

CHAPTER 9

Estimating Biface Production Output at a Basaltic Andesite Workshop in the Blue Mountains

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Introduction

The toolstone geography of the Tri-State Uplands of southeastern Washington, west-central Idaho, and northeastern Oregon is structured by the Miocene lava flows of the Columbia River Basalt Group (Camp et al. 1982). Investigation of workshops where various fine-grained volcanic (FGV) rocks outcrop as nodular clasts or tabular boulders has a long history in this region (Bryan and Tuohy 1960; Bucy 1974; Womack 1977; McPherson et al. 1981). A few studies have included experimental reduction exercises designed to better understand how bifaces or cores were made (Womack 1977; Jaehnig 1991). More recently, geochemical sourcing of FGV rocks has been explored at regional scales approximating those posited for western obsidians (Jones et al. 1997; Smith 2004; Bakewell 2005; Page 2008).

We now have a better appreciation of the variability within this suite of volcanic toolstones, and can distinguish many of them geochemically, sometimes supplemented with petrographic thin section analysis (Bakewell 2005). For example, low silica basaltic andesites of the Grande Ronde Basalt Formation can be readily distinguished from high silica andesites and dacites of the Saddle Mountain Basalt Formation (Dickerson 1998; Bakewell 2005). This chapter furthers these studies by integrating geological and geochemical results with replicative experiments to estimate temporal trends in production biface output at the Pataha Canyon workshop in southeast Washington.

Environmental Setting

Pataha Canyon lies at the northern rim of the Blue Mountains, near the edge of a forested basalt plateau and a rolling steppe formed in loess (Reid and Root 1998). The Blue Mountains form a western spur of the northern Rocky Mountains. The study area lies at the edge of the Arid Transition and Canadian zones, and is ecotonal in character. Pataha Creek is the main tributary of the Tucannon River, which joins the lower Snake River not far above its confluence with the Columbia.

The Pataha Canyon workshop (45UM110) lies at an elevation of 1,155 m at the confluence of Pataha Creek and a small channel from Iron Springs Canyon (Figure 9-1). Pataha Creek is the principal tributary of the Tucannon River and drains an area of about 124 km². The canyon here is about 1,000 m wide at the rim, and about 244 m in depth. The site has an effective temperature (ET) of 9.43°C. By comparison, sites along the Snake River to the north enjoy values between 13-14°C. In fact, all known winter settlements in the lower Snake basin lie in sheltered settings where ET ranges between 13-14°C. We assume that the Pataha Canyon workshop served as a warm weather seasonal camp rather than a winter settlement in prehistory.

Local physiography consists of north-trending plateau fingers and intervening valleys, locally named and mapped as ridges and gullies. The plateau is formed in basalt of middle Miocene age. Locally the flows are assigned to the “Grande

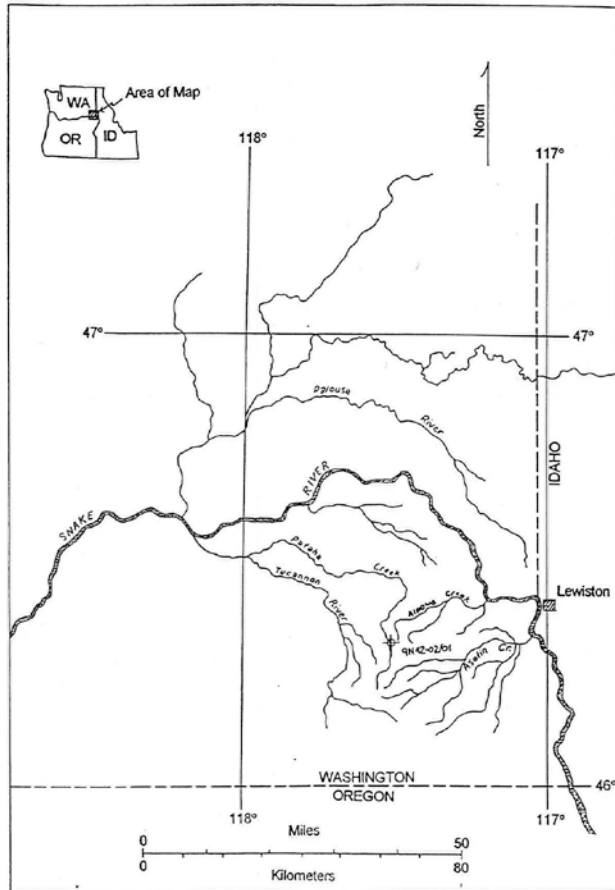


Figure 9-1. Vicinity map of the Pataha Canyon study area.

Ronde basalts of reversed magnetic polarity” (Schuster 1993). To the south, this dissected plateau is studded by several buttes and peaks. These include Huckleberry Butte (1,561 m), Mount Horrible (1,774 m), Sunset Point (1809 m), Diamond Peak (1,950 m), and Oregon Butte (1,951 m). All are subalpine in elevation and lack an upper timberline. The frequency of springs increases to the south, with an average of at least one mapped and named spring per section on the USGS quadrangles. Many are marked by lithic scatters dominated by the locally outcropping FGV toolstone.

Although native place names sometimes offer clues to how a locality was used originally, Nez Perce elder Elmer Paul glossed Pataha (“Puhtuh’puh”) as meaning only “in the bushes” (Chance et al. 1987:136). The site does lie in a forest-shrub plant association where soils formed under a mix of Ponderosa pine, Douglas-fir, spirea, snowberry, and rose. Fringing this association to

the north, and separating it from the more extensive steppe grasslands, was the grass-shrub association of bluebunch wheatgrass, Idaho fescue, Sandburg bluegrass, rose, lupine, and balsamroot. The steppe grassland proper, which extended northward to the Snake River, comprised a mix of bluebunch wheatgrass and Idaho fescue (Raver 1974:65).

