 1:Keatley Pisolite   Group 2: Keatley Jasperoid

```
CLASSIFICATION RESULTS -

                          NO. OF     PREDICTED GROUP MEMBERSHIP
   ACTUAL GROUP           CASES          1           2
--------------------     ------     ---------    --------

GROUP       1               28          28           0
                                      100.0%        0.0%

GROUP       2               62           1          61
                                        1.6%       98.4%

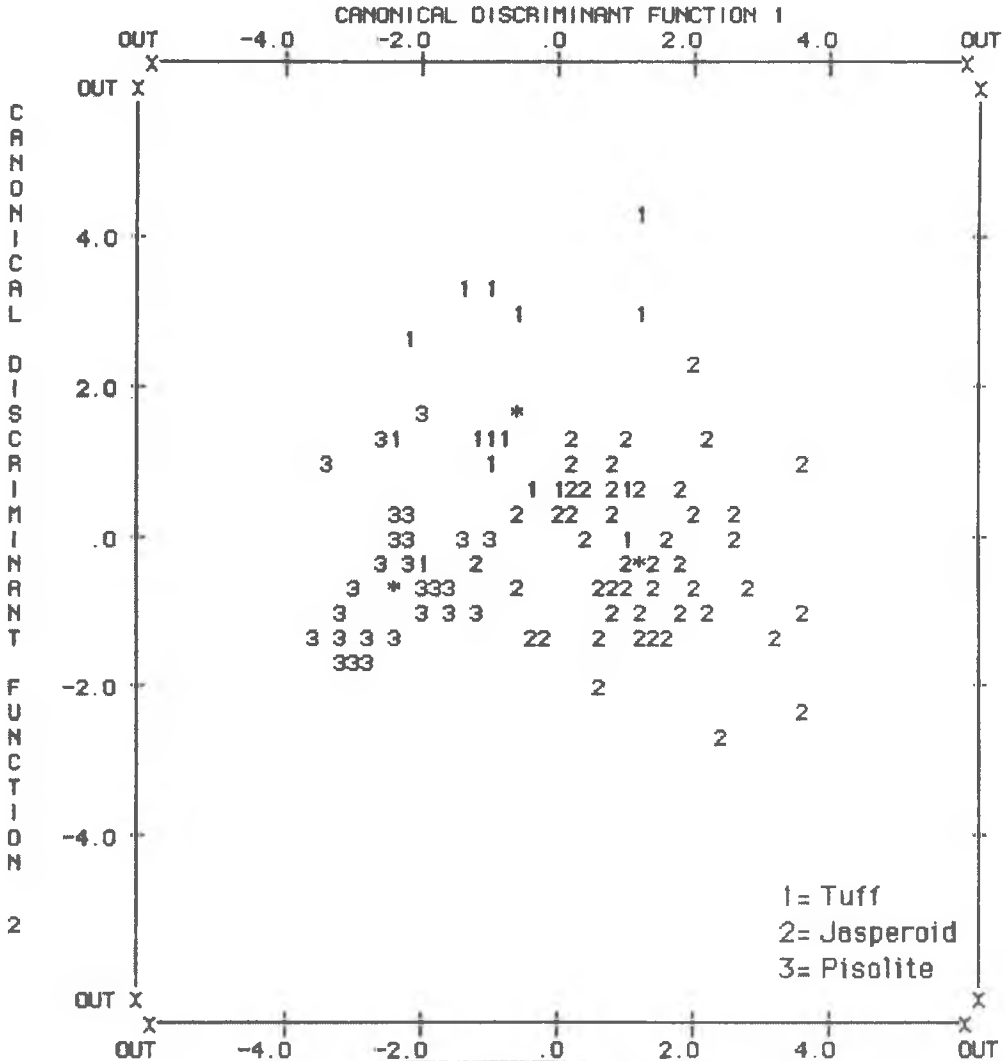
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED:  98.89%
```

Figure 19. Pisolite vs. jasperoid discriminant analysis.

generates two discriminant functions to predict group membership. In the combined analysis, although exactly the same data and methods were used, overall predictability drops to 90.6% (lower than in either of the two paired cases), with predicability of tuff membership dropping from 88.2% to 81.2%.

This demonstrates one of the problems inherent in discriminant analyses. The results change with the addition of new data. Nevertheless, the technique is useful, and points out some interesting facts. The pisolitic material is easiest to identify in the field, even without the use of thin section analysis, and it can be seen in the plot (Fig. 20), that these cases cluster very closely about the group centroid, indicating that the major element chemistry is a reliable predictor of membership. At the other extreme, cases that represent altered tuff are diffusely spread in the plot, have the lowest degree of predictability, and are correspondingly difficult to distinguish in the field, petrographically, and geochemically.

The results of these discriminant analyses may be viewed as statistical confirmation of the proposed types by some, but all the statistics really say is that major element concentrations vary systematically in the selected groups to some degree. The petrographic features and geochemical patterns apparent in the materials are much more indicative of the physical and chemical environment (i.e., the sources), and it is these attributes that demand consideration when modeling and seeking prospective sources and material types.



```
                              CLASSIFICATION RESULTS
                               NO. OF     PREDICTED GROUP MEMBERSHIP
    ACTUAL GROUP               CASES          1            2             3
    -------------------        ------     --------     --------     --------
GROUP        1                   16          13            2             1
                                           81.2%        12.5%          6.2%

GROUP        2                   62           4           56             2
                                            6.5%        90.3%          3.2%

GROUP        3                   28           1            0            27
                                            3.6%         0.0%         96.4%

    PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED:   90.57%
                          106 CASES WERE PROCESSED
```

Figure 20. Pisolite, jasperoid, and tuff discriminant analysis.

One objective of this research was to show that petrographic and geochemical analyses could generate criteria useful for characterizing lithics from archaeological sites and modeling sources, and that major element chemistry could be used to do it. I have shown elsewhere (Bakewell 1995) that major element chemistry varies significantly and in patterned ways in cherts. I have shown in this section that site lithics may also be characterized by petrography and geochemistry of major elements.

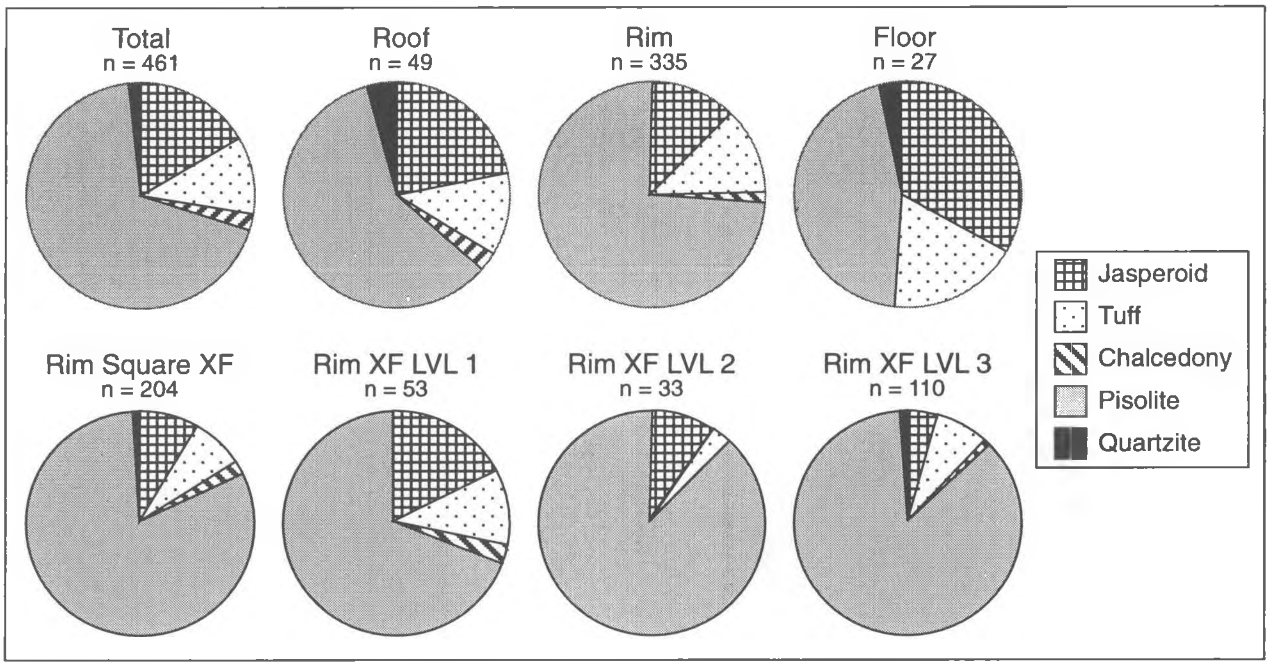


Figure 21. Material distribution in HP 1 by type and level of strata.

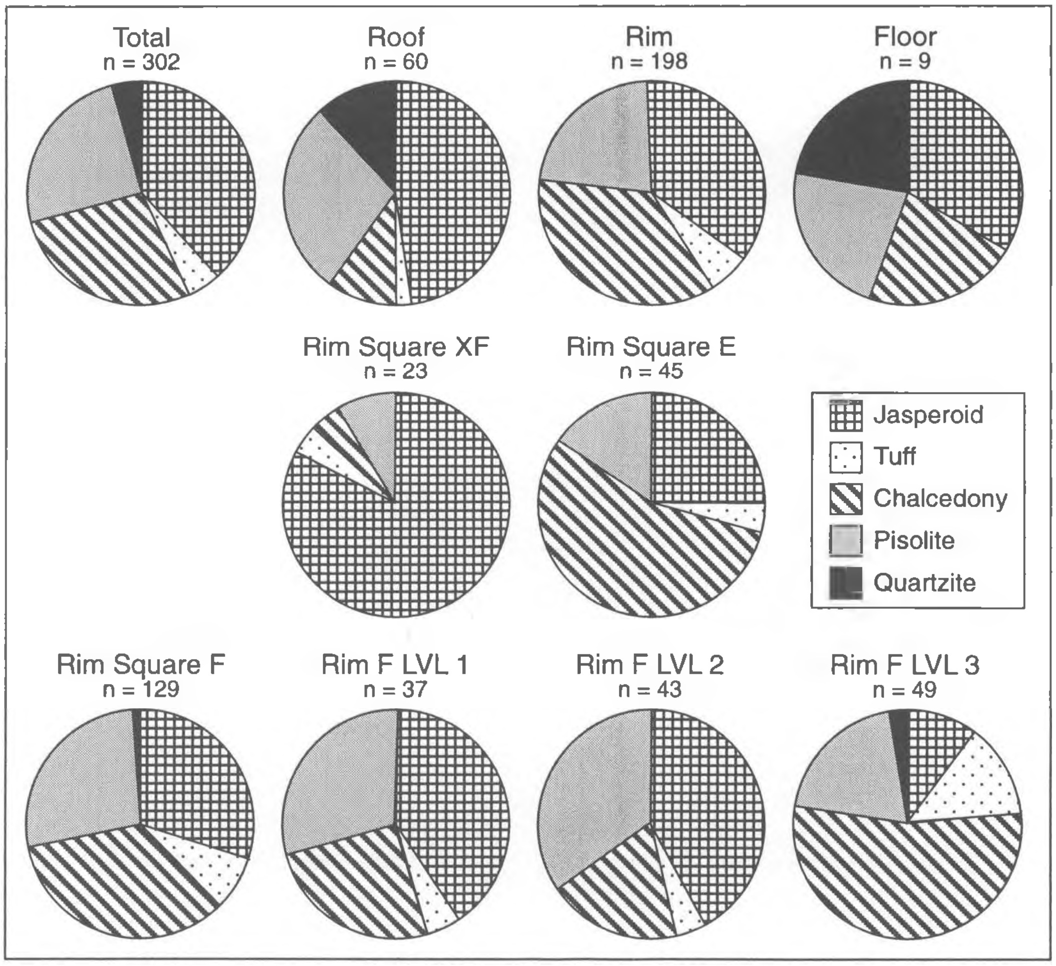


Figure 22. Material distribution in HP 5 by type and level of strata.

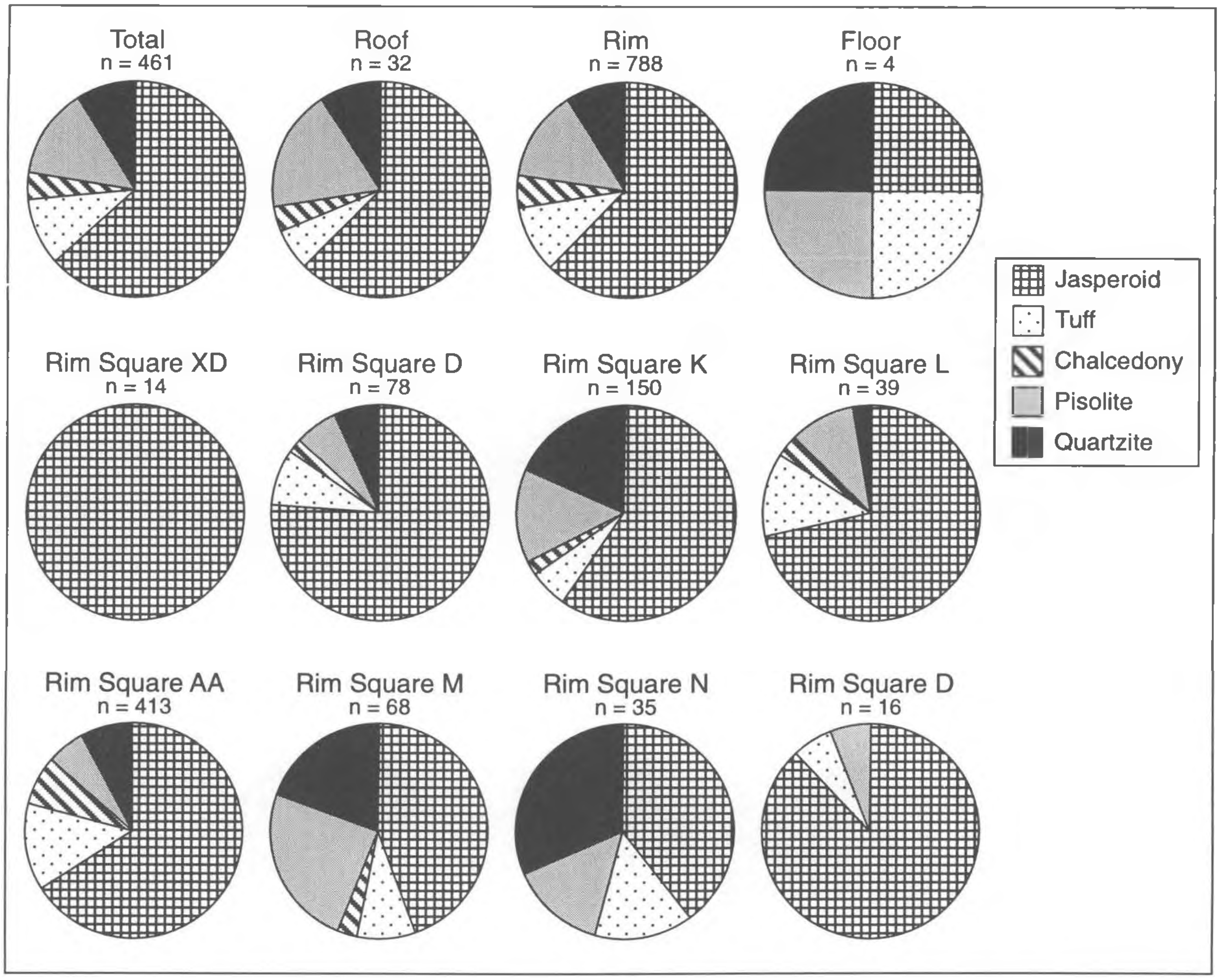


Figure 23. Material distribution in HP 7 by type and Excavation Square.

The results of analyses of Keatley Creek debitage suggest that there are five major types of material present in the site debitage besides trachydacite: jasperoid, pisolite, tuff, chalcedony, and quartzite. Sourcing studies over the last five years at Keatley Creek have located several areas that may be sources for the jasperoid. The material seems to be associated with unconsolidated ignimbrite deposits in several upland localities of the region and is known alternatively as Glen Fraser, Hat Creek, Maiden Creek, and Medicine Creek Chert (Vol. I, Chap. 11). These are surficial, not bedrock sources. Bedrock sources may also have been located (Rusty Creek and Fountain Valley Cherts), but these lack the luster and secondary mineralization resulting from inclusion in the ignimbrite. Petrographic and geochemical analyses have not yet been completed for the proposed bedrock sources, so it is impossible to say with certainty whether they are related to ignimbrite deposits, or whether they may have been directly exploited in prehistory. In five years of searching, no actual source has been located for either the pisolite or the vitric tuff, although high concentrations of pisolitic debitage have been found during surveys of Fountain Valley (Vol. I, Chap. 11). We know from cortical characteristics that the quartzite debitage is reduced from water-worn cobbles. We also know from the delicate cortical features preserved on the chalcedony that this material must be quarried from an *in situ* source. One suggested source for the chalcedony is Blue Ridge Ranch, but these materials have not been analyzed as yet either. Beyond these observations, we know nothing of the exact "chert" sources. What, then, has this analysis produced? Certainly, if this analysis had been available *before* the field surveys, then the search would have been more directed, and the results easier to evaluate. This analysis has established an entirely new approach to the sourcing of chert-like materials. But beyond the obvious, the analysis has been worth the effort if for no more than one fact: each housepit at the Keatley Creek site is itself a lithic source.

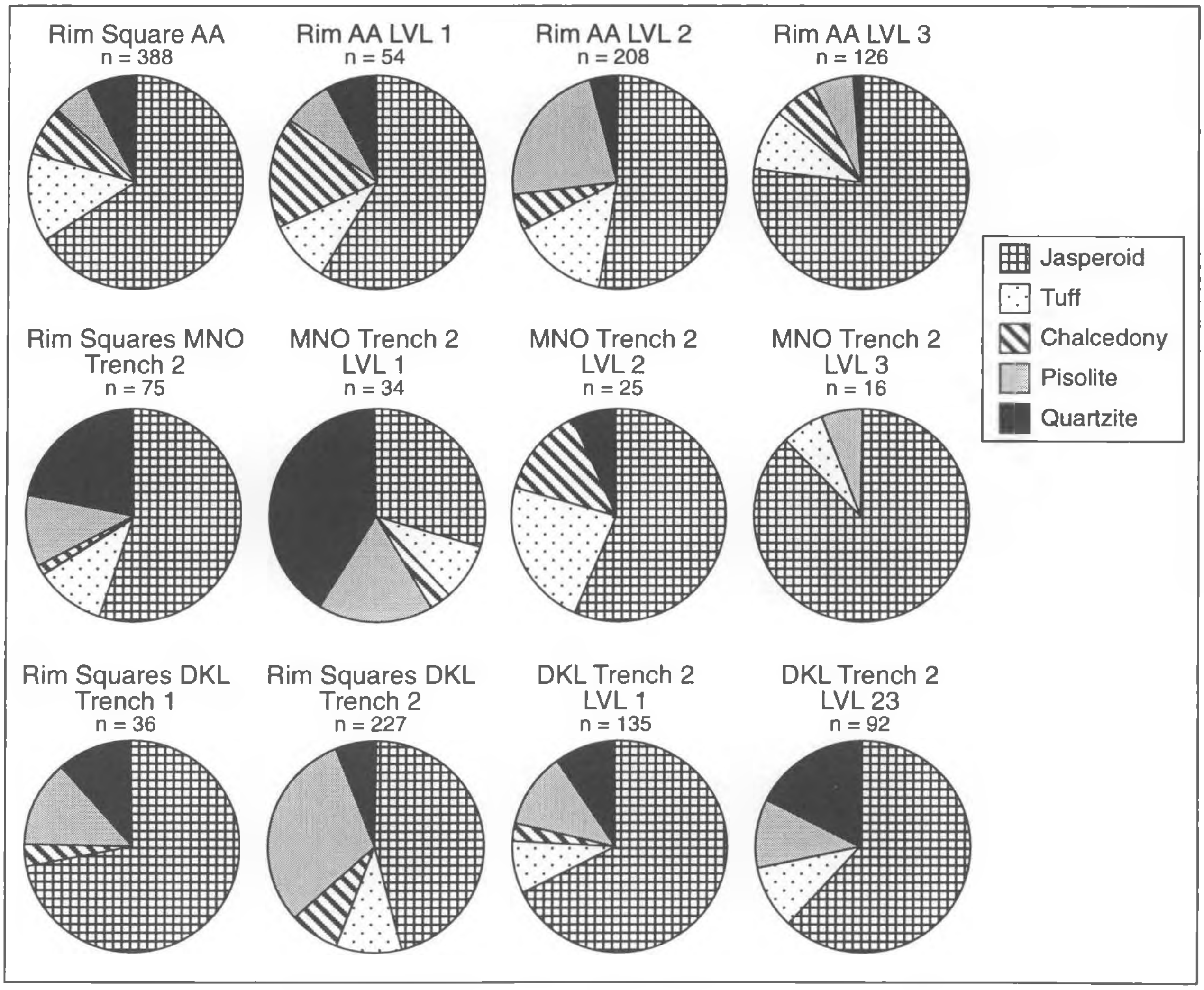


Figure 24. Material distribution in HP 7 by excavation square and sublevels.

Classification of chert-like debitage from HP's 1, 5, and 7 according to the five types of material defined in this study and analysis of distributional trends has disclosed some very interesting patterns.

Distribution of the Keatley Chert

Housepit formation at Keatley Creek represents episodic cultural sedimentation. This sedimentation results in accumulation of stratified deposits, especially in rim strata, debris which rings the housepit from successive roof-building episodes (Vol. I, Chap. 11). The distribution of the five classes of siliceous debitage identified in this study was analyzed by frequency of occurrence in the strata of HP's 1, 5, and 7, including rim, floor, and roof strata (Tables 10–13, Figs. 21–25). Based on the lithic source types defined in this study, it is clear that there were major differences in the use of specific stone types between residents of different housepits (Table 10, Fig. 25). Housepit 1 shows a distribution strongly skewed towards pisolite, which accounts for nearly 70% of the chert-like debitage. Jasperoid and tuff are approximately equal in HP 1, with about 15% of the debitage in either category. Chalcedony and quartzite are present in HP 1 only in trace amounts.