Ethnography tells us that “making meat” was the major subsistence focus in the Blue Mountains, and archaeology has taught us that chipped stone industries flourish where the meat is being made. The principal game animals found within a day-radius of the site were deer and elk. Bears ranged the highlands to the south. Rocky Mountain bighorn remains have been identified in the upper Tucannon basin in Columbia County, and a native bighorn was killed as late as 1917 in the Asotin Creek headwaters (Johnson 1983:116). Bison bones have been recovered in cultural contexts at six sites along the lower Snake River to the north, where they date between 2,500 and 950 years ago (Schroedl 1973:25-32).

The Tucannon River is one of the shorter streams draining the Blue Mountains. However, while spawning beds in the Tucannon basin may have been fewer than those in the Grande Ronde basin, the fish were probably fatter on arrival. We suspect the prehistoric aboriginal fishery within the study area may have been more robust than suggested by historic data (Parkhurst 1950:5-9).

Toolstones

Our focus here is on workshop dynamics within the context of a delimited toolstone terrane. The bulk of our sample consists of a single toolstone, a local outcrop of basaltic andesite. However, the lithic raw materials recovered at Pataha Canyon also include several chromatically distinguishable cherts, chalcedonies, and jaspers, obsidians, and a few rhyolite specimens.

Cherts, Chalcedonies, and Jaspers. The only reported outcrop of upland chert in either the Tucannon basin or Garfield County is located in Section 15, Township 9 North, Range 41 East, at an elevation of 1,097 m. This is about 5.5 km southwest of the Pataha Canyon workshop. An accompanying map suggests an outcrop area of about 200 ha (Hunting 1942:8). The same area has been mapped by Baldwin (1989:102) as the “Big Four Lakes Outcrop,” and described as follows:

...several beds of massive and laminated black and gray chert and massive black argillite about 25 feet thick interbedded with greenstones of about the same thickness. These are overlain by several hundred feet of black and gray cherts, black and olive argillites, and light colored argillites and cherts. In all more than 1,000 feet stratigraphic thickness of cherty argillites have been exposed...The rocks collectively called cherty argillites comprise metamorphosed argillaceous sediments, pure cherts, and all gradations between the two...The cherts range from olive-green to gray and through gray to black, the latter being the most common color. They are very brittle and break with a subconchoidal fracture. They are very dense and are extremely fine-and even-grained and show no signs of organic remains (Hunting 1942:11-13).

Hunting correlated the Big Four Lakes Outcrop as an exposure of what is now referred to as the Elkhorn Ridge Argillite Formation. The outcrop is a potential source for alluvial chert gravels injected into the Snake River by way of the Tucannon (Reid 1997). We hypothesize that most of the chert tools and flakes at Pataha Canyon have their origin in gravel sources to the north.

Obsidians. Obsidian flakes from Pataha Canyon are small and few. Only 57 were recovered in the sample described below. Two flakes from the 1994 excavations were chemically sourced to Dooley Mountain in the lower Burnt River basin, and Whitewater Ridge in the upper Silvies basin (Lucas 1997)(Figure 9-2). Southern sources can probably be assumed for the remainder of the sample. Obsidian is significant in the Pataha Canyon locality chiefly as a measure of mobility and social interaction.

Fine-grained volcanics. Unlike the colorful and often lustrous cherts, chalcedonies, opals, agates, jaspers, and obsidians of the region, the Pataha Canyon toolstone offers little to enchant the rockhound or lithic connoisseur. Gray, grainy, and grubby to the eye, it is difficult for today's knappers to work, and occurs in smallish nodules. Worse yet, it is both widely distributed and chemically too uniform to distinguish from one outcrop to another. Geochemically, the Pataha

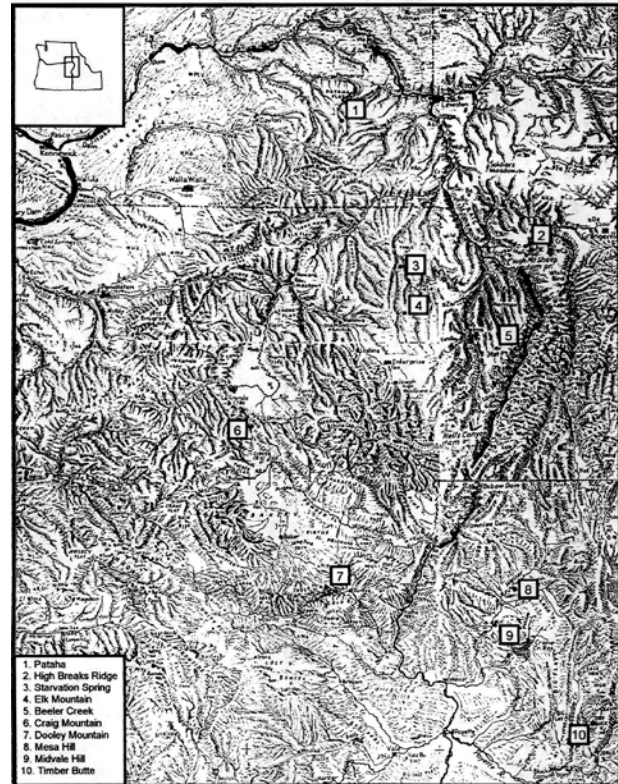


Figure 9-2. Location of major fine-grained volcanic and obsidian toolstones in the Blue Mountains.

Canyon toolstone is a basaltic andesite (Bakewell 1998). Geologically, it assigns to one of the north-trending sheet flows of the Grande Ronde Basalt Formation that forms the northern rim of the Blue Mountains. This formation makes up 85% by volume of the Columbia River Basalt Group. Unit N₂ of the Grande Ronde Basalt underlies the Pataha subbasin, and is locally exposed in deeply incised headwater canyons. The Pataha Canyon workshop is one of many workshops and lithic scatters recorded in similar settings on the Umatilla National Forest (Burney 1985), including nearby Teal Spring and Kelly Camp (Flenniken et al. 1991a, b). All of these workshops map to outcrops of the same Grande Ronde Basalt Formation. Geochemically, they are probably the same basaltic andesite.

More distant basaltic andesite workshops in exposures of the Grande Ronde Basalt Formation occur at High Breaks Ridge (Dickerson 1998), Starvation Spring (Jaehnig 1992), Elk Mountain (Nisbet and Drake 1992); and Midvale Hill (Bucy 1974). Geochemical homogeneity characterizes all

of these widely separated sources (Dickerson 1998; Bakewell 2004). For purposes of sourcing, this is a significant problem, because the Grande Ronde is the most areally extensive of the four units that make up the Columbia River Basalt Group. However, basaltic andesites have been geochemically distinguished from the more siliceous andesites and dacites of the Saddle Mountain Basalt Formation. A cluster of workshops around Craig Mountain shows that these high silica toolstones began to be exploited by at least 10,000 years ago.

The Grande Ronde Basalt Formation is the most extensive of the four Miocene basalt formations that make up the Columbia River Basalt Group. It includes four members with at least 120 separate flows that erupted between 17 and 15.6 million years ago. They extend over an area of nearly 12,000 km² in the Tri-State Uplands. Viewed regionally, the Columbia River Basalt Group comprises a coherent series of chemically related rock formations, and toolstone-quality outcrops within these flows can be modeled as a toolstone terrane (Elston 1990).

Table 9-1. Comparative Fracture Toughness Values¹ for Regional Fine Grained Volcanics Compared to Obsidians and Unheated and Heated Chert, Flint, Agate, and Jasper (data from Domanski and Webb 1992, 1998).

Obsidian	FGV	'Chert' unheated	'Chert' 300°C	'Chert' 400°C
24.01 ^a	73.50 ¹	48.54 (chert)	49.13	36.75
26.30 ^a	70.86 ²	65.85 (flint)	38.84	37.12
27.42 ^a	55.67 ³	51.52 (flint)	37.31	34.88
25.82 ^b	77.16 ⁴	81.96 (agate)	64.92	31.72
	89.51 ⁵	72.41 (jasper)	56.04	47.41

¹ Cylinders approximately 22 mm in length and 15 mm in diameter were mechanically impacted by forces ranging between 21-56 lbs, yielding fracture toughness values expressed as megapascals (MPa.mm^{0.5}).^a Papua New Guinea; ^b Glass Butte, Oregon; ^{1,2} Midvale Hill basaltic andesite; ³ Stockhoff dacite; ^{4,5} Pataha Canyon basaltic andesite

An unanticipated finding of this study is that properties other than silica content or source-sensitive trace elements may usefully distinguish otherwise nondescript basaltic andesites. Fracture toughness testing on sample cylinders shows that this property varies in ways that can be measured and compared. Thus, the Pataha Canyon toolstone is measurably tougher than the basaltic andesite from Midvale Hill (Table 9-1), and both are much harder to work than the andesites and dacites from Craig Mountain. We speculate that FGV toolstones with low fracture toughness (Craig Mountain) came

into use first, and that the tougher basaltic andesites (Pataha Canyon) became part of the regional toolstone suite later in time, as population density increased and territories contracted and stabilized.

Cultural Background

Ethnographic Setting

Pataha Canyon is remote but not isolated. The study area lies near the intersection of two major aboriginal travel corridors. One route ran from Wallula near the confluence of the Snake and Columbia rivers eastward to the Lewiston basin and Clearwater-Snake confluence, approximately following the present course of U.S. Highway 12. The Lewis and Clark expedition used this trail on their return journey to avoid the rapids and portages of the "Big Bend" of the lower Snake. For the Nez Perce, Umatilla, and Cayuse, the corridor linked the buffalo plains of Montana with the great Southern Plateau trade mart at The Dalles (Reid and Root 1998).

A second route ran north to south from the westernmost village near Almota to summer camps at Pomeroy and Dayton, thence south across the Grande Ronde basin to the Wallowa River (Chalfant 1974:117-118). This route brought the lower Nez Perce into shared summer fishing camps with parties of Umatillas, Cayuses, Walla Wallas, and sometimes even Paiutes. These multiethnic summer fishing camps suggest a mechanism for the exchange and northward distribution of Southern Plateau toolstones such as obsidians and Craig Mountain dacite.

During the first half of the 19th century, the study area was exploited by several bands of the lower Snake River Nez Perce, some of them intermixed with the Palouse. Two seasonal camps and two villages occurred in the vicinity of the study area (Schwede 1970). "Pataha" was mapped as a camp at the present site of Pomeroy. Another unnamed camp was shown on the west side of the Tucannon River 7.7 km above Marengo. A village was shown on the east side of the Tucannon opposite Marengo, and a second village was plotted 3.2 km above the mouth of Pataha Creek on the east side of the Tucannon. The latter was named *Tookeeloot'poo*; according to Nez Perce elder Elmer Paul, this was the band that lived at the mouth of Tucannon River (Chance et al. 1987:130).

Nez Perce settlement and subsistence rhythms illustrate Binford's (1980) "logistically organized collector" land use pattern. Field camps were used to bulk process seasonally abundant resources for winter stores at nearby residential bases. Toolstone acquisition was often embedded in the subsistence round. We hypothesize that the Pataha Canyon site functioned as a hunting and fishing camp and toolstone source for logistically organized collectors who wintered along the lower Tucannon or Snake. The site lies on a probable spawning stream for steelhead and spring/summer chinook, and along a travel corridor that leads from the Snake-Tucannon confluence into the Blue Mountains. It is well situated as a hunting hub and could have served as a way station for people moving up into the Blue Mountains from the lower Tucannon or Asotin Creek basins.

Prehistoric Setting

The Blue Mountains have attracted the attention of archaeologists working along the lower Snake River for more than half a century. Upland resources figure prominently in various culture historical, cultural ecological, and processual models for the region.