In HP 7, a markedly different pattern exists: more than half the debitage flakes were jasperoid, while pisolite and tuff occurred with frequencies in the 15–20% range.

Chalcedony, a minor constituent of the debitage materials in HP's 1 and 7, with frequencies of less than 5%, is a major material in the debitage of HP 5, occurring with frequencies roughly equivalent to

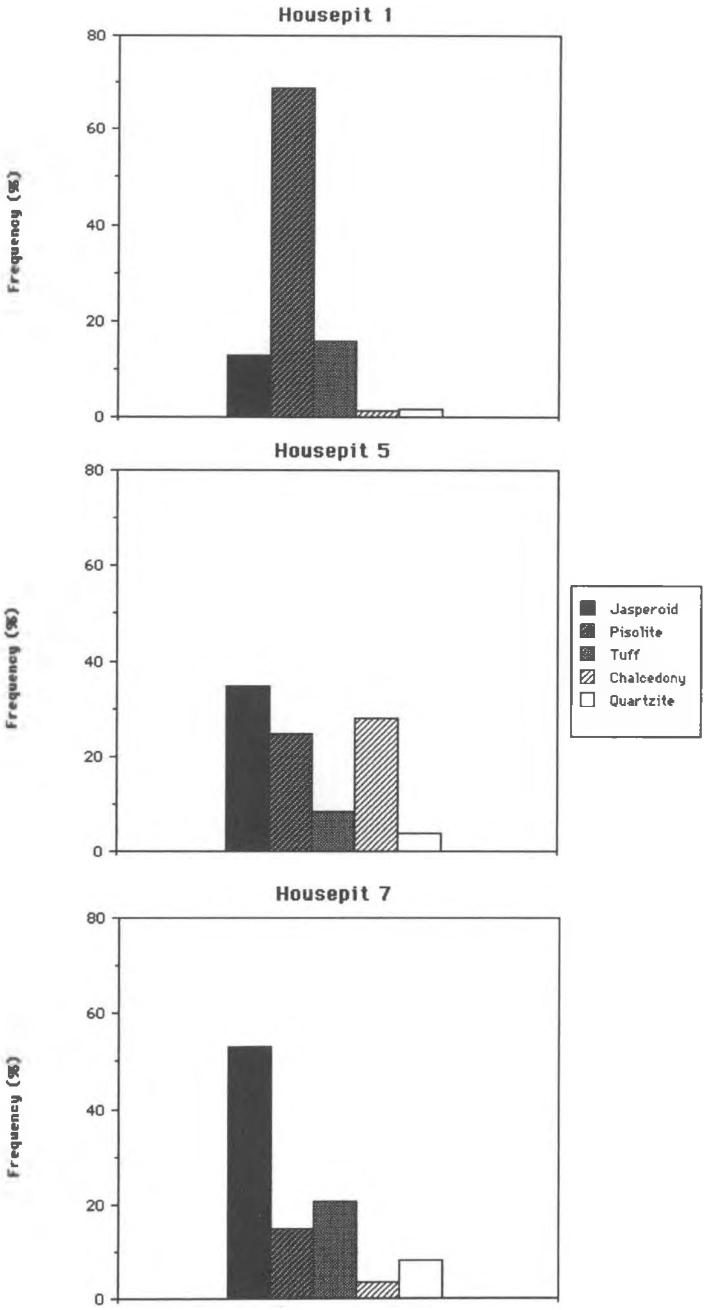
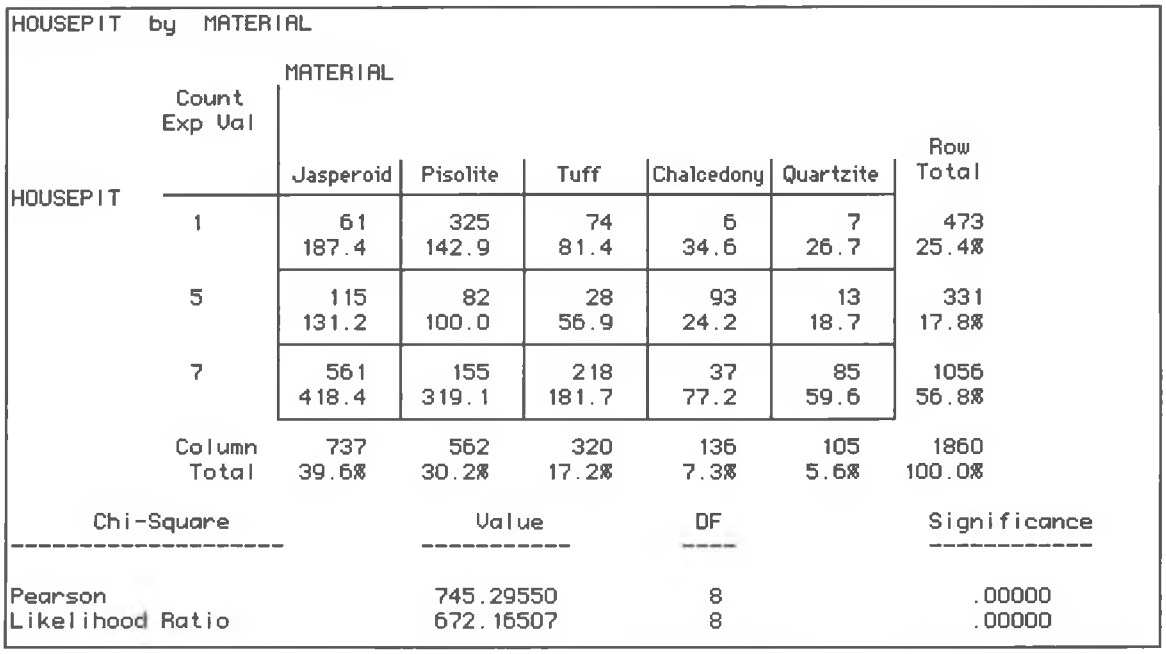


Figure 25. Material distribution by housepit.

pisolite and tuff. Considering that this chalcedony is of gemstone quality, and does not exist naturally in quantities anywhere near that of massively deposited carbonates, like the pisolite and jasperoid, this is truly remarkable. These distributional characteristics do not change substantially in any stratigraphic unit of the housepits in question where large enough samples exist for comparison (Figs. 21–24). The distributions result from the classification of *all* the excavated cherty debitage. Table 10 lists the raw counts by housepit for all 1860 pieces of debitage constituting the five types. Chi-square analysis of the distribution of the five types of material, considered together (Fig. 26), or separately (Fig. 27), suggests that the patterns are not random, but that some culturally selective factor is responsible for the distribution of this material. (Editor's note: In 1999, Bill Prentiss undertook additional excavations in the northwest rim of HP 7. Resutls of his debitage analysis fully corroborate the pattern documented in this chapter.)



```
HOUSEPIT  by  MATERIAL

                  MATERIAL
         Count
         Exp Val
                                                                     Row
                 Jasperoid  Pisolite    Tuff    Chalcedony Quartzite  Total
HOUSEPIT
             1        61       325        74         6         7       473
                   187.4     142.9      81.4      34.6      26.7     25.4%

             5       115        82        28        93        13       331
                   131.2     100.0      56.9      24.2      18.7     17.8%

             7       561       155       218        37        85      1056
                   418.4     319.1     181.7      77.2      59.6     56.8%

        Column       737       562       320       136       105      1860
         Total     39.6%     30.2%     17.2%      7.3%      5.6%    100.0%

       Chi-Square                 Value          DF                Significance
--------------------           -----------      ----               ------------

Pearson                         745.29550        8                     .00000
Likelihood Ratio                672.16507        8                     .00000
```

Figure 26. Crosstabs analysis of material distribution.

Discussion

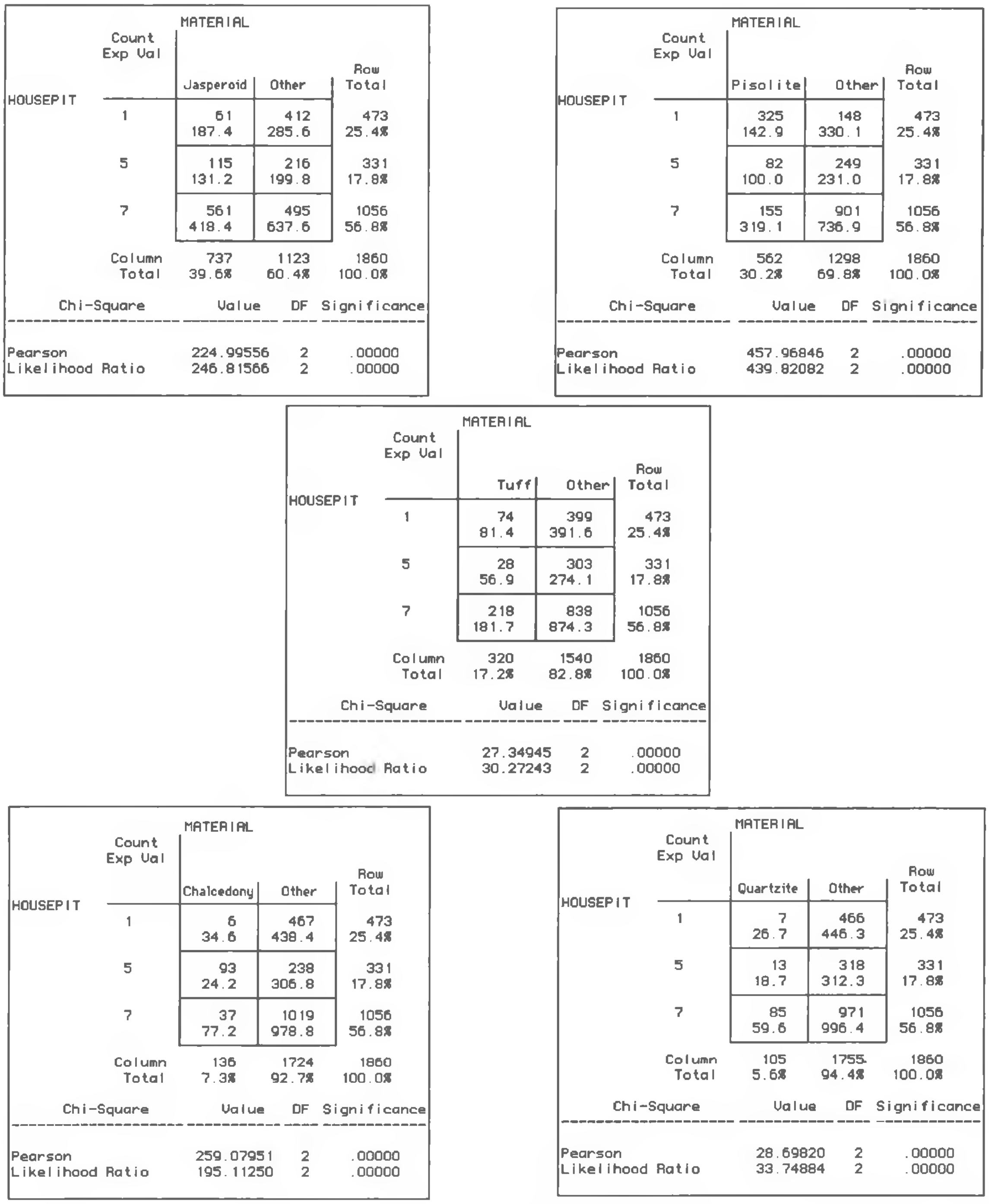
The study of time-sensitive projectile point styles in the deposits of these housepits indicates that they were used during the same span of time (Vol. I, Chap. 3). If we assume that there is no difference of a functional nature (in the engineering sense) in the physical properties of the materials, then we must conclude that the material distribution represents stylistic variation in tool stone between the housepits. Similar stylistic attributes in all deposits within a given housepit imply homologous relationship through time. In other words, the occupants of each large housepit were of the same social lineage throughout the millenia of village occupation, suggesting ownership by specific corporate groups. We could use the distributional characteristics of stone type to analyze other housepits in the village. In this way we might find similarities and differences that could relate to the number of distinct corporate groups in the village, and the number of housepits "owned" by each group. Furthermore, we could hypothesize that sites outside the village (e.g., hunting, fishing, and root-gathering sites) might be recognized as part of the seasonal range of particular corporate groups (assuming that such divisions existed in the landscape) if the characteristic material distributions were present.

If we find that the physical properties of the different types are *not* similar, then perhaps we cannot conclude that material distributions represent entirely homologous relationships. We must then inquire why certain types of materials with different physical properties are distributed consistently through a millenia in what are assumed to be specific domestic locii in the village. Certainly, some of these materials which are preferentially distributed (the quartzite in HP 7 and the chalcedony in HP 5) have quite different physical properties and values, implying that the materials may have been utilized for different functions. It may be possible that both functional and stylistic attributes characterize specific corporate groups in this village.

Summary

Elsewhere (Bakewell 1995), I have shown that chert sources vary by stoichiometric parameters perceptible through analysis of major and minor element chemistry. I have only hinted at theoretical causes specifying which minerals drive variation in the cases I examined since this would require an inordinate expenditure of time and money not available or necessary in the context of the problems addressed by this study.