Rigsby (1965) postulated a Chinookan advance up the lower Columbia River within the last 2500 years. This migration forced resident Sahaptin groups upstream along the lower Snake River, and displaced the Waiilatpu (Cayuse) into headwater hinterlands in late prehistory. Rigsby also postulated the divergence of a Proto-Sahaptian speech community into western Sahaptin and eastern Nez Perce between 3000 – 2500 years ago, with a further divergence between upper (*numipu*) and lower (*nimipu*) Nez Perce speech communities by A.D. 1800.

Brauner (1976) saw the Blue Mountains as an interaction zone between Great Basin and Southern Plateau populations during the Neoglacial, between about 4,000 and 2,500 years ago. His model postulated a mix of environmental collapse and population interaction at the regional scale at the onset of the Neoglacial. A "surge in effective precipitation" at 4000 B.P. incised channels and washed large volumes of formerly stable Mazama ash into the Snake River and its tributaries, destroying the anadromous fishery (Brauner 1976:307). Hungry fishermen tuned to the Blue

Mountains for game. Here they met hunters entering the uplands from the south, and soon the shapes and notch orientations of their projectile points took on a Great Basin appearance.

Brauner's climatic forcing function was criticized by Lyman (1980), who noted healthy shellfish populations continued to flourish in the Snake River after 4000 B.P. Since the mussels require salmon hosts for a part of their life cycle, he concluded that anadromous fish probably also survived. A later revision of Brauner's argument pushed the timing of the disastrous wet interval back by about 1,500 years (Lucas 2000:50).

A recent processual model linking sedentism, demography, storage technology, and climatic cooling (Chatters 1995) draws on several archaeological and paleoenvironmental studies from the lower Snake basin. Chatters sees two discrete episodes of winter sedentism. The first, "Pithouse I" (4400–3800 B.P.), involved housepit clusters occupied by small groups and sustained by large river bottom site catchments. The second, "Pithouse II" (3500–2200 B.P.), involved a smaller number of winter settlements supported by constellations of distant field camps, often located in the forested uplands. Pithouse II "...indicates a logistically organized, delayed-return strategy that was beginning to resemble the ethnographic pattern" (Chatters 1995:349). The latter was clearly recognizable throughout the Southern Plateau by two thousand years ago. The later occupations at the Pataha Canyon workshop may have a logistical relationship to winter villages recorded near the mouth of the Tucannon River.

There is probably nothing exceptional about the Pataha Canyon workshop described here. Lithic scatters at several upland springs on the Pomeroy Ranger District have been tested or mitigated by data recovery excavations (Burney 1985; Berryman 1987; Flenniken et al. 1991a, b). The ages of most of these sites have been approximated through projectile points. A hearth at Warner Spring provided a radiocarbon age of 820 ± 70 B.P. on wood charcoal (Berryman 1987:71). Mazama tephra layers have been used to estimate the age of some levels, but it is not always clear whether the ash is considered to be a primary airfall or redeposited layer. Obsidian hydration dating has been handicapped by small samples and uncertainties about regional hydration rates (Flenniken et al. 1991b:80).

In a summary of the Washington section of the Umatilla National Forest, the Forest Archaeologist commented on the numerous “basalt” lithic scatters. The larger sites were tentatively identified as quarries, though “the source of the basalt material has not been identified” (Fulgham 1989:8). Interpretations of site function usually relied on landscape position and the nature of the chipped stone tools to argue for seasonal hunting and gathering camps. Several investigators have commented on the local availability of “fine grained basalt” and noted a local emphasis on early reduction stage sequences and biface preform production.

Field Investigations

The site was first recorded as a precontact, multicomponent, seasonal camp with an area of 7,600 m². The site underlies a developed recreation area and camp called Pataha Campground. Developments include road turnouts, picnic tables, fire rings, camping surfaces for tents or trailers, and a privy.

Test excavation first took place in 1994 to evaluate the damage from campground development. In 1996, a second round of testing occurred in the northern area because heavy spring rains surging out of Iron Springs Canyon flooded the area, causing extensive gulying. That flood also damaged a road in the north end of the site. Planned road repairs would further compromise the integrity of cultural deposits. Therefore, our excavations in 1997 focused on this area. The 1994 testing was limited to the North Area and included six 50-x-50-cm units and five 1-x-1-m units (Figure 9-3) with a total volume of 4.25 m³. Three of the units formed a 1-x-3-m trench (Busskohl 1997). Artifacts from that trench are the only ones analyzed and reported here from the 1994 testing.

In February 1996, another episode of flash flooding exposed many artifacts and it was clear that the site warranted further attention. Sixteen 50-x-50-cm and two 1-x-1-m units with a volume of 4 m³ were placed in the South Area (Figure 9-3). The recovered sample included 1,861 pieces of debitage and 13 stone tools (Lucas 1997). We do not include the 1996 debitage sample in this analysis.

Projectile points from the 1994 and 1996 investigations frame a sequence that includes a Cascade phase occupation predating 5500 ¹⁴C B.P.

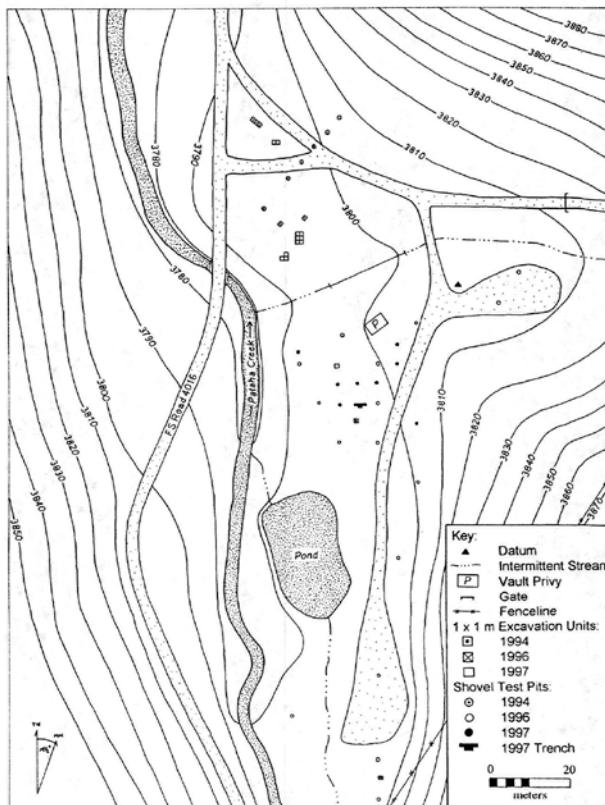


Figure 9-3. Location of the Pataha Canyon excavation units.

and a Harder phase occupation postdating 2500 ¹⁴C B.P. An apparent lack of occupation was noted during the Tucannon phase, from 5500–2500 ¹⁴C B.P. The occupational gap may be related to repeated overbank flooding and alluvial fan aggradation during the cool, moist Neoglacial between 4200–2500 ¹⁴C B.P. when dynamic and unpredictable conditions made the site unsuitable for camping (Lucas 1997:11-12).

Lucas (1997) hypothesized that the site served as a basalt procurement locus during both the early and late occupations when knappers produced large numbers of bifacial preforms. He also noted that chert was more common in the later occupations. Plant processing was evidenced by a pestle recovered in 1996 and another in a private collection. Numerous thinning and resharpening flakes from small chert bifaces suggested a hunting field camp for exploitation of the nearby uplands.

Our 1997 fieldwork was guided by four research problems that emerged from the site testing. As summarized by Lucas (1997), these include (1) determining the depositional history of the site, including the alluvial fan in the North Area and the

alluvial terrace in the South Area; (2) the sequence and chronology of occupations from radiocarbon dates, tephtras, buried soils, and projectile point seriation; (3) changes through time in lithic technology, including use of different toolstones and comparative analyses of successive reduction sequences; and (4) the regional site context, including its relation to ethnographic winter villages along the Snake River and ethnographic travel routes.

Field Methods

We first partitioned the site into north and south areas. Our tests in the North Area included a 3-x-2-m block, a 1-x-3 m right-angled unit, and a 1-x-2-m deep test unit. In the South Area, 1997 tests included two 1-x-1-m units on the sloping terrace above Pataha Creek. In addition, we excavated eight 50-x-50-cm shovel tests, which were dug in 10 cm levels. We placed two of these on the west side of the southernmost 1-x-1-m unit and placed two on the east side of the unit to form two 1-x-0.5-m extensions, thereby creating a 3 m profile exposure.

Similar recovery techniques were followed during all three field seasons. We dry-screened all sediment through 8-per-inch mesh and field sorted natural clasts from artifacts. One wall of each 1-x-1-m unit was profiled, stratigraphically described, and photographed. Features were drawn and photographed in plan and profile. Charred wood and bulk sediment samples were taken for radiocarbon dating, and volcanic tephra samples were taken for microprobe analysis.

Stratigraphy

The Pataha Campground site is mapped within the Tolo silt loam, which formed under mixed conifer forests in volcanic tephra and eolian silt. The modern solum is underlain by an older, buried soil (Raver 1974:25-26).

Excavations in the North Area exposed three depositional units. The profile from the 3-x-2-m block is shown in Figure 9-4. Depositional Unit 1 is 12–26 cm thick and consists of very dark brown (10YR2/2) gravelly silt loam with matrix-supported angular to subrounded gravel and an abrupt and wavy boundary. There is extreme turbation from animal burrowing with many krotovinas.

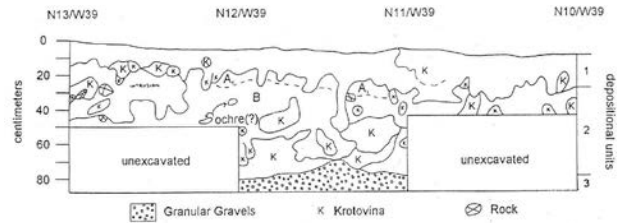


Figure 9-4. Stratigraphic profile, North Area.

Depositional Unit 2 is 19 cm thick, consisting of gravelly sandy loam with angular matrix-supported gravels and an abrupt boundary broken by many krotovina. Depositional Unit 3 is gravelly silt loam with poorly sorted clast-supported gravel. We did not reach the lower boundary and the thickness of the unit is unknown.

Depositional Unit 2 contains a truncated A-Bw solum, suggesting that black sediment in Depositional Unit 1 consists of redeposited, bioturbated A horizon sediment. The truncated A horizon is very dark brown (7.5YR 2.5/3) gravelly sandy loam with a weak fine granular structure. The Bw horizon is a brown (7.5YR 4/3) gravelly sandy loam with a weak fine subangular blocky structure.

The South Area is disturbed with the intact layers in Depositional Unit 3 beginning 35 cm below surface (Figure 9-5). The upper three levels display considerable churning from animal burrowing and possible plowing. Vertical displacement of artifacts is evident as deep as Depositional Unit 5 at 80 cm below surface. Here a glass fragment and .22 cartridge were probably introduced by burrowing animals. Depositional Unit 4 consisted of mixed and pure volcanic tephra. Microprobe analysis of glass chemistry identified it as originating in the climactic Mazama eruption at 6850 ¹⁴C B.P. (Foit 1998). However, the mixed nature of the ash together with the landform position suggest that it is not a primary airfall deposit.