In this study, I have shown that it is possible to model material types of lithics from archaeological sites using petrographic and geochemical criteria without reference to characteristics found at any particular known bedrock source, but on the nature of the phenomena themselves.



```
              MATERIAL
        Count |
      Exp Val |
              |                       Row
              |Jasperoid | Other     | Total
HOUSEPIT      +----------+----------+
          1   |     61   |    412   |   473
              |  187.4   |  285.6   |  25.4%
              +----------+----------+
          5   |    115   |    216   |   331
              |  131.2   |  199.8   |  17.8%
              +----------+----------+
          7   |    561   |    495   |  1056
              |  418.4   |  637.6   |  56.8%
              +----------+----------+
       Column      737       1123      1860
        Total    39.6%      60.4%    100.0%

      Chi-Square            Value     DF  Significance
-------------------- ------------ ---- ------------

Pearson              224.99556      2     .00000
Likelihood Ratio     246.81566      2     .00000
```

```
              MATERIAL
        Count |
      Exp Val |
              |                       Row
              |Pisolite  |    Other | Total
HOUSEPIT      +----------+----------+
          1   |    325   |    148   |   473
              |  142.9   |  330.1   |  25.4%
              +----------+----------+
          5   |     82   |    249   |   331
              |  100.0   |  231.0   |  17.8%
              +----------+----------+
          7   |    155   |    901   |  1056
              |  319.1   |  736.9   |  56.8%
              +----------+----------+
       Column      562       1298      1860
        Total    30.2%      69.8%    100.0%

      Chi-Square            Value     DF  Significance
-------------------- ------------ ---- ------------

Pearson              457.96846      2     .00000
Likelihood Ratio     439.82082      2     .00000
```

```
              MATERIAL
        Count |
      Exp Val |
              |                       Row
              |     Tuff |    Other | Total
HOUSEPIT      +----------+----------+
          1   |     74   |    399   |   473
              |   81.4   |  391.6   |  25.4%
              +----------+----------+
          5   |     28   |    303   |   331
              |   56.9   |  274.1   |  17.8%
              +----------+----------+
          7   |    218   |    838   |  1056
              |  181.7   |  874.3   |  56.8%
              +----------+----------+
       Column      320       1540      1860
        Total    17.2%      82.8%    100.0%

      Chi-Square            Value     DF  Significance
-------------------- ------------ ---- ------------

Pearson               27.34945      2     .00000
Likelihood Ratio      30.27243      2     .00000
```

```
              MATERIAL
        Count |
      Exp Val |
              |                       Row
              |Chalcedony| Other    | Total
HOUSEPIT      +----------+----------+
          1   |      6   |    467   |   473
              |   34.6   |  438.4   |  25.4%
              +----------+----------+
          5   |     93   |    238   |   331
              |   24.2   |  306.8   |  17.8%
              +----------+----------+
          7   |     37   |   1019   |  1056
              |   77.2   |  978.8   |  56.8%
              +----------+----------+
       Column      136       1724      1860
        Total     7.3%      92.7%    100.0%

      Chi-Square            Value     DF  Significance
-------------------- ------------ ---- ------------

Pearson              259.07951      2     .00000
Likelihood Ratio     195.11250      2     .00000
```

```
              MATERIAL
        Count |
      Exp Val |
              |                       Row
              |Quartzite | Other    | Total
HOUSEPIT      +----------+----------+
          1   |      7   |    466   |   473
              |   26.7   |  446.3   |  25.4%
              +----------+----------+
          5   |     13   |    318   |   331
              |   18.7   |  312.3   |  17.8%
              +----------+----------+
          7   |     85   |    971   |  1056
              |   59.6   |  996.4   |  56.8%
              +----------+----------+
       Column      105       1755      1860
        Total     5.6%      94.4%    100.0%

      Chi-Square            Value     DF  Significance
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Pearson               28.69820      2     .00000
Likelihood Ratio      33.74884      2     .00000
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Figure 27. Crosstabs analysis of individual material.

Finally, I have demonstrated that such an exercise can provide useful information above and beyond description of either source models or lithic types. The resulting lithic types can become immediately useful as tools for analysis of cultural phenomena, such as the demonstration of long term differences in lithic procurement and use on the part of residents of different housepits at Keatley Creek.

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CONCLUSIONS

Chapter 17

Site Formation Processes at Keatley Creek

Brian Hayden

Introduction

It is crucial to understand site formation processes before any interpretation of the archaeological record can be attempted. Traditionally, few investigators paid much attention to these factors except as implicit or *ad hoc* afterthoughts. However, Schiffer (1972, 1976, 1985, 1986, 1987) and others (especially Stevenson 1982; and Samuels 1991:196ff) have focussed attention on the critical role that site formation processes play in all archaeological interpretations and especially in reconstructing past economic or social behavior. In order to investigate economic behavior at Keatley Creek, it was necessary to establish what food parts, technological materials, and prestige items were brought to housepits; whether the remains associated with a housepit floor constituted remains of everything that was eaten or used in the house, or whether some portion of those remains had been discarded in other types of deposits such as roofs or rims or special refuse areas far removed from the housepit; whether boiling, pounding, or other processing had destroyed substantial portions of the remains; whether dogs or other scavengers had removed or consumed remains from meals; whether the remains had been burned; and what degree of decay had affected remains wherever they may have ended up.

In order to investigate social organization at Keatley Creek, it was similarly important to know whether artifact patterning in the living floor deposits was due to actual activities and social divisions of the principal residents; whether such patterning was due to transient campers who used the structures after they were abandoned; whether patterning was due to natural or fortuitous mixing of deposits from different origins or time periods; whether patterning was due to sweeping, cleanup or storage practices; and whether all objects of value had been removed in the course of an orderly abandonment or left in the housepit during the course of an emergency abandonment. It was also important to understand whether prestige items had long use-lives, breaking down gradually where they were used most, or whether they were removed from systemic contexts after relatively short periods of use via their inclusion as burial goods or other ritual offerings. Such questions can be extended to include many of the most important aspects of past societies. The full understanding of formation processes is a daunting task, but certainly one worth pursuing. The purpose of this chapter is to synthesize what we have learned about site formation processes at Keatley Creek and to resolve as many of the issues mentioned above as possible.

I have divided the analysis of site formation processes at Keatley Creek into two broad areas: first, general formation processes involved in the overall economy and the deposition of different types of sediments found associated with housepits throughout the site; and second, socioeconomic factors that account for specific artifact occurrences and artifact patterning within housepits or between housepits. Understanding and documenting the general factors constitutes the goal of this volume. The socioeconomic factors will be dealt with in Volume II.

The study of general site formation processes includes the study of the geological origins and nature of the soil matrix forming the bulk of most of the site. Thus, it is important to know the local surficial geology and soil formation history (Vol. I, Chaps. 5–7; also Stein 1987).

The study of what cultural materials were introduced (and why only those specific elements) together with what happened to them subsequently, also forms an integral part of site formation analysis. Much of the inspiration for this type of approach has come from the paleontological subdiscipline of taphonomy, the formation processes involved in the deposition and degradation of faunal remains. Botanical remains can be analyzed using the same basic framework (Miksicek 1987). The study of stone tools, however, requires considerably different kinds of approaches due to the long distances involved in transport and use as well as the selective modification of some stone materials for specific purposes involving design considerations. I have referred to the overall analysis of stone materials from this perspective as "tool formation processes" (Hayden 1990:89). These include factors influencing the design, raw material selection, and manufacture of stone tools; techniques used to resharpen stone tools; wear traces and residues on stone tools; and discard practices and environments. Bone, antler, and shell tools could be analyzed in a similar fashion.

Finally, and not least, in order to understand various kinds of deposits with their cultural contents, it is essential to understand the natural factors that have altered both sediments and artifacts since their incorporation into archaeological contexts. All of the above factors have been dealt with in this volume.

In his analysis of housepit formation processes in the Southwestern United States, Schiffer (1985) suggested that eight types of refuse might occur. Iannone (1990) modified Shiffer's list to reflect what I feel is a more useful set of factors for the housepits at Keatley Creek. These include:

1) Primary Refuse: This is refuse related to an intact occupation surface (e.g., housefloor) involving materials left at the spot where they were used or manufactured, whether tools or waste materials.
2) Secondary Refuse: This is refuse that has been cleaned up and removed from its primary use or manufacturing context and dumped elsewhere, usually in designated refuse areas.
3) De Facto Refuse: This involves refuse which was never fully or intentionally discarded but which was left in the actively used part of the occupation surface at the time of abandonment, whether intentionally or unintentionally. Such items include materials that were lost, materials that were placed in provisional discard locations but never removed, and materials that were too cumbersome or unimportant to remove at the time of abandonment.
4) Prior-Occupation Refuse: This is refuse from earlier occupations that may become mixed with refuse in occupation or discard areas.
5) Post-Abandonment Refuse: This is refuse which may represent either occupation of an abandoned pithouse floor by transients, children, or others, or dumping of refuse from other pithouses in abandoned pithouses.

As we will see, there are additional special cases of refuse deposits, including pit fill, and dumps on pithouse floors. There was also a possible ritual interment of dog skulls and bodies, as well as dog remains left on pithouse floors at the time of abandonment perhaps as part of a ritual.

Aside from the types of refuse associated with housepits, it is important to establish the nature of the abandonment (Stevenson 1982; Schlanger 1989). Schlanger makes a fundamental distinction between planned and unplanned abandonment of households (Fig. 1). In the latter case abandonment is usually due to fires, raids, or other catastrophes leading to the abandonment of virtually all household material items in their use, or systemic, contexts, often referred to as a "Pompeii" condition. Planned abandonment, on the other hand, results in the removal of some or all useful or valuable items from the household depending on such factors as the speed of abandonment, the permanent versus temporary nature of planned abandonment, as well as the distance of the move and the capacity of any transport aids used in moving. Under planned abandonment conditions, only items of inconsequential value are typically left behind. Abandoned households may subsequently be left open to scavenging activities on the part of others who may remove articles of use or interest, or abandoned households may be closed to scavenging activities due to burning and structural collapse, catastrophic burial or other similar factors. The remaining items in all cases constitute the material assemblages that archaeologists recover when the households are excavated. Fortunately, in the housepits at Keatley Creek that we selected for extensive excavation, it was relatively easy to determine refuse types and abandonment conditions and it was quite clear in all cases that little or nothing of value had been left behind.

The general model that has been found to be most useful for analyzing housepit deposits is one that

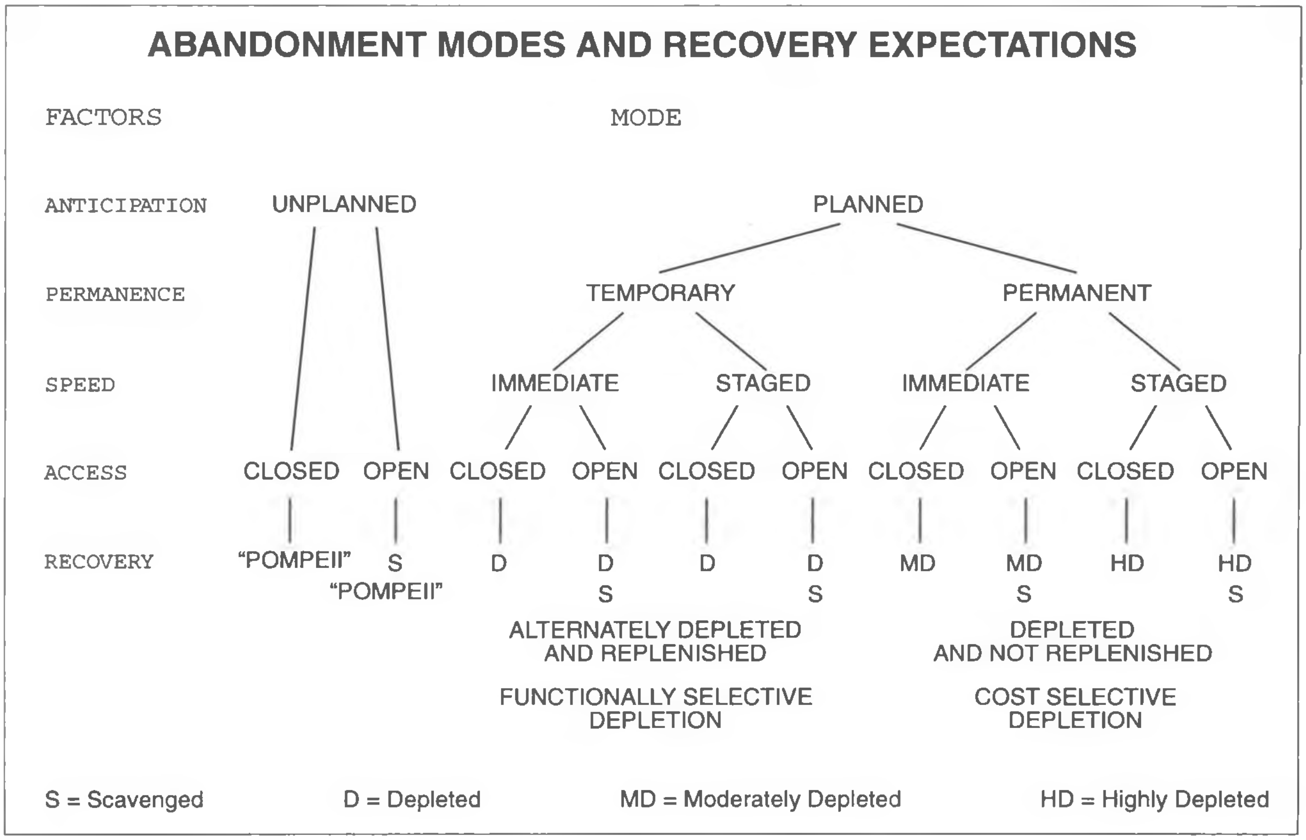
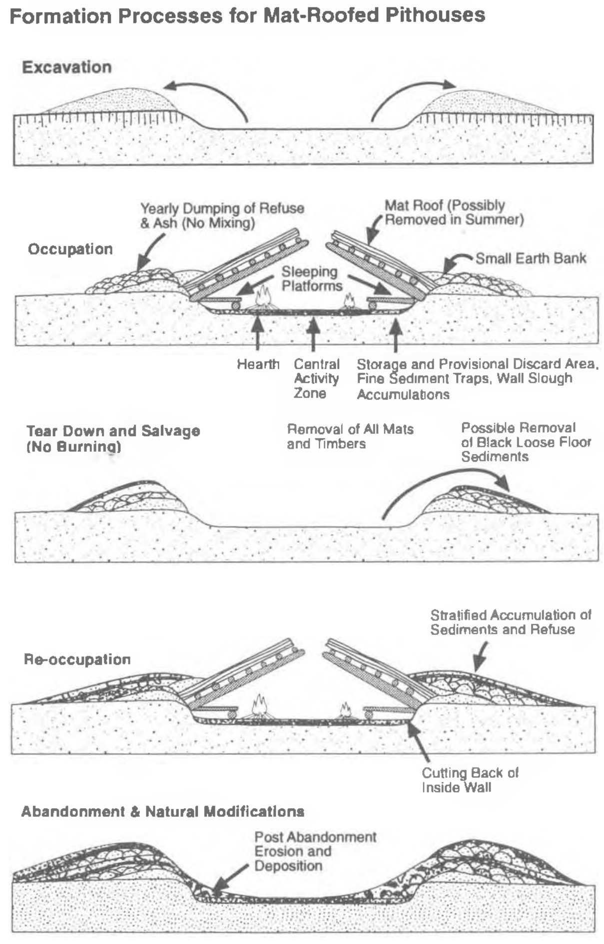


Figure 1. Factors affecting the type of abandonment of structures and their effects on materials left for possible archaeological recovery (adapted from Schlanger 1989: Fig. 3).

divides sediments into three basic categories (based on stratigraphic context, morphological characteristics, and artifact contents): living floor deposits, roof deposits, and rim midden deposits. Pit fill and dump deposits constitute special cases of floor sediments. The ethnography (Vol. II, Chap. 2) and archaeology both concur that at the outset an area was excavated into the ground and the resulting spoil was dumped around the perimeter of the circular depression that was to form the floor. Teit's (1895) unpublished account describes pithouse construction thus:

> Regarding your questions concerning the kekuli houses. The excavation was dug in the usual manner as digging graves etc. Of course none except easy soil to dig was chosen for the sites of kekuli houses, grave yards, etc. Another thing to be remembered all through is that in making a kekuli house mostly all the neighbors lent a hand, principally the women digging and the men doing the other work. The owner of the new house with the help of their relatives furnished the grub for all during the time the work was going on. Sometimes as high as twenty, thirty if even more people worked together to help people who were well liked, or who had plenty of grub so that kekuli houses have been known to be started in the morning and all finished by nightfall excepting the ladder. The tools were the common root-diggers for digging and breaking soil, straight sticks with a wide, flat and rather thin point for scraping etc. All stones found were simply thrown out, and all dirt or earth was put into large baskets, chiefly with the help of the hands and small baskets. The large baskets were then carried or lifted out and their contents dumped in close proximity to the outside circle to be handy for use on the roof. When covering the roof the dirt was loaded in baskets again and these emptied on the roof in the required places. The whole being leveled off with the help of the stick scrapers and the hands and feet.

Further details from this account are provided in the Appendix (see also Teit 1900:192–3). After the roof beams had been put in place and all the intervening spaces between joists had been covered by smaller poles, bark, mats, and conifer needles, soil from around the houses was piled onto the roof as insulation. Archaeological observations of the charred pole remains in HP 104 and ethnographic accounts (Kennedy and Bouchard 1977:Tape 1) indicated that at least some roof elements consisted of split poles and logs. As time passed, roof or support poles began to rot out or become so infested with insects (Kennedy



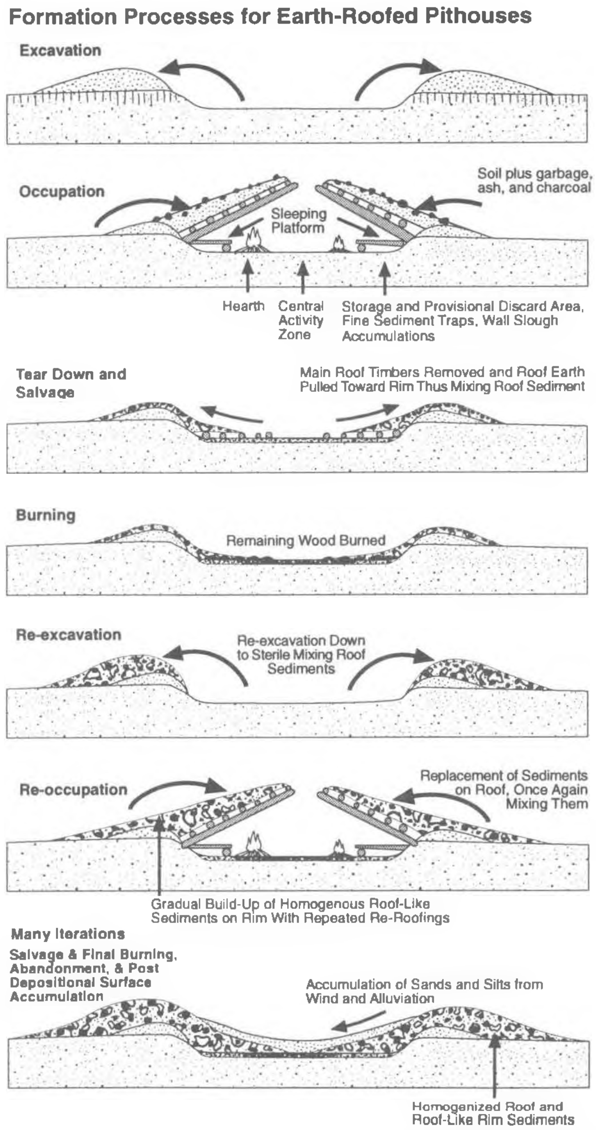


Figure 2. A schematic illustration of the formation of roof and rim deposits over several cycles of roof replacements. Important differences in formation processes and deposit characteristics depended on whether the roofs of structures were mat covered or earth covered. Rim deposits of mat covered structures retained the stratified features of the deposited refuse, whereas the moving and churning of dirt for roofs in earth-covered houses generally destroyed stratification of refuse deposits in the rim. Medium and large housepits display a progression from clearly stratified rim deposits in lower levels to homogenized, churned deposits in the upper levels indicating a change from mat-covered to earth-covered roofs probably around 1,500 years ago.

In each re-roofing cycle of earth-covered houses, refuse accumulated on the roof and on the rim during occupation. All this material was then piled on the rims while the old roof was being replaced, and much of the soil and refuse from the previous occupations was then thrown on top of the new roof or left churned up on the rims. In this way, increasing amounts of artifacts and debris mixed together and accumulated over time in the roof deposits and in the portion of the rim affected by re-roofing activities.

and Bouchard 1978:37) that the roof would have to be replaced. Insect infestations are also a reason frequently given for the intentional burning of structures in other culture areas (Posey 1976:52; McGuire and Schiffer 1983:291). It is highly unlikely that any structures we excavated were accidentally burned or were burned in raids considering the depleted nature of the assemblages and the resistance of pithouses to burning (Wilshusen 1986). While ridding houses of vermin may have been a beneficial aspect of the burning, burning the roofs may also have been an expedient way of dismantling rotting roofs in a hurry so that they could be replaced rapidly in the fall and before the onset of freezing weather in November. If this was the case, it can be anticipated that major posts or beams or other wooden furniture in good condition would have been salvaged before the burning, and that roof soil would have been pulled down from the peak of the roof in order to facilitate salvage efforts and burning. Once the roof had burned and the soil on the roof had collapsed down onto the floor, the sediments on the floor could either be smoothed out to form a new level floor, or they could be removed down to sterile deposits. A new roof would then be built and the sediments that had

Figure 3. An example of stratified rim deposits from HP 5. The dark, homogenized, "roof-like" rim deposits are clearly visible in the top 50 cm of this deposit, while bands of light colored till (thrown onto the rim from periodic excavation of pits or floor cleaning) alternate with darker refuse in the lower part of the rim deposit showing very clearly defined, and largely undisturbed lenses and strata. This shows that in the earlier history of the house, no extensive reworking of rim deposits took place such as appears to have occurred in later times when the "roof-like" rim was deposited.

Table 1. Estimates of the number of re-roofing events for housepits based on the total number of artifacts incorporated in roof deposits in relation to the number of artifacts recovered from floors.*

HP	Number of Sampled Subsquares from Roof	Number of Subsquares in Excavated Roof	Portion of Roof Samples	Number of Flakes in Roof Sample	Estimated Number of Flakes in Excavated Roof	Number of Flakes in Excavated Floor	Estimated Number of Floors in Roof
3	37	269	0.14	1,693	12,309	2,292	5
7	47	640	0.07	2,738	37,283	5,424	6
12	24	96	0.25	442	1,768	672	2

* The figures for portion of roof samples should probably be lower and the estimated number of flakes in the roofs proportionately higher because none of these roofs was completely excavated. While this is also true of the floors the discrepancy between total area and excavated area is substantially greater in the roofs since roof deposits extend out over the rims. Consequently, the estimates for number of floors in each roof are more likely to be low than high. On the other hand, both chipped stone refuse thrown onto the roof during occupation and shorter use-life of the last floor due to forced abandonment would tend to inflate the estimates of floors in each roof. These various factors may well balance each other out thus resulting in a rough, but realistic approximation of the number of reroofing events *involving soil covered roofs*.

been thrown out of the collapsed building (as well as other surrounding soils) could be placed onto the new roof for insulation (Fig. 2). This process could be repeated *ad infinitum*. As a result, roof and rim deposits could be constantly recycled with materials from all time periods mixed up together in a random fashion. Further details of roofing events, including the length of time roofs probably lasted, will be discussed below under the heading of "Roofs."

While our archaeological results at Keatley Creek (Vol. III, Chaps. 4–6, 11) show that this scenario is actually what happened in many cases, there are several important exceptions. First, while the upper, and therefore latest, parts of rim deposits in the large housepits certainly conform to this scenario, the lower levels exhibit a very different configuration. Notably, the upper levels of the rims are mixed and homogeneous as if a rototiller had been used to work them. They resemble the roof deposits in this respect. In contrast, the lower levels, beginning sometime during the Plateau horizon on the basis of projectile point styles, exhibit relatively coherent stratification of brown organic materials, soil, charcoal, and sterile till lenses and layers (Fig. 3; Vol. III, Chaps. 4–6, 11). There is nothing in the lower deposits that resembles the gray mixed roof deposits. I cannot imagine how these strata could have retained their stratigraphic coherency if sediments were periodically being placed onto the roof from the rims and then put back on the rims only to be returned to the roofs. The only scenario in which rim strata could be coherently preserved without any addition of roof-like material is one in which there was little if any sediment placed on the roofs of pithouses during the Plateau and preceding Shuswap horizons. That this was probably the case is also supported by the relative amount of stone and bone remains in the roof deposits. If all the remains in the roof deposits were derived from materials on the floors at the time of abandonment, it would have taken only 5–6 reroofing events to accumulate all the remains in the roof deposits (Table 1). If we assume that roofs were replaced on an average of 10–20 years (see below), this represents only the last 120 years, at most, of the pithouse occupation, whereas the Plateau and Shuswap horizons extend over 1,000 years farther back in prehistory. Any artifacts thrown onto the roof as secondary refuse would only increase the estimated length of time such roof deposits had been in existence, as would any increase in the estimated length of time (and artifact accumulation) floors might have been used before reroofing events. If anything, such estimates therefore overestimate the time that soil covered roofs were in existence. Thus, it seems likely that earlier large pithouses did not have significant amounts of soil on their roofs, but probably were simply covered with multiple layers of mats that were likely held in place by external poles and/or lashings.

The other exception to the general roof sediment scenario that was outlined on the basis of ethnographic observations is the situation in which houses were not burned down but simply left to decay gradually. This would have provided opportunities for the post-abandonment use of the structures by transient hunters or other people, as well as the dumping of refuse from other housepits into the structure's floor—situations more or less precluded by the burning of the roofs. Several housepits exhibited patterns consistent with this scenario (HP's 47, 58, and 105, although the latter may be feasting refuse—see Vol. III, Chap. 11). With these general constructs in mind, a more detailed discussion of our investigations into site formation processes follows.

Results: Rims, Roofs, and Rooms

Parent Materials

Friele and Martin (Vol. I, Chaps. 5–6) describe the Keatley Creek site as situated on a glacial till terrace with an aeolian capping of loam generally varying from 10 to about 25 cm in depth. The till typically contains 20–50% gravel and pebbles and 0–5% cobbles. In very localized areas there appear to be amorphous loam deposits within the till, presumably resulting from water deposition within or under glaciers. Till deposits are not heavily weathered but can be somewhat consolidated and difficult to excavate. The surface aeolian deposits generally display some evidence of light soil formation processes and have less than 5% gravels and pebbles with few if any cobbles. Due to the strong winds in the Fraser Valley, aeolian deposits are still actively forming and eroding today.

Rims

There are two fundamentally different origins of rim deposits:

1) One major type of rim deposit results predominantly from the initial excavation of the housepit and the piling up of the resulting soil around the perimeter of the excavated area, thus forming a rim. Subsequent roof constructions also create rim deposits that can be distinguished from other types of rim deposits. Both roof-like and re-worked till-like components of rims can be considered as "construction" deposits.
2) The other major type of rim deposit that we encountered clearly accumulated over an extended period of time and is composed predominantly of dumped refuse from inside the structure, although lenses of till or floor soils were also present. These deposits are referred to as "refuse" rim deposits. Both construction and refuse components may be present in house rims.

Construction Rims

Rim deposits were much more complex than we had originally anticipated. In all the excavations undertaken, it was apparent that the lowest levels of the rim deposits represented soils and essentially sterile till that was removed from the center of the housepit during the initial excavation of the sunken house floor. These are the basal "construction" rim deposits.

Occasionally small traces of charcoal or other cultural materials may occur in these deposits, but they are usually sterile and difficult to distinguish from sterile till on the basis of color or composition, although they are usually less compact. In some cases (e.g., HP's 5 and 7) the soils which were excavated out of the center of the pithouses contain cultural remains from much earlier occupations, notably Lehman and Lochnore occupations with bladelets. In these cases, such soils were redeposited in a mixed fashion at the base of the rim, and may overlie *in situ* deposits from these earlier components.

Given the low artifact numbers recovered from the rims, roofs, and floors of most smaller housepits and the limited organic staining of these deposits, small structures appear to have been occupied for periods of about a generation or two (in total or for each distinctly separate occupation). For instance, Table 1 indicates that a maximum of two reroofing events took place at HP 12. Each event probably represents one generation. In these cases, little further modification of the rim deposits appears to have taken place aside from some organic staining and soil development near the surface. Having said this, it must be admitted that our investigation of this type of rim deposit is not extensive, being restricted to test trenches that sectioned housepit rims only to their crests. We have not explored rims of small housepits more extensively due to the paucity of materials and the incidental nature of these deposits to our basic research priorities. Nevertheless, tests from all small housepits constructed on relatively pristine surfaces display the same basic characteristics of extremely low artifactual densities in rim deposits (e.g., HP's 4, 9, 12, 47, 58, 90, 104, 106, 107, 108). The comparatively short occupation of these housepits is probably responsible for the apparent relative lack of accumulated cultural materials on the rims (although to be certain, rims would have to be tested around the perimeters of these structures). The general paucity of materials in the rims may be due to several factors, including: 1) relatively small amounts of refuse thrown out on the rims (either because of short occupations or low levels of refuse production related to smaller numbers of occupants or poorer economic standing; or use of the roof rather than the rim as a refuse area); and 2) initially unfavorable conditions for preservation of organic materials on rims, especially if small amounts were involved (see Vol. I, Chap. 9). Low levels of artifacts in the rim of HP 9 which had very rich faunal remains on the floor suggest that poor preservation probably played a major role in the limited occurrence of organic remains in rim deposits of small housepits.