A study of volcanic ash in the Blue Mountains of eastern Oregon concluded that reworked Mazama deposits have been stable since 5300 ± 130 ¹⁴C B.P. (Rai 1971:87-88). Down slope movement of Mazama tephra ended at the Stockhoff site in the upper Grande Ronde basin by 5750 ± 340 ¹⁴C B.P. (Cochran and Leonhardy 1981:16). Deposition rates calculated for Craddock Meadow on the Silvies Plateau show that the major reworking of Mazama ash ended there by 5300 ¹⁴C

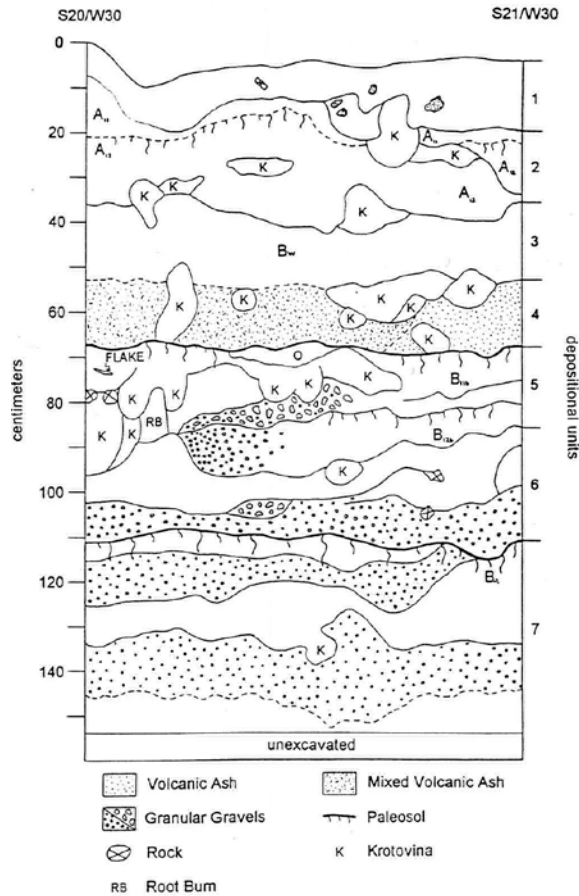


Figure 9-5. Stratigraphic profile, South Area.

B.P. (Wigand 1989:74). We therefore interpret the tephra deposits in Depositional Unit 4 to date to about 5300 ¹⁴C B.P. The tephra rests on a weakly developed 2Bwb horizon. The gravelly texture of the deposits in the Bw horizon suggests that they accumulated relatively quickly with a period of soil formation before the deposition of the reworked Mazama tephra. A second weakly developed buried soil is the contact with Depositional Unit 6 and Depositional Unit 7. This is a 3Btb horizon with a moderate subangular blocky structure. The formation of this argillic horizon indicates a period of landscape stability and a pause in the prevalently active slope conditions that formed the south part of the site. We ceased excavations at 1.55 m, without reaching basal stream gravels or bedrock.

Features

One basin-shaped hearth was completely exposed in plan and section in the block in the North Area. A second precontact hearth probably coincided

with the dense scatter of fire-cracked rock and charred branchwood exposed at the same level in the same block. Vitriified clinkers, chunks of heavily oxidized sediment, and historic artifacts such as cartridges and cut nails from the same context led to the field decision not to give this debris a feature number. However, three radiocarbon dates on charred branchwood are pre-contact in age.

Laboratory Investigations

Analytic Procedures

A detailed summary of the theoretical assumptions, analytic methods, and coding procedures for the lithic artifacts is found in Root and Reid (1998; see also Root 2004; Root et al. 2000). We submitted three radiocarbon samples from Analytic Unit 1 in the North Area to Beta Analytic, Inc., for conventional dating. We submitted a volcanic tephra sample to the Geoanalytical Laboratory at Washington State University. As noted, results indicate a probable source in the climactic Mazama eruption at 6850 ¹⁴C B.P. (Foit 1998). We collected samples of the local basaltic toolstone from the site vicinity and submitted them for petrographic and geochemical analyses (Bakewell 1998). Finally, we submitted samples of the same toolstone to LaTrobe University in Bundoora, Australia, for fracture toughness testing (Domanski and Webb 1998). Fracture toughness comparisons were made with samples of basaltic andesite toolstone submitted from the Midvale Hill workshops in the Weiser basin, and high silica andesite or dacite from the Craig Mountain workshops in the upper Grande Ronde basin.

Radiocarbon Dates

Three radiocarbon samples were submitted from the block in the North Area (Table 9-2) for conventional dating. In addition, two small charcoal samples from within the hearth fill of Feature 1 were collected. The charred branchwood samples and the hearth samples all came from approximately the same elevation and imply that little sediment accumulated in the vicinity of the block between about 2500 and 400 ¹⁴C B.P.

Two discrete occupations of artifacts and hearth debris may be mixed in Analytic Unit 1. Thus, the

Table 9-2. Radiocarbon Dates from the Pataha Canyon Site.

Sample ID	Provenience	Uncorrected Radiocarbon Age
12C	N11.41-49/W40.78-86:29-33 cm below surface	340 ± 40 ¹⁴ C B.P. (Beta 116,421)
12E	N11.67-70/W40.60-72:28 cm below surface	540 ± 60 ¹⁴ C B.P. (Beta 113,824)
Z	N10.25-36/W39.51-70:25.5 cm below surface	2470 ± 60 ¹⁴ C B.P. (Beta 113,823)

three radiocarbon dates mark an early event at about 2500 ¹⁴C B.P., and a later event at about 400 ¹⁴C B.P. Either of these ages could be assigned to the hearth basin designated Feature 1. Two charcoal samples taken from the basin fill were both too small to date by conventional means, but each has sufficient carbon for an AMS date. Another possibility is that all three of the radiocarbon dates record natural forest fires rather than cultural hearth debris. However, the samples cluster near the only recognizable hearth basin, and in the same area where fire-cracked rock is most abundant. Charred wood fragments large enough for conventional radiocarbon dating were not encountered in other units in the North Area. A wider spatial distribution of charred wood, perhaps accompanied by burn lines and evidence for intense mottling and oxidation, might be expected if the site had been swept by a natural conflagration (Connor et al. 1989). Finally, the artifacts from the 20–30 cm level do not display notable thermal damage by comparison with other levels. For these reasons, we accept the three radiocarbon ages as cultural. However, they reflect only a few of many site occupations that probably occurred in the last 2,500 years.