Relatively sterile, unconsolidated, redeposited till material from the initial construction of large housepits were clearly evident at the base of the rim deposits in the north test trench of HP 7 (Stratum XIIId), while the base of the western rim (Stratum XVII) seems to consist primarily of redeposited and mixed soils containing Middle Prehistoric Period artifacts with bladelets. The initial creation of the floor for this large housepit seems to have been restricted to the creation of a level surface by cutting into a gentle slope at the base of a hillside. Thus, rim deposits from initial house construction excavations are rare or non-existent in the upslope sections of the rim (especially the east and south) due to undesirable work involved in throwing dirt uphill as opposed to downhill. Although investigated in much less detail, rim deposits in other early large housepits excavated into hillslopes (HP's 1 and 8) seem to follow this same pattern.

The occurrence of roof-like deposits in the upper part of the thick rim deposits of large housepits also constitutes a type of construction accumulation. However, it is difficult to fully understand the formation of these deposits without first examining the refuse components of the rims, a topic to which I now turn.

Refuse Rim Deposits

The rims of all the tested medium and larger housepits contain thick layers of partly decomposed organic materials (e.g., Stratum XIIIb-c in HP 7). These materials lie either directly on the original preconstruction soil surfaces, or overlie the initial construction rim accumulations which contain very little cultural material.

The refuse components of the rims exhibit occasional stratigraphic bands that extend over large areas as well as smaller thin lenses consisting of charcoal, reddened soil, plant materials, or other distinctive materials (Fig. 3). As already noted, these lenses and bands are important because they indicate that there was no apparent use of rim materials to cover roofs during the period when refuse rim deposits were being formed. Nor was there any indication of a long period when rim accumulation ceased. Prentiss' (Vol. I, Chap. 15) analysis of temporally diagnostic artifact types in the rim strata of HP 7 strongly supports the proposal that these strata are predominantly coherent depositional units, although some rodent disturbance has taken place. Similar coherency also characterizes the other housepits with thick refuse rim deposits (HP's 1, 3, 5).

It was abundantly clear during excavation that all refuse rim deposits were highly variable from lens to lens, band to band, and stratum to stratum. Some deposits were unusually rich in charcoal or ash, others were almost entirely composed of partly decayed botanical remains including still pliable conifer needles and bark, some had varying amounts of soil mixed in, and still others were bands of sterile yellow till that presumably were thrown out after new construction events, whether the digging of a new storage pit, or more likely, the deepening or expansion of the floor. Some flotation samples from the refuse rim deposits could not be "floated" because the entire sample was composed of organic remains and was buoyant, thereby precluding any separation of materials. Lepofsky's detailed analysis of botanical remains from these rim deposits documents the extreme variability involved (Vol. I, Chap. 9). Her analyses also clearly indicate that the rich botanical remains in the rims were largely materials cleaned off the floors inside the pithouses. The density of remains is far higher in the rims than the floors, species diversity is slightly higher in the rims, while multiple dumps are indicated by the presence of both charred and uncharred remains in localized lenses, the variability between samples, as well as in microfabric patterns (Vol. I, Chap. 7). Moreover, the charcoal in the rim has the same species characteristics as charcoal associated with inner hearths, indicating that hearth cleanings were probably dumped on the rims (Vol. I, Chap. 9). This is substantiated by the abundant occurrence of ash in Goldberg's microfabric analysis.

The source of the rich uncharred botanical remains was probably varied, including discarded bedding material (conifer needles and grasses) from the previous year, woodworking debris from inside the house (or from outside activities on the rims during mild weather), bark from making shaft tools or baskets or garments, waste materials from making reed mats, plant food remains from processing or consumption, worn out mats or bark garments, and other items. It is possible that the vast majority of organic material came from the cleaning out of the houses prior to occupation in the fall, since (as described ethnographically by Laforet and York 1981:121) combustible waste generated during the winter might have been used as fuel, but substantial quantities of refuse still could have been dumped on the rims throughout the winter occupations. The absence of any broken wooden tools or basket elements from the rim deposits may be due to the use of such items as fuel, although it is also possible that only birch bark containers were used instead of baskets until protohistoric times. A few of the birch bark fragments had been punched along one edge for sewing. Other cultural components of the refuse rim deposits include lithic materials and faunal materials. Prentiss' (Vol. I, Chap. 15) analysis of the lithics clearly shows that the overall proportion of stone tool types and debitage are the same for both the floor and the rim deposits and he concludes that the vast majority of lithic material in the rim deposits was simply material collected from the pithouse floor and discarded on the rim. Certainly, cleanup of the floor appears to be documented in the analysis of lithic, faunal and botanical remains (see below). The only indication of possible special use of the rim as a special lithic-using activity area is the very dense occurrence of lithics throughout the southwestern part of some rims, where afternoon sun would be warmest in the winter. The slightly elevated number of primary flakes in the rim deposits compared to floor deposits may also be due to some activities being carried out on the rims. Large cobbles and boulders occurred sporadically in the refuse rim, sometimes appearing to line the inner walls like spotty retaining walls (also observed at the Bell site—Eldridge 1971 field notes: EeRk4, HP 3). Boulders sometimes occurred higher in the deposits where they may have been associated with roof beam emplacements in pits dug into the refuse rim deposits. Ethnographic accounts describe large rocks being used to set rafters on (Kennedy and Bouchard 1977:Tape 2). It is also possible that they accumulated at the time of the formation of the refuse rims, and that they were used as weights for holding down roofing mats. In most cases, the resolution of stratigraphic details was too difficult to establish clear associations with these rocks.

Faunal remains, while comprising mostly unidentifiable fragmented mammal bone, nevertheless include an unusual number of large bones, and a slightly lower percent of burned bones than the floor (Vol. I, Chap. 10). Faunal remains are especially concentrated in the north, a pattern also reflected in roof deposits. Whether this was a preferred area for discarding unwanted bones and/or was actually used occasionally as a butchering area is difficult to determine. Refuse bones consisting of fragmented and burned pieces do seem to have been dumped on the rim in localized areas, and presumably constituted waste cleaned off the living floor inside. The concentrations in the north may be related to general refuse disposal of large angular waste materials such as fire-cracked rock which appears to have been preferentially discarded in the north part of the roof (Vol. I, Chap. 14).

The unusually good preservation of botanical remains may stem from a number of factors, including the deposition of large amounts of dry, relatively hydrophobic plant material in one place at one time, the inclusion of high amounts of ash which tend to produce hydrophobic environments (Vol. I, Chap. 6; Hayden and Cannon 1983), the inclusion of large amounts of conifer needles and fragmentary bark which might retard microbiological activity, and the domed shape of the rim which would tend to shed water rather than allow it to stand and soak into the ground. A detailed analysis of the precise reasons for the hydrophobic nature of these deposits would require more specialized analysis.

In sum, the refuse rim deposits appear to be largely composed of waste materials picked up from the inside of the housepit, especially old bedding, hearth cleanings, waste materials from woodworking and other activities producing plant wastes, food waste, and lithic waste. There is evidence for the selective discard of faunal elements in the north and chipped stone in the southwest parts of the rim, but it is also possible that these areas could have been used as special activity areas. The presence of such outside activity areas associated with houses can be expected due to poor lighting conditions inside the houses, or due to activities that generate large amounts of waste or messy wastes. The more acidic or open weathering and scavenging environment on the rim may have led to the depletion of some of the bone elements.

The above scenario is remarkable because it implies that except for a few special categories of objects, almost all of the materials discarded by the residents of each housepit over the thousands of years of occupation have been deposited around each structure and remain associated with each individual housepit. This permits a meaningful comparison of refuse associated with each housepit with other contemporaneous housepits, as well as the tracking of changes or continuity within a single housepit over time. As we have seen in the analysis of stone materials used by each housepit (Vol. I, Chap. 16), such analyses can have unexpected and important implications about the most fundamental aspects of socioeconomic organization. Given the large quantities involved in the refuse rim deposits and given the lack of any evidence for refuse disposal between housepits, it certainly appears that in most cases, we can identify *all* of the preserved garbage produced by the residents of given pithouses. Indeed, given low winter temperatures, it is understandable why refuse would be disposed of in the closest, most convenient location. The buildup of refuse on the rim may have also been an intentional undertaking meant to increase the height of the rim and the insulating characteristics of the house.

Unfortunately, there is also considerable evidence for bioturbation and some cultural turbation within the refuse rim deposits that obscures many of the details of separate strata and lenses. The rich organic matter provided excellent forage and litter material for rodents whose burrows are sometimes apparent in the rim and whose remains sometimes occur in various types of deposits. Burrowing insects would also have found the organic rich deposits fertile ground for their activities. Cultural disturbances include digging into the upper parts of these deposits in order to establish roof beam emplacements (difficult to recognize except for the large boulders and cobbles sometimes associated with these features), the digging of small cache pits in the base of the walls (e.g., for caching the nipple tipped stone maul—probably of Plateau Horizon age—found at the base of the rim deposits in HP 7), and the sloughing off of rim walls that were excavated too steeply. Sloughed off sediments could accumulate inside the housepits and cover objects like the nipple tipped maul which had been stored against the walls. Botanical and micromorphological analyses clearly indicate that agents of bioturbation were active, and they appear to have contributed to the difficulties we experienced in excavating these rim deposits. However, while the bioturbation of refuse rim deposits has blurred some of the patterning, bioturbation has clearly not destroyed major patterning in sediments, as demonstrated by the still visible lenses, bands, sub-strata, and the stratigraphic coherency of period-diagnostic artifact types.

Given these caveats, there appears to have been very little basic economic change throughout the Plateau and early Kamloops Horizons. Although monitoring changes over time was not one of the main goals of our research program, it is nevertheless clear from Prentiss' analysis of lithic tools in rim deposits (Vol. I, Chap. 15), that very little change occurred throughout the depositional sequence of the rims other than the change from atlatl to bow and arrow hunting technologies. Unfortunately, sampling for botanical remains was very limited from rim deposits and faunal remains were relatively infrequent in the deep sections of rims that we excavated. Therefore, little can be said about any possible faunal or botanical changes in household economies over time, although there is nothing to indicate that these aspects of the economy changed in any fundamental way either.

Roof-like Rim

In all of the housepits with thick refuse rim deposits, there is a relatively sharp break or truncation of these deposits within 50 cm of the surface of the rim. In all cases, the upper stratum is composed of much more homogeneous ashy gray soil that is indistinguishable in the field from the roof deposits overlying the floor and forming a continuous deposit with the upper stratum of the rim (Fig. 3). It is clear that if such thick roof-like deposits had existed during the period when layers of refuse were accumulating on the rims, the roof-like deposits would have been very apparent within the layers of refuse. Yet there is essentially no indication that anything like these deposits ever existed in the lower strata. That the roof-like rim deposits are not simply weathered upper horizons of refuse rim deposits is indicated by the clear demarcation between the refuse and roof-like deposits and by the lack of any evidence of lenses of charcoal or other more weather-resistant materials found among the layers of refuse but not in the roof-like rim deposits.

Rather, the roof-like rim deposits of the larger housepits appear to have been churned and homogenized. As implied by Teit, these deposits may have originally covered the roofs and were removed from roofs and placed on the rims during reroofing events, becoming constantly mixed. Presumably, some of the upper levels of the refuse rim deposits became incorporated into this matrix as a result of using materials from the rim area to put onto the roof (Teit 1895). And presumably, despite the homogenizing effects of recycling sediments used to cover roofs in this fashion, people still continued to discard organic and other wastes on the rims. However, with these wastes being churned up every 10–20 years due to reroofing, such wastes would be much more susceptible to decomposition. That this is relatively close to an accurate interpretation of events is indicated by botanical remains. Lepofsky (Vol. I, Chap. 9) in particular shows that the density and preservation of botanical remains of the roof-like rim deposits is almost exactly intermediate between refuse rim deposits and typical roof deposits. Although Kusmer (Vol. I, Chap. 10) does not break down faunal remains according to sub-strata in the rim, it seems very likely that faunal remains, and particularly fish remains, would follow the same pattern except that the more acidic environment of the refuse rim deposits might reduce bone preservation.

In sum, it is most reasonable at this point to view the roof-like rim deposits as representing material that has been repeatedly recycled onto and off of the roof, leaving some residue on the rim either due to excess material, slumpage of soil down the roof over time, or the actual pulling down of roof soil from the roof on to the rim in order to facilitate burning of the wood roof frame and minimize the amount of haulage of dirt off the floor for subsequent reroofing. Whether the roof-like rim deposits were originally obtained from sterile till used on the roof, or whether they were at least partially obtained by using refuse rim deposits to put onto the roof cannot be determined at this point.

As previously noted, on the basis of stratigraphy and artifact densities, the massive placement of sediment on the roofs appears to have been a relatively late development. There is no indication of such use of sediment throughout most of the Plateau horizon refuse deposits, and in fact, most of the projectile points in the roof-like rim deposits are Kamloops with a minor proportion of Plateau points (Vol. I, Chaps. 3 and 15). Although Stryd's data from the Bell site have not been quantified, he, too, had the impression that earth covered roofs were not generally used before the Kamloops horizon in the Lillooet region (personal communication).

Roofs

Ethnographic Observations

Teit (1900:192–4) observed a number of abandoned pithouses and published illustrations and photographs displaying their construction, which are relatively well known and cited. Additional information has been compiled by Alexander (Vol. II, Chap. 2). For the immediate purposes of understanding the formation processes of roof deposits, it is sufficient to note that a log framework was overlain by smaller poles which constituted the roof surface. It is evident from Teit's (1900) illustrations and photographs that the main support beams of the roof were set into the ground near the top of the rim deposits. This coincides with the position of features recorded in the upper eastern wall of HP 7 (Vol. III, Chap. 5). Bark of various tree species was placed over the poles (per Laforet and York 1981:118; Bouchard and Kennedy 1977:63; Kennedy and Bouchard 1977:Tape 1, 1987:260) and we have recorded *Pinus* and *Populus* bark remains over roof beams archaeologically in HP's 7, 47, and 58. A layer of conifer needles, and/or grass was then placed on the bark and these have also been recovered in some less burned archaeological deposits (e.g., HP 12). It is possible that grass or mats might have been used as substitutes for bark or conifer needles. Whether the conifer needles functioned as insulation, or to keep the structural elements dry and away from contact with soil, or to inhibit dirt from filtering into the house interior (e.g., G. Wilson 1934:412; Kennedy and Bouchard 1987:260; Surtees 1975) is unclear. It appears that the same technology was transferred to the construction of native log cabins, as well as other features of residences such as the use of storage pits. Leonard Sampson, an older resident of the Bridge River Band told me that he grew up in such a log cabin. According to him, there was 6 in (15 cm) of pine needles placed on the roof before adding soil. While this may be an exaggeration, it is clear that ideally, a thick layer of conifer needles would be placed on the roofs; and these must have burned readily when roofs were burned. I observed this same construction technique in a partially collapsed cabin on the Pavilion reserve, used by Desmond Peters' grandmother (Fig. 4). In this case, as in most sod roofed cabins, shakes had been used to fill in spaces between joists and cross poles.

One other aspect of roof construction that is important for understanding formation processes of all deposits associated with pithouse occupation is the length of time that roofs would last before they had to be replaced. This interval basically determines how long floors could be used before they were scraped down to sterile and removed during reroofing events. In turn, this interval also set the number of years that

Figure 4. **The collapsing roof of a traditional "sod" roof log cabin on the Pavilion reserve. This structure is reported to be over 80 years old and has only recently begun to decay because it was abandoned and unheated in the winter. Roof construction techniques are probably very similar to those used to roof pithouses. Note the use of pine needles and pine bark slabs at the base of the earth covering in the detail photo. Wood shakes have probably replaced poles as construction material used between the roof cross beams and the pine bark.**

refuse could accumulate on the floor and how frequently materials left in or on the floor sediments would be removed to be added to the roof deposits—which as we have seen can be useful in estimating the amount of time roofs had been covered with soil (Table 1). Thus, it is of some consequence to determine such intervals fairly accurately.

Unfortunately, there is no simple solution. None of the traditional ethnographers comment on this topic. Leonard Sampson thought that sod roofs of log cabins would last about 75 years. He noted that the first parts of the cabin to decay were the logs in contact with the ground. Sod roofs together with the wall supports of log cabins that are clearly over 100 years old (e.g., Desmond Peters' grandmother's cabin, cabins in the historic village of Bridge River, and root cellars associated with the Pavilion General Store) are still partially intact, and according to informants were still functioning or being lived in up until the 1950's. Only when they were abandoned did they begin to decay due to the absence of heat keeping moisture away from needles and wood. This implies that the structural supports and sod roofing would probably remain in serviceable condition for about 50–60 years or more. Interestingly, these structures never seem to have been intentionally burned by their occupants to get rid of vermin or for any other reasons.

On the other hand, untreated fence posts made of pine in similar environments generally last only a fraction of this time, typically about 5 years (McGuire and Schiffer 1983:291). Even our survey stakes were frequently insect riddled and decayed after a few years. There are several wood related factors that affect the rate of decay. These include the wood type, the diameter of the wood (Wainwright 1971:224), and the presence or absence of bark. Pine decays the most rapidly, yet Lepofsky's (Vol. I, Chap. 9) analysis of wood remains from major interior postholes indicates that pine was being used for the principal structural supports of the pithouses. This fully corroborates Teit's (see Appendix) observation that pine was used for the major support posts and joists, "as it was soft wood to cut." He also states that all logs and poles used in the roof were peeled. Evidence from structures like the root cellars at the Pavilion General Store, indicate that even untreated wood in contact with the ground may last much longer than the brief 5 year periods noted for fence posts, perhaps in large part due to the roof acting as protection from moisture. In the Southwestern United States with a similar environment, archaeological evidence also indicates that juniper log roofs of housepit structures were replaced about every 20 years (McGuire and Schiffer 1983:291; Allen Kane, personal communication). G. Wilson (1934:372) reports that Hidatsa earthlodges ordinarily lasted from 7–10 years, with posts rotting out at the base first. Similarly, experimental housepits such as the one built by Roscoe Wilmeth at Anaheim Lake, have generally not lasted more than about 10–20 years before serious collapse began. Condrashoff (1972; 1980:5), too, reports that the roofs of British Columbian housepits lasted about 10–20 years, based on information from Isaac Willard who was born in a pithouse near Kamloops.

Given all the above factors, a relatively conservative estimate of 20 years seems reasonable for roof replacement at Keatley Creek. Coincidentally, this exactly coincides with Alexander's independent estimate (Vol. II, Chap. 2). There is, nevertheless, a slight chance that roofs may have lasted up to 50 or even 60 years. That insect activity did affect roof beams was clearly revealed by several carbonized beams in HP 7 where the interior portions consisted entirely of insect debris. I suspect that the considerably longer use-lives that seem to characterize sod roofed log cabins are due to the use of harder, more rot resistant logs such as douglas fir, the use of much larger diameter logs, and the systematic use of stoves for heating. All of these changes were probably made cost-effective by the introduction of metal cutting tools and stoves. As argued in subsequent sections, fires were probably only used in pithouses for special occasions.

Archaeological Observations

In comparison to rim deposits, roof deposits appear exceptionally homogeneous in the field. They are generally derived from till deposits and display the characteristic high gravel and pebble content (33% on average—Vol. I, Chap. 6) of the local till, although one housepit is aberrant. Organic staining varies from housepit to housepit, as does artifact density, according to intensity of occupation. In the most intensively occupied housepits, the roof is characteristically dark gray brown. In the less intensively occupied housepits, the roof deposits are much browner.

There are some important exceptions to the generalization that roof deposits are homogeneous. Occasional concentrations of large charcoal segments and fire-reddened pockets sometimes occur in the middle of roof deposits. These may in part represent beams and other plant material that remained partially upright as the rest of the roof collapsed around them when burned, or they may represent other processes that we do not fully understand as yet. There are also some localized concentrations of bone or artifactual materials that seem atypical of most roof deposits. These may represent basketloads of refuse thrown onto the roof shortly before abandonment that had not lost all their coherency during collapse or been exposed on the surface long enough to decompose. Other concentrations of bones and artifacts occurred close to the surface and were associated with hearths dug into the top of the collapsed roof deposits. These were so distinctive that they could easily be recognized as transient camp remains of hunters who had used collapsed, abandoned housepit depressions for camps (see summaries of HP's 7, 9, and 90 in Vol. III).

In some areas of the roof of HP 7, especially the west, the texture of the roof sediments changed in unusual ways. This area contained alternating bands of the usual coarse roof gravels but also contained bands of much finer loams typical of surface aeolian deposits in the area. Oral accounts collected by Steven Romanoff indicate that special efforts were occasionally made to obtain fine river or anthill sediments for the final layer of roofing material in order to reduce water penetration (cited by Stryd 1971 field notes:232). Nancy Condrashoff Romaine (personal communication) was told by a Shuswap man who was born in a pithouse that dirt from anthills was placed on roofs to keep snakes away from the houses. Kennedy and Bouchard (1977:Tape 1; 1978:37) provide further documentation of these practices. The finer materials in the west sectors of the HP 7 roof may have been intentionally added to the roof by residents of the house residing in that sector, or simply been inadvertently added by those throwing roofing soil onto the roof from the most convenient sources which happened to be nearby aeolian deposits. Given the general high status nature of the domestic groups in the west half of HP 7 and the desirability of using fine sediments for roofing, I suspect that the addition of the fine silts was intentional.

The coherency of the different textural bands indicates that large sections of the roof may have collapsed as entire units rather than burning through as localized hotspots with roof materials funneling through the holes to the floor. This observation supports the notion that the larger structural elements may have been scavenged from the house prior to burning. Furthermore, except in HP 104 and 106, we found no *in situ* stubs of burned posts or joists where they would have abutted the rims. Experiments that we conducted in which wood beams were partially buried in the sides of large campfires demonstrated that burning stops only a few centimeters from the ground surface. Thus, if any major support posts or joists had been left in the house prior to burning, we would have expected to find their charred stubs. Except for HP 104 and 106, we found none, and we infer that all of the principal structural elements were removed prior to burning in most houses.

There are a number of accounts of pithouses being disassembled prior to collapse in order to salvage usable wooden structural members. For instance, the Hidatsa removed timbers that were still usable (Wilson 1934:372), as did the Pueblo Indians (see Vol. I, Chap. 2). In an analysis of Anasazi pithouses, Glennie 1983:129) proposed that primary, secondary, and tertiary beams would have been difficult to obtain, especially since they had to be straight and thick. Because of the potential depletion of wood sources especially near large, regularly occupied sites, it would be worth retaining larger beams during reroofing events or even at the abandonment of a pithouse. The degree of beam salvaging should be dependent upon the size of the population in a community, the rate of reroofing or house replacement, and the rate of natural forest renewal, which in semi-arid environments such as Lillooet would be low. Thus, expecting considerable salvaging of major roof elements prior to burning the roofs of pithouses at Keatley Creek is a reasonable premise that is consistent with general ethnographic observations and archaeological evidence.

Once the major support elements had been removed, the remaining lower parts of the roof may have either remained standing, being held in place like a fragile upside down basket rim by mutual pressure of the lighter roofing poles against each other, or the remaining lower roof may have collapsed immediately onto the floor as joists were removed. In this last instance, considerable air space would undoubtedly be left between the horizontal roof poles lying on the floor, allowing for considerable burning resulting in the pattern of burned beams observed archaeologically (Vol. III, Chap. 6:Fig. 3). Overall, this last scenario seems most realistic. On the Coast, Samuels (1991:203) reports comparable removal of roof supports from abandoned houses. Indications that useable major structural beams were removed from the roofs prior to burning are important for interpreting dates obtained from housepit roof beams. As with the Southwestern United States housepits (Bullard 1962; Wilshusen 1986:248), the main beams at Keatley Creek seem to have been removed upon abandonment and were recycled. Those beams not directly in contact with earth may have been in use for several generations, or more in some cases, before finally decaying beyond use or being burned. Thus, carbonized roof beams laying on occupation floors may have been procured over a period of a hundred years or more prior to that occupation, but may all have been in use during the occupation of the floor. Thus, there may be a significant spread of dates from a given occupation floor if the larger roof beams are used for dating.

Although very few roof samples were examined for botanical remains due to our research focus on the floor deposits for the purposes of the project, it is nevertheless obvious that there is considerable variability in botanical remains across the roof of HP 7 (Vol. I, Chap. 9) especially in charred conifer needles and seeds. This variability was unexpected, but may be due to a number of factors including: disposal of hearth cleanings containing charred materials in preferential locations on the roof; activity areas on the rim or against the base of the roof that left botanical remains; differences in the completeness of burning or in burning environments around the roof involving conifer needles and/or grass materials used in roof construction; and the differential growth of plants on the roof with their subsequent carbonization during the burning of the roof.

Roof Activity Areas

On the basis of his previous experience in excavating housepits, Mike Rousseau suggested that parts of the roof might have been used for special activity areas. This also made sense in terms of our supposition that lighting would be poor inside housepits and that outside areas would be used during mild sunny winter days for activities requiring good lighting or large areas. Thus, there was some reason to expect that there might be patterning in the roof deposits representing activities that took place on or near the base of the roofs while the houses were occupied. Certainly, the concentration of fragmented faunal remains in northern and eastern roof deposits (Vol. II, Chap. 7) mimic the concentrations of fire-cracked rock concentrations in *all* extensively excavated intact housepit roofs (HP's 3, 7, 12). This indicates that there were at least preferential areas of the roofs where these materials were discarded. In the case of the concentrations of unusual identifiable bone elements and unusually low proportions of unburned bone near the northeast and east edge of the HP 7 roof, these may result from butchering activities that took place on the coolest side of the house. In contrast, lithic concentrations on the southwest edge of the roof of HP 3 may indicate activities were conducted at the base of the roof in order to take advantage of the warmth in that sector (Vol. I, Chap. 14). The distinctiveness of the lithic assemblage in that area and the concentration of unidentifiable fragmented bone in the same localized area makes this appear especially likely.

Assuming that there was no earth covering for the roof during the formation of the refuse deposits in the middle zone of the HP 7 rim and that debris from outside activities in the southwest would be left on the rim instead of on the base of the roof at pre-Kamloops houses with no dirt roofs, the concentration of lithic remains in the southwest Kamloops period roof deposits may be the late period analog of the concentration of lithic debris in the west rim deposits of earlier structures. Similarly, the possible butchering concentrations of bone in the northeast edge of the roof may be the analog of similar bone concentrations in the north part of the rim that we sampled, while the concentrations of bone in the east could simply represent one component of the disposal of hard refuse (including fire-cracked rock), as documented in the roof. Fresh bone left on the roof or rim was probably heavily scavenged by household or vagrant dogs.

In interpreting patterns of artifact concentrations in certain sectors or quadrants of roofs, it should also be borne in mind that reroofing events would mix materials left in the floor deposits with those of the roof. Everything else being equal, economy of effort would dictate that on average, floor deposits would be thrown up on the rim (and subsequently onto the roof), at the closest rim location to the area of the floor being cleaned. In this manner, if there was an unusually dense concentration of bone in one sector of the house, and if the pattern was stable over several reroofing events, such a concentration could be expected to be reflected in the roof deposits covering that sector of the floor, although they would not necessarily be expected to concentrate at the periphery of the roof deposits. Some of the concentrations in the roof deposits analyzed may in fact be due to this factor, in particular the bone concentrations in the southeast quadrant of HP 7.

Based on ethnographic observations among the Maya (Hayden and Cannon 1984), it also seemed possible that long, thin items such as bone tool blanks, some bone tools, ornaments, large primary flakes, or arrow foreshafts, might be stored in the inner roof, wedged between roofing poles just above the sleeping or working locations for domestic groups. Similar storage behavior (but using walls) has been reported for traditional Northwest Coastal houses (Maugher 1991:116). While such items are normally infrequent and are only abandoned because they have little value or are forgotten, we suspected that there might be some patterning of these types of items in the lowest levels of the roof deposits, especially if large sections of the roof collapsed as units. Thus we tried to ensure that the bottom 5 cm of the roof deposits were always identified. That artifacts were stored on the inside of the roof in HP 3 is indicated by an unusual concentration of bone artifacts in the bottom roof levels, including two barbed bone points, two awls, and four incised or polished pieces of bone, whereas only two other bone artifacts were found throughout the rest of the roof deposits.

Aside from the few likely special activity areas on roof surfaces that have been mentioned, most of the differences in the faunal assemblages associated with the roof versus floor deposits can be explained by differential preservation and/or removal of hearth (including burned bones) or other refuse from the floor area and subsequent discard onto the roof. Roof materials from all analyzed housepits display very similar faunal characteristics. As a rule, fish bone is rare in comparison to the floors, probably due to less favorable preservation conditions in the roof deposits, which also explains the substantially greater proportion of weathered bones in roof deposits compared to floor deposits. Burned bone can be much more frequent in the roof deposits than in floor deposits, which may reflect either the high proportion of burned bone in post-abandonment hunters camps or the removal of burned bones with hearth remains from the floors and their dumping on the roofs. Similarly, the total lack of uncarbonized botanical remains (except for occasional pieces of birch bark) and the very low values of carbonized needles and wood compared to rim deposits may reflect more adverse preservational environment of the roofs compared to other types of deposits.

Again, aside from the southwest sectors of the edge of the roofs which may be special lithic using activity areas, the lithic assemblage from the roofs bear striking resemblances to the lithic assemblages from the floors in almost all characteristics: flake sizes, raw materials, flake types, artifact types, wear state, and amount of cortex (Vol. I, Chap. 14). The only consistent differences of any magnitude are the slightly greater proportions of flakes on the roof produced by hard hammer percussion as well as flakes with more cortex, with greater weathering, and more fragmentation. Some categories in HP 12 with small sample sizes provide a few exceptions. However, the main differences are all understandable in terms of different weathering environments and the preferential discard of the least useful reduction products. The consistently greater occurrence of 1–2 cm flakes in the roofs compared to the floors, and a higher percentage of larger flakes on the floor may be due to the clean-up of small debris from the floor and discard onto the roof. In contrast, flakes smaller than 1 cm are more common on the floor indicating that hand picking up of refuse rather than sweeping may have been the most widely used technique for cleaning up, although floor mats used for sitting or serving could have been swept off on a regular basis. The overall similarity between the roof and floor deposits implies either that the vast majority of the lithics in the roofs were materials cleaned up off the floor and dumped on the roof during occupation, and/or that the materials in the roof were largely derived from the incorporation of floor deposits in the roof deposits during reroofing episodes (Fig. 2).

In sum, the cultural material in the roof deposits appears to derive largely from the discard of refuse from the occupation floor, but also undoubtedly includes a great deal of material originally deposited in the floor matrix. As the roof was repeatedly replaced and all loose floor deposits were removed from above the sterile till, the floor matrix and contents were added to the dirt roof covering. Localized activity areas also occur on the periphery of the larger roofs.

Collapse Events

The nature of the roof collapse may have important consequences for the patterning of any primary, secondary, or de facto refuse left on the surface of the roof. The major factors of importance are whether the roof was burned or left to decay by natural processes, and whether the roof collapsed in coherent large sections or whether dirt gradually filtered through multiple holes throughout the roof. Much more needs to be known about the conditions and processes involved, however, at this point it appears that if roofs were left to decay slowly through natural processes, localized areas between main support beams were more likely to rot resulting in the gradual funneling of roof sediments onto the floor. This would mix artifacts laying on the roof surface with prior occupation refuse in the body of the roof sediments. The same processes can be observed occurring today with collapsing sod roofs on early log cabins in the area (Fig. 4), and are also evident in early photographs of partially collapsed housepit roofs (Teit 1900:Plate XV). So far, there is only one clear example in the 26 housepits tested at Keatley Creek of a roof having decayed naturally (HP 9); most if not all the others appear to have been intentionally burned.

Burning roofs could result in a similar pattern of localized holes and filtered collapse due to the more rapid burning of smaller wood elements between the main roof beams. However, removal of the largest structural beams before burning might weaken the roof to such an extent that burning could result in the massive collapse of large sections of roof, or as argued in the discussion of roof deposits, sections of the roofs may have collapsed before burning. In this case, any refuse patterning on the surface or inside of the roof might be retained to a much greater degree and artifact dips might frequently be relatively horizontal, although the pulling down of roof soil from the center of the roof towards the edges in order to remove structural beams and posts could obscure some of this patterning. Subsequent to the collapse, slumping and colluvial movement of roof materials toward the bottom of the house depression would rework the uppermost collapsed roof deposits even further.

As noted above, there are a number of indications that roofs at Keatley Creek were weakened before burning by the removal of main structural beams and posts and that some segments of the roofs collapsed as coherent units. The occurrence of large carbonized roof beams laying directly on the floor of the houses instead of mixed with the body of the roof deposits or laying on top of the roof deposits also indicates that large sections of the roof collapsed directly onto the floor rather than burning through in localized spots through which roof sediments could fall onto the floor and cover it before the beams collapsed. The relative lack of any roof deposits in the central areas of the housepits together with Kusmer's (Vol. I, Chap. 10) observation from the HP 7 roof that bones from the peripheral areas of the roof were primarily found below the uppermost 10 cm of roof also strongly indicate that roof soil was pulled down from the center of the roof toward the edges prior to burning.

In some of the excavations, attempts were made to recognize "filtered roof collapse." These were thought to contain fewer coarse clasts due to the greater ease with which finer materials could pass through the initial decay or burn holes in the roofs. While a number of excavators felt that they could detect a vertical gradation in the occurrence of coarse clasts within the roof corresponding to this model, I had difficulty in perceiving such a change given the local variability in large clast occurrence and the general small size of the vast majority of clasts. The "filtered collapse" deposits identified in HP 3 even had the lowest proportion of flakes under 1 cm of all deposit types, which is contrary to what one might expect with filtering effects. I suspect that holes in the roof would tend to break through in large enough sections during burning or natural decay so that size filtering effects would be negligible. The issue certainly requires further experimental work and detailed texture analysis of soils in order to be clarified. However, it is evident from the very low percentage of fish (1%) and elevated percentage of weathered bone (8%) in the filtered collapse that these deposits were derived from the roof rather than any interior sediments.

One other factor affecting variability in roof deposits is the completeness of burning that took place. This obviously would affect factors such as the preservation of roof beams, conifer needles and bark used in roofing, and any botanical remains (cultural or natural) associated with the roof surface. The patterns of carbonized beams (which are well preserved in some housepits (e.g., HP 3) or portions of housepits, but only intermittently present in others) and the localized preservation of bark or conifer needles in association with roof beams (e.g., HP 12) indicates that there was substantial variability in carbonization versus complete oxidation of wood during house burning.

After the collapse of the roof into the center of the housepit, roof deposits would be loose and poorly consolidated, especially given the low clay content in the parent material. Thus, considerable downslope movement could be anticipated, depending on the depth and slope on the inside of the pits. Slopes vary from less than 10 degrees to over 30 degrees.

In sum, roof deposits, like the other major types of deposits associated with housepits, have proved to be considerably more complex than we assumed before taking a detailed look at the variability and processes involved. Subjectively, it is easy to focus on the homogenous field appearance of most roof deposits and ignore some of the important variability, especially if roof materials are not obviously central to one's main research objectives. Yet, the broad patterns involved in the formation of roof deposits seem clear enough to inspire confidence in our interpretations, including the use of roofs as refuse disposal areas as well as special activity areas, and the manner of their construction and collapse.

Despite these factors, it is still puzzling as to why larger housepits throughout most of the Plateau and Shuswap occupations do not seem to have used significant amounts of soil to cover the roofs. Excavation of smaller Plateau period housepits (e.g., HP's 4, 9, 90, 107) seem to indicate that some earth was used as part of the roof. It might be suggested that during the Plateau and earlier periods mats were primarily used to cover these structures during the winter and that such mats would quickly rot out if left covered with earth for the entire year and therefore had to be removed after every seasonal occupation. For smaller housepits, it would be a relatively small task to cover such mats at the bottom or even relatively completely with earth and to remove this earth after every occupation, much as earth banked winter mat lodges continued to be made in historic times (Alexander 1992: Plate 3.3). However, for larger houses it may have involved an excessive amount of time and labor to cover any significant part of the roof with earth every year and to remove it after every occupation. This may be the reason why roofs of large Plateau period houses involved negligible use of dirt. Instead, mats may have been secured on the roof by the use of poles attached to the mats on the outside. Access through the smokehole could have been achieved via an outside ladder (Condrashoff 1972). Given this arrangement, almost all refuse would presumably have been thrown on the rims in order to avoid damaging mats, and of course outside activities would be conducted on the rims rather than on the roofs.

The above model assumes that the dirt roof covering of later period roofs was left as is after collapse, or was totally removed in order to construct a new roof and then used as part of the new roof soil covering.

Although most of the housepits that we excavated or tested did conform to this sequence of events, there were a few occasions where subsequent occupations did not clean out all roof and floor soils down to sterile till, but rather simply removed some of the collapsed roof deposits and leveled out the remaining material to create a new living surface above the older buried one (e.g., HP 9 and probably 110). Partially collapsed structures might also be repaired and fallen roof material smoothed out for temporary or single season use, as appears to have happened during the natural decay of the Stratum VI roof in HP 9.

The strong similarity between the lithic assemblages of roofs and floors (Vol. I, Chap. 14) and between floors and rims (Vol. I, Chap. 15) strongly indicate that no basic economic changes took place from the time that the rim and roof deposits accumulated and the time that the floor deposits accumulated. Faunal and botanical differences between roof versus rim and floor deposits can be entirely accounted for in terms of the differential preservation conditions that typify these different types of deposits, and in terms of differential discard behavior that characterized different types of deposits.

Surface Deposits

Typically, all relatively deep housepits at Keatley Creek have a deposit of fine, dark gray-brown loam containing about 5–20% gravels and pebbles in the top 5–15 cm. This stratum is quite distinct from the roof deposits (which contain much higher gravel and pebble volumes) in most cases, although in other cases there is a much more gradual transition between the two deposits. The higher gravel and pebble content in these surface deposits within housepits indicates that they are not simply aeolian accumulations similar to the aeolian loams that occur at the surface of the till elsewhere. While there may be some, perhaps considerable, aeolian enrichment of silts and sands, especially due to the dead air spaces and lower air velocities within housepit depressions, it also seems probable that much of the fine fraction of the surface deposits (as well as their coarser fraction) is derived from the water transport of silts and sands from the uppermost collapsed roof soils down toward the base of the housepit depressions. This is further indicated by the progressive thinning of these surface loam deposits as one moves up the inside slope of the housepit to the rim (Fig. 2). The collapsed form of a housepit constitutes a closed depression which naturally tends to concentrate and retain rainwater at the bottom. This appears to favor the development of grass vegetation at the bottom of many housepits, and it is probable that some of the rich dark color and high organic content of the surface loams in housepit depressions is due to soil formation processes associated with these richer grass microenvironments.

Most post-housepit occupations of the site by transient hunters occur within the surface loam deposits and are concentrated toward the center of the housepit depressions where there is the most flat area and least wind. These occupations are generally easy to recognize on the basis of the occurrence of hearths within the surface loams, as well as localized scatters of distinctive lithics (endscrapers and cherts) or historical artifacts (metal knife blades, arrowheads, axes, bottle fragments, leather scraps, pipes), or distinctive faunal remains. Sometimes pits, hearths, or occupations occurring shortly after the roof collapse extend into the uppermost roof deposits as well but are generally easily distinguished from housepit occupation activities.

Deposits Outside Housepits

Before turning to formation processes of floor deposits, it is worth mentioning that some activities do appear to have taken place away from housepits, resulting in some bias in housepit refuse in terms of the overall representation of activities performed at the site. These activities can be classified into three basic categories: refuse disposal, special activity areas, and communal activities.

One of the most common comments concerning archaeological reconstructions of housepit socioeconomic organization is that much of the refuse may have been removed from the housepit and dumped elsewhere, or that the patterning on the floors could simply represent refuse thrown into abandoned housepits. The dumping of refuse in abandoned housepits will be addressed in the next section. We investigated the possible disposal of refuse away from housepits by undertaking a transect sample across the site between housepits and by the excavation of small depressions that were the most obvious potential facilities for refuse disposal. The transect excavations (Vol. I, Chap. 6) revealed essentially nothing but natural deposits containing no or very rare cultural material. Investigation of 13 small cultural depressions selected to sample all parts of the site and all sizes of smaller depressions revealed no concentrations of refuse such as would be expected from refuse dumping (Vol. III, Chap. 12). Some of these depressions constituted abandoned storage pits that had been filled with what excavators termed "refuse," however, in all cases this was predominantly composed of soil with low densities of artifacts that was indistinguishable from general roof fill. There were no dense concentrations of faunal remains, fire-cracked rocks, or botanical remains as one would expect from a basket load of refuse collected from elsewhere and dumped in a pit. Rather the pit fills appeared to have been obtained from nearby housepit roof or other associated deposits. Except for a few clear instances at the site (e.g., HP's 47, 58, Vol. III, Chap. 11), there is no evidence for the disposal of pithouse refuse away from the immediate pithouse that generated it. One area which remains to be investigated as a refuse dumping location is the creekbed of Keatley Creek.

The testing of small depressions did lead to the identification of a number of special activity areas. Many of these were interpreted as roasting pits for cooking meat (EHPE [Extra Housepit Excavation] 2 and 12) or plant materials (EHPE 1 and 2, just north of HP 7). One larger structure (EHPE 20) was so charcoal rich and devoid of other cultural remains, except FCR, that it must have been a root roasting pit or perhaps even a feature used for producing charcoal. Other small cultural depressions appear to have been small structures possibly used for secluding women during menstruation, or as residences of very poor individuals or families. The amount of cultural material associated with these small depressions was generally very limited, but distinctive in terms of faunal remains, amount of charcoal, and some lithic materials. The scarcity of these specialized activity areas and the low numbers of artifacts involved indicates that they probably have not created a major distortion in our modeling of the activities that occurred inside the housepits. There are also a number of storage pits that occur between or far from housepits, especially on the terraces to the east and south of the site core. Several structures may have been used for special community structures. They are discussed in Volume II, Chapter 1.

In sum, the immediate deposits associated with most housepits (roof, rim and floor) appear to contain the vast majority, if not all, of the refuse that was generated by daily activities of the residents of each housepit. There is very limited evidence for refuse dumping away from housepits or in other abandoned housepits. Only occasional activities appear to have taken place away from housepits or in specialized community structures.

Floors

Identification and General Characteristics

Floor deposits were considerably more complex than originally anticipated. If we are going to reconstruct socioeconomic organization within housepits with any degree of detail and confidence, it is necessary to be able to distinguish floor deposits from roof and till deposits in the field with relative confidence and to determine whether any mixing with non-floor deposits has taken place. Distinguishing floor deposits from sterile till, and even middle prehistoric components (4,800–7,000 BP), posed no problem given the striking difference in color between the yellow till/early components and the blackish floor deposits. Careful attention to the problem of distinguishing floor deposits during the test trenching of housepits in 1986 led to the fairly confident subjective identification of floor deposits versus roof deposits in several housepits (HP's 1, 3, 7, 12). These impressions were reinforced during subsequent more extensive excavations in these housepits.

Before excavations began, we proposed on the basis of the literature (e.g., Schiffer 1976, 1985, 1986) as well as on the basis of postulated theoretical and common sense grounds that living floor deposits might exhibit some or all of the following characteristics:

Sediments

1) If the roof acted as a filter that permitted fine sediments to sift into the house but blocked coarser materials, or if the interior acted as a trap for aeolian particles, or if silt and clay-rich sediments were brought into the houses by people, the floor deposits might be enriched in fine sands, silts, and clays in comparison to roof or till deposits. We therefore examined the textures of these deposits. In most cases, the floor deposits were about 10% richer in sands, silts, and clays (Vol. I, Chap. 6).
2) Floor deposits were expected to be more compact than roof deposits, especially since collapse of the roof should have disaggregated any compaction in the roof soils. We used bulk density tests in an attempt to measure compaction, however, variability in pebble and cobble content appear to have overwhelmed any differences due to compaction. Gravels and pebbles in the soils rendered the use of penetrometers ineffective. Despite our inability to monitor compactness in a precise way, we nevertheless collected subjective impressions of excavators in a relatively systematic fashion (see below). These data clearly indicate that floor deposits were generally distinctly more compact than roof deposits (Vol. I, Chap. 8).