Projectile Points as Phase Markers

The point types in the collection fit well into the Leonhardy and Rice (1970) sequence for the lower Snake basin (Figure 9-6). Cascade, Tucannon, and Harder phases are represented, a time range that extends from at least 5000 to 2000 radiocarbon years ago (Table 9-3). The points are distributed in approximate time sequence with depth. Thus, the two lanceolate Cascade points and the Cold Springs Side-Notched basal fragment are typologically early points recovered from the 50-60 cm level. One corner-removed Alpowa type typical of the Tucannon phase was recovered from 50-60 cm, while a second Alpowa point came from 0-10 cm.

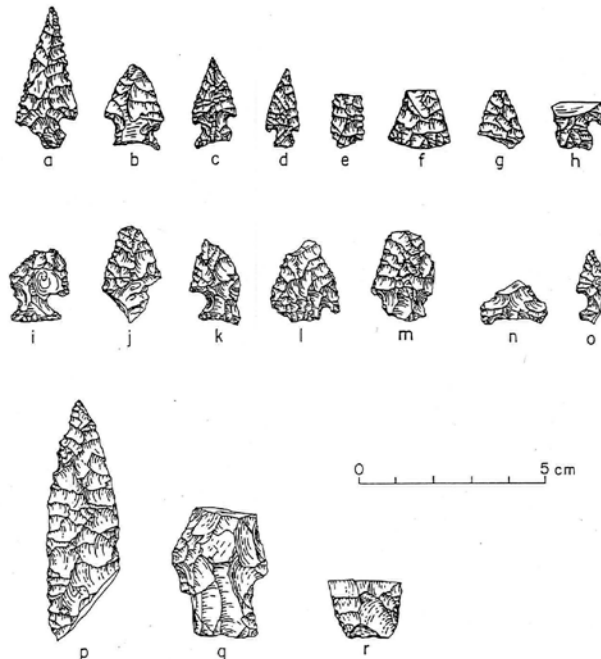


Figure 9-6. Projectile points recovered from Pataha Canyon: (a, d) Columbia Stemmed; (b, c, h, k, o) Columbia Corner-notched B; (i, m) Columbia Corner-notched A; (l) Snake River Basal-notched; (e) Wallula Rectangular-stemmed; (n) Cold Springs Side-notched; (p, r) Cascade; (q) Stemmed dart point; (f) arrow point preform; (g) arrow point fragment; (j) dart point fragment.

Table 9-3. Phases and Age Ranges for Pataha Campground Projectile Points.

Point Type	Phase Marker	Age Range (¹⁴ C B.P.)
Columbia Corner Notched B	Harder/Piquinin	2000 – 150
Columbia Stemmed A	Harder/Piquinin	2000 – 150
Columbia Stemmed B	Harder/Piquinin	2000 – 150
Wallula Rectangular Stemmed	Harder/Piquinin	2000 – 150
Quilomene Bar Basal Notched	Harder	2500 – 1500
Columbia Corner Notched A	Harder	2500 – 1500
Alpowa Type 01-02A	Tucannon	4000 – 2000
Rabbit Island Stemmed A	-	4000 – 2000
Nespelem Bar	-	5000 – 3000
Mankin Shouldered	-	8000 – 3500
Cold Springs Side Notched	Cascade	7000 – 4000
Cascade C	Cascade	8000 – 4000
Cascade B	Cascade	8500 – 6500

The base of what may be a lanceolate or large stemmed point came from the 40-50 cm level. Clearly, bioturbation has mixed deposits. Point types listed in Table 9-3 were defined after consulting three references: the Leonhardy and Rice (1970) cultural chronology for the lower Snake River, Lohse's (1995) review and

comparison of point chronologies for the Intermountain West, and Brauner's (1976) data recovery project at Alpowa in the Lewiston Basin. The age range of 4000 – 2000 ¹⁴C B.P cited by Lohse (1995: 9) for Columbia Corner Notched A has been reduced here to 2500–1500 ¹⁴C B.P, which better accords with the lower Snake sequence. Finally, Brauner's Apowa Type 01-02A is so similar to examples of Rabbit Island Stemmed A, Nespelem Bar, and Mankin Shouldered, that we have listed them all. A reasonable guess is that our sample postdates or overlaps the late Cascade phase, and predates the early Harder phase.

The projectile points fall into early and late groups. The corner-notched dart and arrow points all cluster in the upper 30 cm, with most of them in the upper 20 cm. These forms are typical of the Harder phase. The corner-notched arrow points are also common in the Piquin phase. There was no stratigraphic separation between corner-notched dart and corner-notched arrow points. This group is late Holocene in age and assigned to Analytic Unit 1. The early group of lanceolate, side-notched and stemmed dart points is late middle Holocene in age and assigned to Analytical Unit 2. No projectile points were recovered from Analytic Units 3 and 4.

Analytic Units

We defined four analytic units (AU) for the 1997 excavations based on depositional units, buried soil horizons, density modes in lithic debris, time-sensitive artifacts, and radiocarbon dates. We incorporated the 1994 and 1996 excavations into this framework using field notes, stratigraphic profiles, photographs, and unit depths.