3) Chemical residues from food processing and consumption were expected to vary in a structured and patterned fashion across the floor. Concentrations of chemical elements in floor deposits should therefore reflect activity areas identified on the basis of other indicators such as hearths and faunal remains. Phosphorous, nitrogen, calcium, strontium, and magnesium were the most obviously relevant elements. Analysis of these elements does in fact reveal strong concentrations of these elements where they would be expected (Vol. II, Chap. 6).

Table 2. Distribution of Artifact Orientations by Strata Type

	Floor		Roof		Surface	
	No.	% of Floor	No.	% of Roof	No.	% of Surface
Horizontal						
HP 1	33	75	130	62	38	66
HP 3	24	92	27	34	—	—
HP 4	31	72	31	55	65	63
HP 7	22	96	74	74	22	81
$\Sigma/\bar{M}$	*110*	*81*	*262*	*58*	*125*	*66*
Slanted						
HP 1	10	23	72	34	18	31
HP 3	2	8	47	59	—	—
HP 4	11	26	23	41	31	30
HP 7	1	4	26	26	4	15
$\Sigma/\bar{M}$	*24*	*18*	*178*	*39*	*53*	*28*
Vertical						
HP 1	1	2	7	3	2	3
HP 3	—	0	5	6	—	—
HP 4	1	2	2	4	7	7
HP 7	—	0	—	0	1	4
$\Sigma/\bar{M}$	*2*	*1*	*14*	*3*	*10*	*5*
Total	136	100	454	100	188	100

Fauna Remains

1) Due to the rapid covering of floor deposits by collapsing roofs, and given the churned and exposed nature of roof soils, we expected that bone preservation would be best in the floors and poorest in the roof deposits, especially of small delicate elements (Schiffer 1986). Deposition of fresh faunal remains on roofs would also expose them to scavenging by dogs or other animals since dogs generally appear to have been kept outside and not inside houses (there is minimal evidence for canid gnawing or digestion of bones in floor deposits and ethnographic accounts refer to dogs outside houses—Teit 1912a:250, 256, 307; 1912b:325; 1917:46). This expectation was strongly supported by excavation data. Deposits identified in the field as living floors contained far more fish bone and unweathered bone than roof deposits: 56% fish in the floors versus 5–10% in the roofs, and 0–4% weathered bone in the floors versus 20–30% in the roofs (Vol. I, Chap. 10).
2) Bone remains, as well as lithic artifacts and botanical remains, were expected to exhibit spatial patterning in floor deposits corresponding to activity or storage areas, whereas such patterning should be largely absent in roof deposits (except a few possible activity areas on the periphery of the roof and general disposal areas on the roof for refuse). Concentrations of bone near hearths and large bone artifacts or refuse near the floor perimeter were the types of patterns expected to occur in floor deposits (Hayden and Cannon 1983; Hayden 1982). Results from botany, fauna and stone artifacts amply confirm these expectations (Vol. II, Chaps. 4, 7, 11; Spafford 1991).
3) Mesodebitage (1–10 mm) from bone and stone processing activities were also expected to be primarily associated with obvious activity areas on the floor (Schiffer 1987:267–9). The concentrations of bone and stone debitage evident in the floor deposits clearly support this expectation (Vol. II, Chap. 9).
4) Due to the thin and horizontal nature of floor deposits, all relatively large bones and flakes found in floor deposits were expected to exhibit little or no dip, that is, little deviation from a horizontal plane; whereas due to the mixing of deposits thrown onto the roof, dip angles of larger objects were expected to be much more variable (Schiffer 1986). While all observations did not conform to expectations, over 80% of the artifacts recorded from floor deposits were horizonal, whereas only 58% of the objects from the roof exhibited horizontal orientations (Table 2).

Botanical Remains

1) Aside from the patterning in floor deposits mentioned above, lower densities of botanical

remains might be expected to occur in the roof as a result of the open weathering environment and repeated churning of roof sediments during reroofing episodes. These trends were not apparent in Lepofsky's analysis (Vol. I, Chap. 9), perhaps due to continuous discard of organic remains on the roofs or to a greater resistance to weathering than anticipated.

2) Charcoal might also be more rounded in floor contexts than in roof contexts due to scuffing and treadage on the floor. This was not apparent in subsequent analyses, perhaps because so much of the material thrown out on the roof was derived from the floor deposits or due to mixing of earlier floor deposits in with roof soils during reroofing events.

Stone Materials

1) Aside from the patterning in floor deposits already mentioned above, more worn out and broken tools were expected to occur in roof deposits than in floor deposits (Schiffer 1986). The previous discussion on roof formation processes has already established that there are some differences conforming to these expectations, but that these differences are not pronounced (Vol. I, Chap. 14). This is probably because most of the materials left on the floors were objects of little value or objects ready for discard.
2) Because of the difficulty of picking up very small debitage for discard, proportionally more small debitage may occur in floor deposits unless sweeping and removal of floor sediments was common (Schiffer 1987:267–9). As mentioned in the discussion of roof formation processes, flakes under 1 cm in size were more common in floor deposits (Vol. I, Chap. 14), although mixing of floor and roof deposits during reroofing events must have also tended to homogenize such differences over time.
3) Weathering was expected to be more pronounced in roof deposits than floor deposits (Schiffer 1986). Probably due to the much greater resistance to weathering of stone materials, only slight differences in this direction were observed (Vol. I, Chap. 14).

Testing Expectations

Archaeological observations were gathered to test the above expectations. These data empirically documented the distinctive living floor origin of the deposits that excavators had subjectively identified as living floors in the field on the basis of color, texture, and compactness. These subjective field criteria sometimes varied across the floors, but locally could exhibit striking differences in color, texture, and compactness compared to roof deposits (Vol. I, Chap. 8). Other localized areas exhibited more subtle differences that made the distinction between roof and floor more a matter of intuition than observation. Nevertheless, even in situations that were difficult to interpret, the unanticipated occurrence of carbonized roofbeams or charcoal flecks at the contact between field-identified floor and roof deposits sometimes confirmed the accuracy of these identifications. On the whole, excavators felt that they could distinguish floor deposits from roof deposits in the field with relative confidence. Where there was doubt, we assumed that the 3 cm above sterile till represented floor deposits, although with hindsight it seems possible that a minimum of floor deposits were present in some localized parts of the floor and that roof deposits were almost in direct contact with the sterile till. The occurrence of carbonized roof beams and charcoal flakes at the presumed contact of floor and roof deposits over large parts of the floors greatly enhanced our confidence in field identifications of floor deposits (Fig. 5). Similarly, occasional large flat artifacts such as spall scrapers, plank segments, and bones lying horizontally on this contact also strengthened confidence in our field interpretations.

Thus, on the basis of field indications and on the basis of laboratory analyses, there was a relatively high degree of confidence that floor deposits had generally been accurately identified in the housepits that we chose for extensive excavation.

Sediment Composition

In general, floor deposits had high gravel contents and pebble contents (15–35%) with a dark gray brown color similar to the roof. Floor deposits usually ranged from 3–5 cm thick. An initial working assumption was that floor deposits would be a relatively homogeneous type of hopefully distinctive sediment. As mentioned previously, some of this sediment was assumed to have been introduced from external sources. After textural analyses and fortuitous marked variations in the till composition underlying single floors, it became evident that most of the sediment forming floor deposits was actually derived from the scuffing, loosening, and subsequent mixing of the uppermost till deposits as people carried out activities on the fresh till surfaces after the initial excavation of the housepit or after cleaning out loose sediments for reroofing. Textural analysis showed that the gravel and pebble content of the floor deposits is essentially similar to till and roof deposits with about a 10% enrichment of fine sands and silts in floor deposits for most housepits (Vol. I, Chap. 6)—a difference detected by excavators in the field. While some of the enrichment in sands and silts may have come from finer elements filtering through the roof as people or dogs walked upon it (a phenomenon I observed inside modern pithouse reconstructions), it is doubtful that many of the coarser elements would have penetrated the bark, pine needles, and poles at the base of the roof. It seems far more likely that larger materials would be derived from scuffage of the underlying till materials. This was also the subjective impression of several excavators who noted that charcoal had discolored the bottom centimeter or so of the floor deposits while artifacts predominantly occurred in the upper parts of the floor deposits. Similarly, charcoal stained earth sometimes occurred partially, but not completely, under pebbles and cobbles that were still firmly embedded in the till matrix. Furthermore, in the south central part of the floor in HP 7, the underlying till was locally composed of fine yellow loam instead of the usual gravel and pebble rich matrix. In this loamy till area, the floor deposits also had a very loamy composition and were very easy to distinguish from the overlying roof deposits which were much more gravel and pebble rich. Elsewhere in the house floor where the underlying till had a typically high percent of gravels and pebbles, the floor deposits of HP 7 contained much more gravel and pebble material, similar to the underlying till deposits. Thus, there are a number of indications that the matrix of the floor deposits was derived primarily from the underlying till, with some possible enrichment of fine fractions from material filtering in through the roof or perhaps blowing in through the entrance/smoke holes. Loose till material may have also been added to the floor from the excavation of new storage pits or other features.

On the other hand, if the fresh till forming the floor surface after each reroofing event was eventually scuffed up to a depth of about 3 cm (the median thickness of floor deposits) and removed during the next reroofing event, this would result in the removal of about 1 m over the course of a millennium. None of the large postholes, hearths, or storage pits indicate that their original depth had been truncated by anything approaching this figure. All of the bell shaped pits still retain their bell shaped profiles and all are approximately the same depth (90–110 cm). I suspect that the reason for this lies with the proposal made earlier that earth covered roofs on larger houses were a relatively recent phenomenon, and that prior to their adoption, there would have been no need to periodically shovel out collapsed roof sediments, nor for that matter loose floor deposits.

Mixing Disturbance

One of the most common questions asked about the floor deposits is how it is possible to determine whether the assemblages on the floors represent "pure" assemblages from the last occupation (i.e., from the period between the last reroofing event and the collapse of the last roof, which may represent a period of a few years to as many as 30 or more) or whether the floors contain mixed assemblages from prior occupations as well as the last occupation. Presumably, artifacts falling onto the floor from roof deposits or mixed into the floor by bioturbation, cryoturbation, or other mass-turbation processes would be responsible for such mixing. There are a number of types of data that can be used to evaluate the extent of any possible mixing. First, as discussed in the opening of this section, the distinctiveness of the deposits in terms of color, texture, compactness, the undisturbed occurrence of carbonized roof beams, and the differential occurrence of organic remains or weathering all attest to strata that have remained coherent on a large scale.

Second, indications of bioturbation can also be used. While rodent burrows were sometimes detected or suspected in the refuse rim deposits, they were comparatively rare in the actual floor deposits, perhaps in part due to the difficulty of burrowing in the consolidated till under the floors. In fact, the only indications of bioturbation that occurred in the floor deposits were the dark plugs of earth that filled cicada larvae burrows (about 1 cm in diameter) in the sterile till, and indications in microfabric sections that insects had passed through parts of the floor deposits (Vol. I, Chap. 7). The cicada burrows were rare in the gravel rich till, probably because of difficulty in burrowing in gravels, but they were relatively numerous in the looser roof deposits and where the till was composed of loams. Even here, however, the density of burrows was never so great that there was any trouble at all distinguishing the contact of the floor from the sterile till. Since the dark soil that filled the burrows left an indelible mark that lasted for thousands of years, it must be assumed that the soil record of these burrows represented virtually all the significant bioturbation that had occurred since the housepit was built. While these burrows may have affected the vertical distribution of occasional artifacts less than 1 cm in size, they cannot be expected to have affected a large proportion of the assemblages in any other size category. On the other hand, these kinds of vertical openings in the earth may have been a source of introducing very small modern seeds such as Chenopodium seeds into deep roof and floor assemblages.

A third type of data that can be used to assess mixing of assemblages is the relative degree of easily understood patterning in floor assemblages. While there is never any *a priori* guarantee that the occupants of any house left their refuse in a sensible patterned fashion when they abandoned their sites, the occurrence of clear and sensible patterning in living floor deposits cannot be accounted for on the basis of natural mixing processes. Thus, the systematic clustering of fire-cracked rock, seeds, mammal bone fragments, debitage, tools, and phosphorous levels in proximity to hearths in HP 7 (Vol. II, Chaps. 4, 6, 7, 11), the clustering of conifer needles together with large bones and stone artifacts along the walls (Vol. II, Chaps. 4, 7, 11; Spafford 1991:103–4), and the occurrence of fish bones clustered in specific areas all make a great deal of sense in terms of an unmixed, undisturbed occupation floor, and seem impossible to account for in terms of natural processes. Even more compelling is the occurrence of areas where almost nothing is found on the floor, such as the south central sector in HP 7. If mixing had been significant, these occurrences would be very difficult to account for. The occurrence of large and numerous items (at Keatley Creek, large flakes, large faunal elements, segments of articulated salmon backbones, and re-used scrapers) near structure walls has been documented for ethnographic households in the Maya Highlands as a common means of storage or provisional discard of the largest objects in the least heavily used areas (often under beds or in corners—Hayden and Cannon 1983). Catastrophically buried houses exhibiting "Pompeii"-like refuse characteristics such as those at Ozette also display the same pattern as observed at Keatley Creek (Samuels 1991:240ff).

In all the ethnographic and archaeologically "intact" cases, the patterning of artifacts on the floor is never crisp, but is relatively blurry. This can be expected wherever there were densely packed populations who constantly displaced objects and dust as they walked from one area to another within structures. In fact, the comparable degree of clarity in the artifact patterning between housepit floors at Keatley Creek and at Ozette make it possible to say that there was no significant mixing or turbation of artifacts over 1 cm in size in the floor deposits. This led Samuels (1991:262, 268) to argue that there had been no significant movement of artifacts from area to area within the Ozette houses. Thus, the occurrence of artifacts in specific floor areas was a result of their use or storage in those areas. The same conclusion seems warranted for the housepits we excavated at Keatley Creek. On the basis of a careful analysis of debitage, Prentiss (Vol. I, Chap. 13; 1993:517) arrived at a similar conclusion. Nor does sweeping appear to have been used in cleanup activities (based on the size fractions of debitage discarded on roofs) or at least sweeping does not seem to have significantly affected artifact distributions. Given the powdery, dry, silty condition of the floors, sweeping would probably have created uncomfortable dust levels in houses unless it was simply used to clean off mats used for sitting or serving food. The analysis of mesodebitage (1–10 mm) from flotation of heavy fractions would be expected to reveal effects of sweeping or other sediment displacements. However, there is no dramatic deviation from the patterns apparent in studying the spatial distribution of the larger size artifacts (Vol. II, Chap. 9).

There are two types of evidence that point to possible mixing of assemblages, either due to items falling from the roof or incomplete cleaning out of earlier floor deposits. These indicators consist of varying dates on charcoal from floor deposits, and varying styles of projectile points found on the floors. I have dealt with the problem of dates from any given occupation floor spanning several centuries in discussing roof formation processes (above) and the dating of the site (Vol. I, Chap. 2).

I am convinced that the occasional (sometimes up to 25%) occurrence of Plateau horizon points in Kamloops horizon floor deposits, shows that, as in the Great Basin, atlatl technology persisted for several centuries after the introduction of the bow and arrow. There is no reason why this could not have also occurred on the British Columbia Plateau. Stryd (1973:49) found similar mixed point styles on some of the floors at the Bell site. Since Kamloops points are clearly arrow points and Plateau points are clearly atlatl points, perhaps they should be expected to coexist for several hundred years after the introduction of the bow and arrow, with the older technology being used especially by poorer families or for specialized types of game. Such situations clearly occur on the Coast. At the Tualdad Altu site, Jim Chatters (1989:176–7) documented the division of a house into two halves with the apparently privileged half having, among other things, exclusive use of harpoon technology, while the poorer half used bows and arrows. Similarly, at the Meier site, the house excavated by Ken Ames exhibited a division into privileged and poorer halves with the new technological introductions (iron blades) associated with the privileged end of the house (Ames, personal communication).

The last occupations at Keatley Creek represent a comparable period of technological change, that is, the first century or two of the adoption of bows and arrow points. As in the Coastal examples just cited, the large house (HP 7) that we excavated is divided into privileged and poor halves. The occurrence of the more archaic atlatl (Plateau style) points in the poorer half of HP 7 is twice that of the privileged half (Spafford 1991:134). However, another complicating factor on the Plateau is the fact that older projectile points found on the ground were sometimes recycled by Plateau Indians (Teit 1900:241, 338; 1909:519, 539, 645; Smith 1899:126–7, 137), and this may also account for the occurrence of some Plateau points on Kamloops floors. If one were to postulate that these points fell through the roof, it would be necessary to envisage truly enormous quantities and sizes of materials streaming down onto the floors during occupation. There is no reason to suspect this. Nor do the relatively thin floor deposits bear any indication that prior loose floor materials were not almost all removed during reroofing episodes. The few clearly identifiable earlier occupation deposits were all quite compact.

Thus, the two types of data (dating and mixed point styles) that do not superficially conform to expectations concerning the purity of assemblages can be relatively easily accounted for. Variable dates from roof beams can be accounted for by the scavenging and recycling of structural timbers. Mixed point styles can be accounted for by scavenging and recycling of earlier points and/or by the co-existence of new bow and arrow technology with older atlatl technology for a few centuries.

On the basis of distinctive floor deposit characteristics, artifact patterning, and evidence of bioturbation, it seems abundantly clear that mixing of deposits did not significantly affect the large-scale, overall patterning of artifacts in the floor deposits, although small scale insect activity obviously has been responsible for the introduction of small broadcast seeds and some vertical introductions or displacements of small cultural materials.

Variations Across Floors

Variations across floors in the composition of the soil matrix was an unanticipated element that complicated, but also enriched, our formation process models. Socioeconomic factors may have had important roles in the creation of the variability of soils within housepit floors, and they are therefore dealt with here where appropriate.

During the first season of excavation in 1986, it became apparent that instead of a homogeneous deposit that could be referred to as "floor," there were considerable differences in the sediment characteristics of floor deposits within a single housepit. Attempting to describe and explain this variability proved to be very challenging. Given the large areas involved, it was clearly impractical to obtain detailed textural analyses across the floors. Recording Munsell colors was equally futile given variations in moisture of excavated sediments and the very coarse grained color distinctions that the Munsell color codes provide. Compaction tests were equally difficult to implement given the high gravel and pebble content. Therefore, rather than engage in expensive, time-consuming objective analyses, we gradually evolved a set of subjective observations to be recorded by excavators. Assuming that the roof deposits were much more homogeneous than the floor deposits, excavators were simply asked to record whether floor deposits seemed finer/coarser, lighter/darker, looser/more compact than the overlying roof deposits. This was admittedly a crude measure of variability in floor deposits which evolved imperfectly over a number of seasons, but it was hoped that results would reveal the most general patterns present in floor soil variability, as well as provide some indication as to whether more intensive investigation of this variability was warranted.

With only occasional exceptions, all excavators in all housepits reported that floor deposits which could be easily distinguished from roof deposits were more compact (Vol. I, Chap. 8). The domestic sleeping areas (between the walls and the main hearths in HP 7) tended to be the easiest to define and were the most obviously compact, while the central areas of the housepit where one would expect most foot traffic tended to be less distinctive in terms of compactness. Interestingly, the only very clear instances of floor deposits that were less compact than the roof occurred in very localized patches immediately adjacent to the walls.

Variation in texture (Vol. I, Chap. 8) exhibits interesting patterning. In HP 12, floor sediments that are finer than roof sediments occur in the north (around the hearth) and east near the walls. In HP 3, finer floor sediments also occur near the walls, but in the west and east sectors. In HP 7, finer floor sediments also occur primarily near the entire perimeter of the walls. Unfortunately, the central portions of both HP's 3 and 7 were excavated in the early phases of development in this recording system. As a result, much of the data from the central areas of these housepits is either missing or of such a general nature that conclusions about the patterning involved cannot be advanced with very high levels of confidence. As an independent, quantifiable means of verifying the subjective impressions, we weighed the coarse heavy fraction (larger than 1 mm) from the floor flotation samples and plotted the weights There may be a number of factors affecting these measurements including the removal of larger pebbles in some samples by excavators, some variation in the actual amounts floated (1 liter plus or minus 200 g.), and underlying variations in the gravel content of the parent till material. The precision of this type of data collection can certainly be improved in the future.

Nevertheless, in HP's 3 and 12, it is clear that the densest gravel concentrations occur in the central area of the floor. This may be due to the heavier foot traffic and scuffage in this area and the settling out of the dusty fine fractions in peripheral zones. Such processes may explain why the floor sediments of HP 3 had an anomalous higher gravel content than roof sediments

(Vol. I, Chap. 6), since the floor samples from HP 3 were largely taken from the central part of the floor where gravels tend to concentrate. Housepit 7 displays more variation, but the unusually low values of gravels and pebbles are almost all in the peripheral zone. Thus, both subjective evaluations and limited quantitative measurements indicate that finer, more compact sediments tend to concentrate in peripheral areas where low traffic and protected sleeping areas most probably occurred. Whether bedding material was placed directly on mats laying on the floor, or whether beds were usually elevated on wood benches made of logs, poles, and/or planks around the entire floor circumference as described by Lillooet elders (Kennedy and Bouchard 1977:Tape 1) cannot be determined with confidence, although plank segments have been recovered from both HP's 3 and 7 and it seems likely that they would have been used to make bedding and storage platforms. The occurrence of large flakes, large faunal elements, and articulated salmon vertebrae near walls strongly indicate that these floor areas were low intensity activity zones used for storage and/or provisional discard and little else as described in Lillooet oral accounts of eating on sleeping platforms and storage under them (Kennedy and Bouchard 1977:Tapes 1 and 2). Areas under such platforms would have been protected from foot traffic and would have tended to concentrate finer sediments which could compact more easily. This may also explain, in part, the tendency for floor deposits to be somewhat thicker near some walls, although other factors such as wall sloughing may also be involved.

In addition to these areas of finer floor texture, there was a broad area of finely textured floor in HP 7 roughly corresponding to squares A, B, E, and F, and to the central part of Spafford's Inner Zone (Vol. II, Chap. 11) where very few artifacts occur. The underlying till in this area, which also extends partially into some surrounding squares, is very fine yellow brown loam. Initially, it seemed possible that this material had been brought into the house for use as flooring, similar to ethnographic accounts of fine loam being spread on the floors of the larger houses for dancing (G. Keddie, personal communication—see Vol. II, Chap. 1). Upon investigating the depth of the loam deposit in HP 7 and the nature of its contact with the more gravelly till, it seemed more likely that the fine loam in HP 7 was a natural occurrence. Even if this loam is a natural deposit, its occurrence in an area which may have been used as a high status ritual and dancing area in HP 7 (Vol. II, Chap. 1) makes it seem likely that the occupants of HP 7 focused on this natural occurrence of loam to organize their use of space as well as the overall construction and the orientation of the pithouse. Similar loam deposits are associated with the floor of HP 1, but in this case whether these are naturally occurring or imported into the house must be determined by future excavations.

Color is much more variable from housepit to housepit. In HP 12, with two localized exceptions, the floor deposits are almost uniformly darker than roof deposits. This is probably due to the limited number of times the roof would have been replaced (Table 1) and the limited amount of refuse that would have been mixed into the roof soil in comparison to the much more intensive accumulation of charcoal and organic wastes in the thin floor sediments during the same period. In contrast, the periphery of floor in HP 3 was generally lighter than the roof deposits. Data was unfortunately lacking for the central parts of the house floor. The same is true of HP 7 (Vol. I, Chap. 8). The overall lighter color of floor deposits in these housepits may be due to the much longer period during which ash and other organics were thrown onto the roofs, the much larger volume of material discarded onto the roofs, the relatively protected nature of peripheral floor areas (under benches or mats), and possibly to a relatively shorter formation period for the floor deposits, especially in HP 3. If reroofing and floor cleaning had taken place only one or a few years prior to abandonment of the housepit, then only a limited amount of organic staining of the yellow till parent material would have taken place. Thus, the floor deposits would appear relatively light in comparison to roof deposits that had become stained over a number of centuries. Localized areas of unusually dark soil could be logically expected to occur in the immediate vicinity of hearths. This clearly seemed to be the case in HP 9 (Vol. III, Chap. 7), and may have also been the case in HP 7.

The fact that the subsquares near the fire-reddened area of HP 12 and those around most of the fire-reddened areas of HP 7 (at least where observations exist) are lighter than the roof, probably indicates that fires were very infrequent in smaller housepits and that probably only one or two hearths were used on a regular basis in the larger housepits with the rest being used on special occasions. This is another important aspect of the formation processes for floor deposits. In fact, there are numerous other indicators that hearths were not generally used (see Hayden et al. 1996 for details). These include the fact that no white ash or charcoal deposits were associated with most fire-reddened areas; there was an absence of charcoal concentrations in flotation samples taken near some hearths (Vol. II, Chap. 4), the existence of highly trampled debitage around and over fire-reddened areas (Vol. I, Chap. 13), and field observations that floor deposits overrode fire-reddened areas. The very extensive size and shape of some hearths also made it apparent that these hearths were expanded for special activities such as feasting or jerking deer meat. Moreover, smaller housepits generally had very superficially fire-reddened till deposits, and appear to have been used very infrequently. Oral accounts too, indicated that fires were used infrequently and that dried foods were eaten without cooking (Kennedy and Bouchard 1977:Tapes 1 and 2). That all the fire-reddened locations in HP 7 were active hearths, at least episodically, is clearly indicated by the concentrations of fire-cracked rock, debitage, artifacts, bone debris, and anvils that cluster around the fire-reddened areas. However, all other indicators seem to imply that these hearths were not used on a regular basis, and that when not in use, the areas occupied by hearths were simply used like any other part of the floor for foot traffic or other activities. Such episodic use of special purpose hearths is recorded by Hill-Tout (1978:58) for warmth during particularly cold periods in pithouses, and by Barrett (1975:39) for baking bread inside Pomo houses. These infrequently used hearths reverted back to normal floor use once their special functions were ended. Prentiss (1993:493) also detected considerable evidence of trampling in lithic debitage overlying firereddened areas, indicating that these zones were being used as ordinary floor surfaces.

Thus, morphological and color variations in floor deposits provisionally seem to correspond to four different types of depositional environments: 1) low traffic areas near walls or under benches where stored materials and fine fractions were enriched by air borne dust or wall tricklings; 2) activity areas near hearths where greases and charcoal were concentrated; 3) high activity or traffic areas toward house centers where coarse fractions were enriched; and 4) special ritual or other specially avoided areas. A fifth type of deposit consisting of dumped sediments can be added to this list and will be discussed in a following section.

Chemical Variations

In addition to sampling floor deposits to monitor botanical and mesodebitage variability, we also used portions of the same samples for analyzing chemical variability across the floors, reasoning that major activity areas might leave floor sediments enriched in certain elements such as phosphorous, nitrogen, calcium, and magnesium from plant or animal waste materials. While the patterning is certainly not as coherent as the clusters of debitage or fauna, it is nevertheless clearly present and corresponds to the peripheral versus central areas and to hearth locations, with the highest concentrations typically occurring between the hearths and the walls in the large houses (Vol. II, Chap. 6). Given the controversy about whether total or available phosphorous is the most meaningful to measure, we measured both values for a sample of our samples over a wide range and found the two to be almost perfectly correlated. Phosphorous and calcium are perhaps the two most likely elements that would be expected to concentrate around food preparation and/or consumption areas. The fact that they do exhibit higher values in these areas adds confidence to many interpretations advanced in the socioeconomic interpretations, such as the use of two hearths on a regular basis in HP 3 (one in the north and one in the south), and the division of the interior of HP 7 into numerous independent domestic groups. In HP's 9 and 12, phosphorous and calcium concentrate very strongly around the hearths and associated food preparation areas. The concentrations associated with single hearths and food preparation areas emphasize the communal nature of the socioeconomic organization in these housepits. Nitrogen and magnesium (not illustrated) display roughly similar patterning, although many of the peaks of these elements seem to be slightly displaced or more broadly spread out than was the case with phosphorous and calcium. It is difficult to know exactly what to attribute the concentrations of nitrogen and magnesium to.

More detailed investigation of plant, animal, and soil chemistry are required to unravel the full meaning of these distributions. However, three meanings are clear: first, the overall patterns certainly seem to confirm other indications of activity and social patterning on the floors. Second, although some bioturbation has clearly occurred in the floor deposits, it has not obliterated or even dramatically affected the basic chemical patterning in the floor deposits. Third, all the elements show an overall increase in value from the smallest housepit (HP 12) to the larger housepits. On the basis of other archaeological indicators, it was suggested that HP 12 had a shorter overall occupation and probably much reduced economic activities in comparison to larger housepits. The lower concentrations of waste-related elements not only support these interpretations, but also strongly indicate that the concentrations of these elements is due to cultural factors rather than natural variations in the till or in the soils above the buried housepit floors. That the results are not simply a function of differential soil development according to the thickness of overlying roof deposits is clearly demonstrated by the distributions in HP's 3 and 12 where the phosphorous concentrations are strongly related to the one or two hearth locations, but display no relation to the roof deposit contours. Soil pH exhibited broad variations that could not be related to other types of socioeconomic patterning.

Finally, the conditions of abandonment and accessibility after abandonment had major impacts on the nature of the artifactual content associated with living floor deposits. The situation concerning HP's 3, 7, 9, and 12 seems fairly clearcut in this respect. All artifactual indicators point to a planned abandonment with the systematic removal of everything that was of value from the housepit floor prior to burning the roof. The only whole tools left behind were large, heavy items difficult to carry (anvils, sandstone abraders, spall tools). The only objects of value left behind seem to have been lost (one small sculpture and a copper tubular bead in HP 7; a graphite crayon in HP 3), or cached and forgotten about (one pestle cached in a pit in the base of the wall in HP 7). All the storage pits had been filled in; there is no evidence of wooden tools or furniture left on the floors; the main structural elements of the roof had been removed; and there was no evidence of killing or violence. In fact, there are no human remains at all. The skull of an aged dog was left near the center of the floor in HP 7, while the headless body of a young dog was left near the center of the floor in HP 3. These appear to have been intentional acts performed at or around the time of abandonment. It is always possible that these were random acts by individuals without ritual intentions; however, the very clear contact with the floors, the short time that appears to have elapsed between abandonment and burning, the obvious important curation and burial of dog skulls in some storage pits of HP 7, and the central location of the skull in an area with little else around it all indicate a more probable intentional and meaningful deposition of these remains. Moreover, the occurrence of dog remains in similar special contexts in three separate housepits (HP's 3, 7, and 110) seems unlikely to occur by coincidence. Dog remains were also left in a similar fashion on the floor of a housepit at Monte Creek (Wilson 1992).

Everything speaks of a planned, intentional departure from the housepits, either with the intention never to return, or to return at a later date in order to rebuild the burned superstructures. Nor does it appear that these structures were open for access after abandonment. There is absolutely no indication that anything was dumped into these structures through their smoke holes. There are no identifiable dump deposits or anomalous concentrations of refuse near the centers of the floors, such as do occur in HP 58; and there is no evidence of encampments on the floors that do not conform to the overall organization of other features and artifact concentrations on the floors.

Housepit 9 is exceptional in that it was not burned down during any of its occupations and in the occurrence of numerous pieces of antler that may have had considerable value including a digging stick handle and a very long split and shaped bark peeler. Whether these items had become damaged or were considered of no further use, or whether they indicate that the house was abandoned in an unplanned fashion (e.g., due to death prior to a planned return) is difficult to tell. The main storage pit also seems to have been left partially open. It also appears that the housepit was left open to use in its partially decayed state of collapse and that a small group occupied it after partial collapse; however, no other extraneous or post-abandonment dumped refuse is evident in examining the distributions of artifacts across the floor. This is the only probable case of post-abandonment reoccupation of a partially collapsed structure that we encountered during our excavations at Keatley Creek.

In sum, floor deposits could usually be distinguished from overlying roof deposits relatively easily in the field. A broad series of analyses confirm the distinctiveness of these deposits and strongly support their identification as living floor deposits. While some small-scale mixing and turbation clearly occurred, it does not appear to have affected the basic artifactual, chemical, and pedological patterns created by the last occupants in the floor deposits. As will be seen in Volume II, the basic organization of activities on this floor seem to have remained remarkably stable throughout the last occupation and even over a much longer period of time as indicated by posthole patterns and locations of large storage pits. Similarities in the lithic assemblages of floors and rims (Vol. I, Chap. 15) also indicate that no other major economic changes occurred throughout the duration of occupation of the housepit except for the change from atlatl to bow and arrow technology. Most housepits were abandoned in a planned fashion with all objects of value and usable timber being removed. Since most structures were burned upon abandonment, they were effectively closed to post-abandonment scavenging or re-use of the living floor areas, although much later some groups camped on some of the collapsed surfaces.

Dumps and Pits

While the occurrence of large storage pits had important implications for the interpretation of socioeconomic organization within the houses, it was not until excavations were well underway that we appreciated the very important role that pits might also play in understanding floor formation processes. In almost all cases, it was abundantly clear that the large storage pits had been intentionally filled in over a very short period of time since there were no clear lenses of different types of materials and the fill of the pit interiors was unusually soft as occurs from single filling events. Bones from the same animal that occur in the top and bottom parts of the fill of a single pit (as in pit P-4 of HP 7) also indicate that pits were filled very rapidly.

At this point, it is difficult to tell whether large storage pits would have been used on a yearly basis (being emptied of earth, filled with dried food, gradually emptied, and refilled with earth every year), or whether their use might be much more occasional, only occurring in years when salmon harvests were exceptionally abundant, as might occur every four years with sockeye salmon (Kew 1992). Nor is it clear why some large storage pits occurred inside houses while others occurred outside, and still other stored foods were recorded ethnographically as being cached on elevated pole platforms. It does appear, however, that large interior storage pits were associated with richer, more powerful members of the housepits (Vol. II, Chap. 1). Nor is it clear whether all large pits were contemporaneously used, although their locations conform to a single pattern indicating that they were probably dug and used penecontemporaneously. While some of the pits were clearly capped by floor deposits, some even being covered by concentrations of fire-cracked rocks and fire-reddened earth, it is not easy to know whether the floor deposits had been laid down a month or a year or a decade or a century before abandonment of the house. Similarly, the occurrence of a Plateau point in the fill of a large storage pit in HP's 3 and 7 cannot be used to conclusively date the last use episode since Plateau points also occur relatively frequently in the floor deposits. Dating the large storage pits at Keatley Creek remains a problem but the dog remains at the bottom of one of the large storage pits of HP 7 were dated to 2,160 BP, well into the Plateau Horizon.

However, in terms of formation processes, the real problem presented by large storage pits exceeding a cubic meter in volume is what people did with the earth fill when they excavated the pits for storing food, and where the earth came from when they wanted to fill in the pits again. These are not trivial questions considering that six such pits might have all been in use at one time in large housepits based on the floorplan of HP 7. To have taken all the pit fill out and thrown it on the roof only to haul it down again to refill pits seems like an excessive amount of work if there were other easier alternatives. One possible alternative would have been to have areas within the housepits where dirt from the pits could be temporarily banked until the pit was ready to fill in again. These areas would have to be little used zones of the house, such as spaces underneath sleeping benches or sectors of the house not occupied by domestic groups. It is possible that the great thickness of earth on the floor of the northeast sector of HP 7 may represent such a pit fill storage area, however, field indications make it seem more likely that this earth was derived from a partial roof collapse during occupation. Combinations of these strategies may have also been used, such as the dumping of excavated dirt on the roof, but the filling in of pits with scrapings from the surrounding floor.

From the archaeological remains, two inferences are relatively apparent. First, it is clear that pits were filled in with dark floor-like material from inside the house, whether from stored dirt banks or scraped from the floor. Some scraping from the floor seems to have taken place given the occasional inclusion of thin lenses of sterile yellow till in the fill deposits. The most probable origin of such yellow till would be scrapings from the floors after the dark floor deposits had been removed. In addition to the overall resemblance of pit fill to floor deposits, the very high percentage of fish bone (64%) resembles the floor deposits (56%) rather than the roof deposits (10%), although some of these clearly came from the bottom of the pits where remains of stored fish were concentrated (Vol. I, Chap. 10). Mammal bone in three pits was also most similar to bone in floor deposits. It was also clear that during filling events other unwanted items were thrown into these pits, including debitage, large (and perhaps other) pieces of bone, anvil stones, and fire-cracked rock.

The second inference concerning pits is that relatively clear instances of dumped deposits occurred at the edge of some housepit walls (HP's 7, 9, 90), although the clearest instances of these dumps contain considerable charcoal or ash and almost no artifactual or faunal material. These deposits were noted during excavation, while microfabric analysis by Goldberg clearly identified dumped deposits, some with high concentrations of grass phytoliths and hearth materials, in peripheral floor areas. We treated these dump deposits as special cases of floor deposits. The conclusion that can be derived from these observations is that there were strategies for the management of excess earth inside housepit structures. Whether the amounts involved were derived only from medium or smaller sized pits and/or hearths, or whether such strategies could have accommodated soil removed from the larger pits as well, is difficult to answer. The fill from one large pit would cover a 100 square meter floor such as HP 7, with 1 cm of pit fill; conversely, it would take 1 cm of floor deposit from the entire floor area to fill in one large storage pit. The simultaneous filling in of 3–5 large storage pits in HP 7 could have removed virtually all the accumulated floor deposits.

It is possible that a large part of the soil emptied out of large pits was simply spread over the floor. If this was done frequently, it would obviously have a randomizing effect on the distributional patterns of artifacts and faunal materials in the floor deposits. There are several indications that the large storage pits were not emptied very frequently, and certainly do not seem to have had much use during the years (or centuries) preceding housepit abandonments. In the first place, patterning on all the floors is very strongly developed and clearly centers around hearths. This artifact patterning makes sense in terms of the use of space and bedding areas around those hearths (Vol. II, Chaps. 4, 7, 11) rather than in terms of pit fill spread over floors. Secondly, floor deposits, including hearth development, clearly overrode many storage pits. Thirdly, in other cases, there were indications that the storage pits had not been used for some time, such as the recovery of a Plateau point from the fill of one pit in HP's 3 and 7, and the occurrence of an interred dog and remains of 8 other dogs overlain by layers of birch bark and wood planks about half way down in the two pits in the northwest sector of HP 7 (dated to 2,160 BP). Finally, it can be noted that virtually all the large storage pits had been clearly filled in well prior to house abandonment, certainly long enough to permit the regeneration of typical thicknesses of floor deposits over the entire floor (assuming that floor scrapings were used to fill in the large pits). Thus, no impact might be expected to occur on artifact patterning on the floors from emptying pit fill and spreading it over the floor. Nevertheless, it is not clear whether all pits may have been dug and used during the Plateau (or even Shuswap) horizon and perhaps had gone out of use by Kamloops times, or whether only a few (or all) of these pits may have continued to be used sporadically throughout the entire occupation of the housepit.

Thus, there are still many intriguing questions concerning the use of these pits, the dirt management strategies for the earth used to fill in the pits, and the effects of these management strategies on living floor deposits. Answering these questions will require considerable effort, but because of the overwhelming impact pit fill can have on floor assemblages, they are important to deal with if researchers want to ask questions about socioeconomic organization within housepits. At this juncture, it is fortunate that such factors did not appear to have played a major role in the formation of floor deposits prior to the last abandonment of housepits we investigated.

One other type of deposit which merits attention, and which can be confused with dumps near the walls, are slump deposits (alluded to ethnographically by Laforet and York 1981:121). There are a number of indications that these types of deposits regularly occurred in some housepits. When houses were reroofed and cleaned out, or when they were enlarged, the floors sometimes were extended at the base of the walls so that they formed very steep wall angles (e.g., Fig. HP's 5 and 7). Where the walls were cut too steeply into loose rim refuse or other loose rim deposits, they would eventually become relatively unstable and parts of these rim deposits could be expected to slough off onto the floor. The large cobbles or boulders sometimes set into the wall deposits appear to be meant to stabilize these walls to some degree. At the Bell site, Eldridge (1971, EeRk4, HP 3 field notes) recorded a much clearer example of a stone retaining wall on the inside of a floor. The unusually clear distinction between floor and roof deposits often became blurred at the juncture of the floor and the wall. At these juncture locations in larger houses, floor sediments often became loose, more brownish, and graded into rim and roof deposits. This situation may well be due to the very protected depositional environments of these areas, but also seems to have been due to gradual or even mass sloughing off of refuse rim deposits along the wall.

In addition to these unique and specialized types of deposits, we have not investigated in detail other minor types of deposits such as post hole fills or fill units within pits, or special types of feature fill such as the broad shallow rock filled pits in HP 9 and 90 (Vol. III, Chaps. 7, 10). These were originally very puzzling features but seem to be related to occurrences of wet areas (due to seepage), the use of wet objects (such as water buckets), or the use of interior earth ovens. We did not always recognize the significance of these features in the field and missed some important opportunities for investigating these features in more detail. Some "pebble fields" also occur on the floors inside houses on the Coast at Ozette (Samuels 1991:187). Other types of pit fills related to the caching of valuables are discussed below in the context of lithic artifact formation processes.

Other Deposit Types

In the preceding pages, I have dealt with the most important types of deposits and formation processes in the housepits that were extensively excavated. In part, these housepits were specifically chosen for excavation because of the relative clarity of their deposits as determined from initial test trenches. Other housepits were rejected for excavation partially because of the complex or uninterpretable nature of the deposits revealed in test trenches (see for example HP's 2, 47, 58, 101, 104, and 109). Some of these deposits were very deep and ashy light gray with unusually dense artifact or faunal material, while some were simply very deep deposits with little cultural material. Others were confused lenses of materials or were broad thick ash deposits covering the entire floor, or were black, heavily charcoal stained deposits with little or no artifactual material or fauna. To deal with the formation processes of these more unique deposits would require many specialized studies and a great deal of effort. This is all work for future researchers. We have sought to initially establish a firm basis for understanding the most widespread and "simplest" types of deposits at the site. Once this has been successfully achieved, researchers should be in a much better position to deal with questions involving the more unusual and difficult to understand types of deposits. Certainly, simply dealing with rims, roofs, and floor deposits has been a challenging undertaking in itself, while the field identification of floor deposits has repeatedly required all the attention and observational resources that excavators could bring to the endeavor. By engaging excavators in questions of interpreting strata and modeling formation processes during the excavation, the undertaking becomes an intriguing intellectual adventure for everyone in the field.

Formation Processes of Cultural Materials

While frequent reference has been made to faunal and lithic materials in the preceding discussions, a complete understanding of the formation processes of site deposits must also include specific kinds of cultural remains together with explanations of how they came to be deposited (Prentiss 1993). In this section, I will briefly review some of the major factors which have formed the cultural assemblages present in the deposits that have been discussed.

Lithics

A wide range of lithic materials were obtained from different sources for use at Keatley Creek. For the present purposes, lithic raw materials can be grouped into 4 general classes: locally available materials, materials from Hat Creek and Pavilion Mountain quarries, trade materials, and prestige materials.

Quartzites were obtained locally for making adzes or spall scrapers used in hide working. Other local materials included anvil stones made from granite boulders, and boiling stones made from a variety of local cobbles found in the till and creek beds.

Mountain sources of vitreous trachydacite and chert were used for most other cutting and scraping tasks. These materials were obtained from the Upper Hat Creek Valley, Maiden Creek, or the headwaters of Rusty Creek (in Fountain Valley) (Vol. I, Chaps. 11, 16), probably during fall hunting and gathering trips into the mountains. Bakewell (Vol. I, Chap. 16) has shown that the large residential corporate groups at Keatley Creek used separate source areas from each other to obtain most of their raw materials. Specially shaped flake blanks, roughed out bifaces, and cores of raw material were carried back to the Keatley Creek winter village. However, due to the need to transport gear and as much food to the village for winter as possible, amounts of raw material that could be transported in the form of cores was probably very limited. Cores were stored and used at the winter village to produce expedient tools (e.g., expedient knives, general scrapers, notches, utilized flakes) for tasks as they arose. Even very small flakes were often used and retouched, while larger ones were frequently broken intentionally and recycled. These factors reflect the scarcity of raw material at the site. Because trachydacite wears down more rapidly, it was largely used for expedient tools with short expected use-lives, while the longer-lasting cherts were used preferentially for tools meant to be used for longer lasting activities, more intensive processing, or in highly mobile situations such as on hunting trips (e.g., endscrapers, drills, key-shaped scrapers). Projectile points may have been kept in storage for long periods, but their actual use-life was very short, and they were thus usually made of trachydacite. Because of the short use-lives of the expedient tools, they are by far the most numerous elements in the lithic assemblage at the winter village. Bifaces may have been developed primarily for use in highly mobile contexts, such as hunting trips, but it is clear that they were stored and used and resharpened at the winter villages as well. It is worth noting that, contrary to Binford's (1972:189; 1973:242, 249–60) expectations, there were essentially no "curated" tools at the winter villages that were not also used there. Binford argued that curated items used at specialized procurement sites should be brought back to main camps of collectors where they would be repaired and would constitute significant parts of base camp assemblages. Yet, despite the fact that although the overwhelming staple of the Classic Lillooet people was fish, there are only one or two tools out of thousands that can be related to fishing at Keatley Creek—a slightly barbed bone point and a possible net needle as well as a net needle and two ground slate knife fragments from the Bell site (Vol. III, Chap. 2; Stryd 1973:67, 372, 385). This is the more remarkable since Teit (1906:204) reports that slate fishing knives were common among all groups of the region.

In all, several different strategies are represented by the Keatley materials. The debitage left on (and discarded from) the floors of housepits predominantly reflects both the expedient production of tools and the resharpening of bifaces and making of projectile points (Vol. I, Chap. 13; Vol. II, Chap. 11).

Trade materials have not been intensively investigated due to the low frequencies of these materials and the difficulty of identifying specific sources. Nevertheless, Bakewell (cited in Mierendorf, in press) has identified the Hat Creek/Cache Creek vitreous trachydacite used in the Lillooet area as also present in archaeological sites in the North Cascades National Park in Washington State. He also feels that some examples of North Cascades Hozomeen chert are present in the Keatley Creek assemblages. In addition, optical identification of unusual green chert and white chert with rusty speckles indicates that flakes of these materials at Keatley Creek probably come from Walhachin (B.C.) and Monty Creek respectively, near Kamloops (Vol. I, Chap. 11), indicating either trade with or travel to these areas by members of the Keatley Creek community.

We suspect some other examples of rare materials may come from the west side of the Fraser River, while obsidian probably is derived from more distant sources. Obsidian from the neighboring Bell site was sourced by Arnoud Stryd indicating several unknown sources, but most samples were identified as originating from Tsitsutl Peak near Anahim Lake (Stryd 1973:46, 125). Assuming that much of the obsidian at Keatley Creek is from this same source, it is difficult to know how these trade materials fit into the overall lithic formation processes at the site. They do not appear to have been treated in any particularly distinctive fashion, and may therefore represent incidental acquisitions associated with other activities. Certainly, they indicate either exchange with, or travel to, these distant locations (or both) by individuals in the Classic Lillooet communities. Sandstone used for abrading stones may also have been obtained via trade since no known local sources for these stones has been located. As with faunal remains such as shells, the actual number of items representing regional trade is quite limited, a situation that also characterizes Coastal assemblages (Mitchell and Donald 1988:339).

Prestige materials are generally locally available (e.g., nephrite, copper, soapstone, marble, or other ground stone), but involve investments of time and energy in their procurement or manufacture that far exceed utilitarian requirements, and often no utilitarian function is apparent. These materials were used to produce high status ground stone celts, copper ornaments, stone sculptures, sculpted mauls, and delicate stone pipes. Occurrences of ochre, mica, and ground graphite can also be classified as prestige materials. Ochre occurs as a powder in the mountains to the east of the site, while no source for graphite is known. As might be expected, prestige materials were highly curated and rare to begin with. They are even more rare in the archaeological habitation deposits. Rarity of prestige items in habitation sites may be a relatively common phenomenon among transegalitarian and chiefdom societies (e.g., Cunliffe 1986:151), although there are some cases where items of lesser value that occur in moderately high frequencies can be associated with high status living areas (Chatters 1989; Ken Ames, personal communication). But fundamentally, the main depositional context for prestige items in most transegalitarian and chiefdom societies appears to be burials. This may be even more pronounced among groups with a highly mobile component in their seasonal round since possession of wealth would have also entailed requirements for the means to carry it around (wives, children, slaves, dogs) or to store it securely. People that could potentially inherit wealth would not necessarily have the means to maintain it.

Some items were certainly stored in pits in housepits while the occupants went on seasonal hunting and gathering trips into the mountains. Teit (n.d.) wrote that:

> If all the people of one house were going off on a trip, they buried some of [sic] valuable tools they did not want to take along. Especially things made of stone.

In moderate size pits at Keatley Creek, we have found a sculpted maul, a palette, antler billets, bone flakers, anvils, and a copper bead all apparently cached and never retrieved.

Fauna

There are four basic sources of faunal remains at the Keatley Creek winter village site: animals or fish brought in from expeditions to procure food; small game from the immediate site environment used for meat; prestige or display fauna; and bones introduced for use as tools.

Salmon, deer, and mountain sheep constitute the major sources of meat for the Keatley Creek community, as well as ethnographic communities in the area (Vol. I, Chap. 10; Alexander 1992). The drying of sockeye and spring salmon fillets for winter consumption separates most of the meat of the fish from the bone. If only these dried fillets were brought to the site, fish bone would be extremely rare or completely absent. However, fish bone tends to be abundant in most deposits. This means either that the backbones and fins (with their not-inconsequential amounts of meat adhering to them) were also dried and stored for winter food (as documented ethnographically, i.e., Romanoff 1992; Kennedy and Bouchard 1992), or that late species of fish such as pink salmon were being dried whole without removing the backbones or fins. Whichever was the case, it is clear that large amounts of fish bone, including some head elements, were being brought to the site as part of the winter supplies of dried fish (Vol. I, Chap. 10).

Deer meat and mountain sheep were similarly deboned and dried when obtained far from winter village sites. Deer are presently more abundant than sheep and the taste of deer meat is preferred. The same situation appears to have characterized the past environments and peoples (Alexander 1992). However, when deer were killed within a few kilometers (four miles according to Lillooet elders—Kennedy and Bouchard 1977:Tape 2) of the winter village, it appears that the entire animal or large parts of it were brought back to the site for butchering. Bones with high marrow or grease content were systematically smashed for use in soups resulting in very high proportions of the faunal assemblage made up of unidentifiable mammal bone fragments and only occasional whole or identifiable bones.

Local hare and grouse bones also occur and were undoubtedly hunted opportunistically around the site during winter occupations. However, due to the high human population at the site, and the low natural population of these species in the vicinity, it is not surprising that remains from these animals are relatively rare in the faunal assemblages at the site.

All scrap food bones were probably cleaned up and discarded on the roof and rim together with other hard refuse such as fire-cracked rock. It seems highly likely that household or vagrant dogs would have heavily scavenged the bones discarded on the roof, especially the unburned bones, thereby reducing the survivability of discarded bone and leading to under-representation of bone material from the houses. Presumably any bone consumed by dogs would be excreted at various locations away from the immediate house structure. As previously noted, there are a number of ethnographic accounts that indicate dogs were usually kept outside rather than inside houses.

There are very clear examples of bones being introduced into the faunal assemblage at Keatley Creek for prestige or display purposes. These include bones of furbearers (lynx, fox, fisher), cervids (moose antler, and probably most of the elk antler at the site), ritually important animals (grizzly bear), birds (especially wing bones of loon, hawk, eagle), and shellfish (dentalium, whelk, rock scallop, marine mussel). I would also argue that domesticated dogs (Vol. II, Chap. 10) were bred and maintained primarily as prestige or display animals much in the same fashion that slaves were used to display prestige and economic power. Many worked, decorated pieces of mammal bone were probably also introduced into the site from mountain sources, although some could have equally well been manufactured from local deer kills or obtained via exchange.

Some elements of the faunal assemblage have also clearly been introduced from afar in order to fulfill technological needs. This is particularly evident in the case of the numerous beaver teeth found at the site given the very rare occurrence of other bone elements of beavers. The worked deer scapulae and antler objects may have also been brought in from mountain kills to be used as special tools (Vol. I, Chap. 10; Vol. III, Chap. 2), especially the antler billets, digging stick handle, and bark peeler. The more common bone awls and pins may have originated in the mountains as well. Mussel shells were most likely brought to Keatley Creek from Seton Lake where Nancy Turner (personal communication) has observed them. No other sources are reported in the region. Teit (1898:56; 1912a:338; 1912b:300; also Gould 1917:108) makes numerous references to shells being used for carrying coals for making fires.

As mentioned in the discussion of lithic curation, with one or two exceptions, there are essentially no bone tools associated with fishing at either the Keatley Creek or Bell sites (see Stryd 1973:67).

Finally, there are animal remains that largely entered the archaeological deposits by accident. These include small rodents that may have died naturally or been killed by residents.

Plants

There are six major sources of plant remains at the Keatley Creek winter village: construction materials, technological materials (including firewood), dried stored foods, local fresh foods, medicinal plants, and fortuitously introduced plant materials (Vol. I, Chap. 9).

Construction materials by far account for the greatest amount of preserved plant material at the site, involving main support posts of pine, roof beams of pine and fir, conifer needles, and deciduous or conifer bark used as roof covering. In many cases roofs were burned, but some of these materials were preserved due to collapse of the earth covered roof. In other cases, the roof was left to decay and little is left except a few cases of post mould in post holes.

Plant remains from technological activities constitutes the next largest category of remains. These concentrate in the refuse rims and in the floor deposits. They consist primarily of wood used for fuel (mainly Douglas-fir, pine, and Populus), scraps of birch and pine bark (much birch bark was used as "torches"—Kennedy and Bouchard 1977:Tape 2—and some birch bark was clearly sewn and probably represents containers), remains of wooden planks used for sleeping benches or as scaffold storage areas, sedges and reeds possibly for mats, sagebrush (bark was used for clothing), conifer needles and probably grasses used for bedding around the edge of the floors. The large masses of unidentifiable organic material in the rims may contain decayed bark, reeds, and shavings, however this cannot be ascertained at present.

Remains of basketry are particularly interesting. With one protohistoric exception in HP 104, at both Keatley Creek and the Bell site (Stryd 1973), the only remains of baskets recovered were birch bark fragments rather than the coiled baskets that were well known from the region in historical times. Assuming that preservation has not biased the admittedly small sample of basket remains, it would appear that most or all of the baskets in the Classic Lillooet settlements were birch bark. In fact, even ethnographically, Teit (1900:87; 1906:205–7; 1909:477) states that coiled baskets were rare for all Interior Salish groups and absent for the Shuswap and Upper Thompson. Even on the Coast, they were adopted relatively late (Hoover 1989:9; Bernick 1987; 1989:8). Post (1938:32) observed that the Southern Okanagan preferred coiled baskets for boiling since they lasted longer than birch bark baskets. Coiled baskets were always set in pits near hearths (Post and Commons 1938:63). No pits suitable for such purposes have been observed near hearths at Keatley Creek. Thus, on the basis of basket remains, ethnography, and pits, it seems that coiled baskets were lacking in the Classic Lillooet communities, or, if present, occurred only in low numbers and may have served as labor-intensive, exotic elite prestige items obtained through exchange. The popularity of coiled baskets in historic times was most likely the result of industrial markets and the native need for relatively high value crafts that could be exchanged for industrial goods (Hoover 1989).

Remains from stored plant foods are very scarce, probably due to limited quantities of these foods stored for winter use, as well as the lack of the need to prepare dried foods in or around a fire. Most dried food, including fish may have been eaten without being cooked during the winter (see Hayden et al. 1996; Kennedy and Bouchard 1977:Tape 2). Fires in pithouses may have created severe smoke problems (e.g., Teit 1912b:363) and firewood may have become depleted within easy walking distance of the site. Even on the Coast, John Jewitt (1974:96) had to go three miles to procure firewood. Most root foods also preserve poorly unless heavily charred. The few seeds of rose hips, cherry fruits, Saskatoon berries, and other berries that were carbonized probably fell into the edge of the fires by accident. While they do support the ethnographic accounts of using these foods during the winter (Turner 1992, Alexander 1992), they do not necessarily attest to a very important role in the winter diets. This is also a conclusion that emerges from close examination of the ethnographies.

Evidence for the use of local fresh plants is limited to a few rare occurrences of cactus, pine nuts, and kinnickinick. It is likely that little fresh plant food was available at the site during winter occupations.

Archaeologically recovered items that could have been used medicinally are limited to juniper, waterleaf, and kinnickinnick (used in smoking). Residue analysis from the inside of pipe fragments has not confirmed the use of tobacco at the site. Given the rare use of these plants and the limited quantities usually involved as well as the accidental circumstances usually required for their preservation, it is not surprising that smoking plants should be very rare elements in the macro-botanical assemblage at Keatley Creek.

Fortuitously introduced plant remains (aside from uncarbonized materials) include relatively frequent occurrences of chenopodium seeds, which presumably were collected by accident together with the large amounts of grass used in bedding, and other weed seeds such as *Silene* which may have been introduced by the same mechanism. Stone-seed plant (*Lithospermum*) seeds and many cactus seeds appear to have been introduced into various deposits by rodents. The sedge, *Carex*, may have been accidentally introduced with tule leaves.

Feces

One of the most abundant types of waste that must have been produced at the site consists of human and canid feces. Given the important amount of subsistence remains that must have been contained in all the feces produced at the site, it is worthwhile addressing the question of what became of them. The only feces that we recovered were fairly clearly canid feces associated with the dog inhumations in the large storage pits of HP 7. These appear to have been preserved due to the unusually rapid burial of the dogs, which, it would appear were thrown into the pits together with their entrails.

It is probable that all defecation took place away from the pithouses as related in a number of traditional stories recorded by Teit (1909:614, 630) and Kennedy and Bouchard (1977:Tape 2). Long distances seem unlikely given the cold weather, and the fact that even to get firewood, residents of pithouses had to borrow skin clothes from several families to protect them from the cold (Romanoff 1992:224). It is far more likely that defecation took place in the immediate environs of the pithouse, possibly on the roof or rim, or not far away.

Dogs and other scavengers probably consumed most of the human feces left outside. This is a pattern which is well known to traditional peoples whether in Europe, Africa, Australia, or Mesoamerica. Dogs might then defecate relatively farther away from the pithouses.

In addition, microfabric analysis (Vol. I, Chap. 7), indicates that any feces which were left on the surface of pithouses were quickly broken down by insect and other decay processes, leaving only small fragments of dung in the housepit deposits. Any partially digested bone or plant material in feces would probably undergo complete decay in these types of environments.

Summary

The documentation and understanding of even the simplest deposits at the Keatley Creek site has been considerably more complex than initially anticipated. Nevertheless, in part due to serendipitous practices and perhaps historical events such as the widespread simultaneous abandonment of all major settlements in the Lillooet region (Hayden and Ryder 1991), the archaeological record at Keatley Creek can be understood in terms that are useful for examining the socioeconomic organization within the community. There are clearly very significant differences between housepits both in general formation processes and in artifact formation processes. There are also strong organizational socioeconomic forces at work creating artifact and soil patterning on the living floors of pithouses. These patterns have been preserved due to the conditions of abandonment and the practice of burning the roof structures at the time of abandonment.

Overall, despite some bioturbation, the sites in the Lillooet region provide relatively ideal archaeological conditions for investigating prehistoric socioeconomic organization. Households are separate and the refuse that they generated has remained almost entirely associated directly with them in their rim, roof, and floor deposits. Deep accumulations of refuse on the rims have remained largely stratified enabling archaeologists to monitor changes over time. Abandonment conditions have preserved the patterns of activities and the organization that tended to take place in the same areas. Great stability is indicated over long periods of time not only in the internal organization of space, but also in the social identity and economic rights of specific corporate groups living in specific structures. However, without a clear understanding of the formation processes responsible for each type of deposit and each type of archaeological material, it would not be possible to engage in any meaningful reconstruction or explanation of these patterns. Although the exposition of observations and analyses dealing with site formation processes is generally less spectacular or sensationalistic than the presentation of results about socioeconomic organization, site formation processes constitute the very foundation for these other interpretations without which any reconstruction would crumble. It is very satisfying therefore, after all the analyses have been completed, to find that initial field impressions have been found to be justified and that there are solid foundations to the patterning that we had provisionally related to socioeconomic factors.

In addition to the stability in socioeconomic organization in some pithouses, it would also appear that great stability characterizes the faunal and botanical subsistence patterns over time from the beginning of the Plateau Horizon (or earlier) to ethnographic times (see chapters in Hayden 1992). This stability can probably also be extended to the approximate range of land use including ownership of prime fishing locations along the Fraser River and the controlled use of hunting areas and root collecting areas in the Clear Range mountains. In order to integrate all of these aspects, we will now take a closer look at the details of socioeconomic patterning evident in the floor deposits and housepits at Keatley Creek (Vol. II). These are some of the most exciting empirical and theoretical glimpses of prehistoric organization that we had hoped to obtain at the beginning of the project, particularly since they occur at one of the critical developmental phases of cultural evolution: complex hunting and gathering societies.

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Appendix: The Kekuli House

Further excerpts from a letter from James Teit to Franz Boas at the American Museum of Natural History—1895

According to my information the circle was often measured in the following way. A long bark rope was taken and knotted at say 20, 30 or 40 ft. from one of its ends or whatever length was intended to be the diameter of the hut. Another rope was taken and knotted at exactly the same length as the first. The ends of these ropes was then taken by four men and held in the position of sketch 1 immediately over the place selected for the site of the hut. These men tried to stand as much as possible at right angles and equidistant from each other. Sometimes these two ropes were previously folded up with the two ends together, the bight [?] consequently being the centre of the rope was knotted. When stretched out were the two knots came together was the centre of the circle or if without knots in the middle of the ropes, where the two ropes crossed one another was the center and accordingly marked with a stone or a small stake. Where each of the men stood was also marked likewise as A in sketch 2 and the butt ends of the four beams were placed at those places. Between the four marks a man scratched the surface of the ground with a stick in the form of a quarter circle as B in sketch 2. If after the hole was dug it was seen that it was not perfectly circular every place in its circumference, the diggers remedied this by digging a little more out here and there as they thought it required to make the circumference as uniform as possible. I think these somewhat hasty and not very concise remarks will be made clear by the enclosed rough sketches 1 and 2. Regarding the logs they were all measured with the bark ropes knotted as the required length. The "tEku/mEtin" were thus measured and cut the length which experience had taught them would be about right for a hole of a certain diameter. Sometimes however it happened that they were cut a little too short (taking into account the required elevation) for the size of the excavation. In such cases, the roof would when finished be rather flat and low, or if the beams happened to be cut a little too long the roof consequently was toward the opposite extreme, a little too steep and high. But they generally managed to get it about what they thought was the proper elevation. All the sticks used both great and small were peeled, excepting in the case sometimes of the thin poles of dry or dead when cut were not peeled as the bark had dried on and they would not rot, and moreover was hard to peel. These long thin poles etc. were done up in bundles and carried on the backs of men and women (with the ordinary packing lines) to the site of the building. Green timber was generally used for the other logs, especially yellow pine if obtainable within convenient distance was used for the tEku/mEtEn and ska/tsamin as it was soft wood to cut. These large logs after being peeled were simply drawn over the ground to the building site by no other means than a stout bark rope and plenty of men. The tEku/mEtin all those I have seen in kekuli houses have been round, in their natural shape without being squared, but the Indians admit this was the common way but they say that sometimes also the tEku/mEtEn were squared or more frequently squared only on the outside and sides (3 sides). These timbers were cut or chopped in the usual way by means of horn of stone "wana/u" struck with hammer (tul/kist) generally of stone but sometimes of wood the peeling and squaring (if any) and all notching and sometimes the chopping of the poles was done with stone adzes having a short crooked handle. The ska/tsamin was the first stick put in, the butt end of which was sunk some 15 inches in the ground and tamped [?] with sticks and the dirt [?] so that it stood in position perfectly solid as seen in A sketch 3. The upper extremity of the ska/tsamin was notched as B sketch 3. The tEku/mEtEn was next place in position as in sketch 4 with its butt end sunk in the ground some 2 feet and a little above its centre resting in the notch B of the sketch 3. They were at their junction securely fastened with withes of willow similar to B sketch 4. The other ska/tsamin and tEku/mEtEn were then placed in their respective positions in like manner to the above description. The "tsamani" or "tsamanis" braces of the tEku/mEtEn were usually simply lashed on somewhat like sketch 5^A. Those I have seen were thus fixed, but I have also heard they were sometimes notched probably in the manner of B sketch 5. In every case however they were securely fastened with willows at their junction with the beam and their butt ends slightly sunk in the ground. The ntlukamanktEn of horizontal poles were put on generally about 1 foot apart from one another although sometimes they were put as much as 2 feet or over apart and sometimes as close to one another as 8 or 10 inches. An idea of how they were put on will be got from sketch 6. Their ends were lashed to the beams with willows in every case. From those marked (3) in the sketch the remaining ntlukamanktEn (or those from (3) upwards) were generally (although not always) laid in exactly the same manner as in your sketch of the Shuswap one, that is, the ends were laid one on the top of the other and resting on the beams. They were also generally lashed. In at least two kekuli houses which I have seen the kitctcintEn were not hooked with one another not yet notched. The others I have seen I don't remember how were they fixed. The Indians say that some times they were notched but as a rule they were not being simply fixed as sketch 7 and very strongly lashed to one another and to the end of the beams. The sticks used for them were generally a good deal thicker than the ntlukamanktEn sticks, and were invariably peeled and sometime squared. In cases where they were fixed, and those who have seen them so fixed and not at hand tonight for me to ask. My wife says she thinks there were two or three different ways in vogue of fixing the tulctcintEn but she says after looking at sketch 7 that that was the way she had generally seen them placed. The T'skae/lx or outside poles were placed on the manner of sketch 8 the tops may be more plainly seen as in B sketch 7. The whole was thickly covered with the dry pine needles or dry grass. The T'skae/lx were not fastened in any way only simply laid on. The ladder was not slanting like Father Morice sketch but was like that in your sketch almost perpendicular and sometimes stuck out the hole some 5 or 6 feet. It rested in one corner of the entrance as sketch 9 and was sometimes lashed here with a rope or willows. In many if not most cases (but not in all cases) the lower end was slightly sunk in the ground. In the back of this log or ladder a groove was made to run its entire length for a hand hold. The groove was 2 or 3 inches in depth and about the width of an adze blade with which tool [?] is was usually made. Sometimes but rarely the groove was made in the side. You will see by the above information which I have given you as minutely as possible that the ktetcitEn took only a secondary place in holding the tekumatin in position the main stay being really [?] the skatsamin. I think you will now thoroughly understand the construction of the average NkamtcinEamux kekuli house. I know the Cawaxamux ones were the same and according to what the Indians say the other parts of the tribe, the Eastern and Southern Shushwaps and Okanagons built exactly the same way. I am not sure of the Utammke but I think theirs were almost if not exactly the same also.

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