Analytic Unit 1 is late Holocene. Projectile points and radiocarbon dates indicate it dates to the Harder and Piquin phases, or the last 2,500 radiocarbon years. Analytic Unit 2 dated to the end of the middle Holocene and the beginning of the late Holocene. Projectile points and stratigraphy link this unit to the late Cascade-Tucannon phase interval, or from about 5,300 to 3,000 radiocarbon years ago. All of the 1994 and 1996 collections were assigned to AU1 and AU2. Most of the 1997 collection is also assigned to AU1 and AU2, but deeper deposits in the South Area are assigned to Analytic Units 3 and 4. These are stratigraphically dated to before 5,300 radiocarbon years ago, with AU4 somewhat older than AU3. No diagnostic

projectile points or radiocarbon dates were associated with AU3 or AU4. The relatively coarse nature of most of the sediments below the redeposited Mazama tephra suggests they accumulated fairly rapidly. We suspect AU3 and AU4 are middle Holocene in age, younger than the climactic Mazama eruption at 6,845 ¹⁴C B.P. The landscape stability implied by the development of the 3Btb horizon, however, opens the possibility of an earlier, perhaps early Holocene, age.

Lithic Analysis

Our goal here is to explore changing rates of biface production output at one of the many basaltic andesite workshops recorded in the Grande Ronde Basalt Formation. The morphological and functional analysis of the stone tools from Pataha Canyon is summarized elsewhere (Reid and Root 1998).

We first conducted a set of reduction experiments to evaluate the basaltic andesite toolstone, and to establish experimental expectations with respect to flake types and reduction staging debris. These experiments provide an empirical model with which to interpret the archaeological flake debris. We analyzed stone tools and cores according to morphology, raw material, and production technology. We then compared the experimental and archaeological data to arrive at estimates of workshop tool production output over time. Our experiments provided empirical grounding for interpretations of the reduction technologies at Pataha Canyon. They were not exercises in "ego-graphic analogy" intended to prove that we can do what they did. In fact, we found that we couldn't do some of the things they did. However, the results provide a basis for estimating the amount of tool production and changing rates of production over time (e.g., Root 1992, 1997).

Reduction Experiments

The local pebbles and small cobbles of basaltic andesite are at best a moderate-quality toolstone. Controlled fracture in tough toolstone was considerably more difficult than with more siliceous andesites and dacites such as those from the Craig Mountain region in the Grande Ronde headwaters. This very toughness, however, may

have been desirable in shaping bone or woodworking tools, or for butchering large game. Once knappers fashioned the Pataha toolstone into flake or bifacial tools, the sharp edges were probably durable.

We collected large pebbles and small cobbles from the site along with several cobbles from further up Pataha Canyon. However, we were unable to replicate the maximum size of the archaeological bifaces with the small cobbles we collected. Therefore, we also used one large flake blank from a large prepared core of andesite from Craig Mountain. Experiments included the replication of core and biface reduction technologies represented at the site. Matthew Root and Daryl Ferguson were the knappers.

Experimental replications provide empirical links between flake classes and lithic technologies. Designing experiments to interpret archaeological collections employs basic tenets of replicative systems analysis (Flenniken 1981). An advantage of such an experimental approach is that it allows us to examine *rates* of change over time, rather than merely quantifying changing *amounts* of workshop discards that resulted from knapping errors (Watson et al. 1984:159). We will return to this point in our conclusions.

The first experiment reduced six unprepared cores from small cobbles to produce flake blanks suitable for utilized or retouched flake tools. The second experiment reduced two prepared cores. We trimmed, beveled, and ground the platforms and shaped the core face to guide the removal of large blanks. In the third and fourth experiments, we shaped bifacial blanks from the flake blanks produced in prepared core reduction. We divided biface manufacture into two parts: (1) initial bifacial edging and shaping, and (2) percussion bifacial thinning. The flake blanks of Pataha Canyon basaltic andesite, however, were smaller than the largest bifacial blanks recovered from the site. Our experiments only replicated the middle part of the size range of the archaeological bifaces. We also made one biface from a 123-mm long flake blank of dacite. From this blank we produced a thinned biface 108 mm long and 38 mm wide, approximating the size of the larger archaeological bifaces. Skill levels evident in the Pataha bifaces, however, are higher than we were able to achieve.

The analytical methods and flake class definitions are detailed in Root and Reid

(1998:Appendix A); Root et al. (2000); and Root (2004). All debris was size graded through four nested screens with openings of 25.4 mm, 12.7 mm, 6.35 mm, and 2.54 mm and then sorted into the raw material types. We then recorded technological flake class (defined in Table 9-4), cortex, heat-treatment, and the presence or absence of a detachment flake scar. Detachment flake scars are the ventral surfaces of flake blanks (Flenniken et al. 1991:105).

Table 9-4. Definitions of Flake Technological Classes.

Flake Class	Summary Definition
Primary decortication Shatter	Entire dorsal surface is covered with cortex. Cubical and irregularly shaped chunks that lack bulbs of percussion, systematic alignment of fracture scars on the various faces, striking platforms, or points of flake initiation.
Percussion bifacial thinning flakes	Flakes with bending initiations and a narrow and faceted striking platform without cortex, thin, curved longitudinal sections; extremely acute lateral and distal edge angles; at least three dorsal flake scars that originate from varying directions, 20% or less cortex on the exterior surface, and an expanding shape in plan-view.
Late-stage biface shaping (pressure) flakes	Small, thin flakes (<12.7 mm, size-grades 3, 4) with multifaceted and ground platforms, multiple scars on dorsal surfaces, are curved in long section, dog-legged or petaloid in plan-view.
Notching flakes	Flakes are circular in plan with a concave or lunate platform. In profile with the platform facing the observer and the dorsal surface upward, they have a gull-wing appearance.
Alternate flakes	Flakes are thick in relation to their length and width, are triangular in cross section, have a squared edge adjacent to the platform, have single faceted platforms, and a skewed orientation in relation to the axis of percussion.
Bipolar	Flakes with wedging initiations, shattered or pointed platforms with little or no surface area, and pronounced compression rings.
Blades and microblades	Flakes with parallel or subparallel lateral margins, dorsal arrises that are parallel or subparallel with the lateral margins, and at least two flake removal scars evident on the dorsal surface.
Uniface modification flakes	Flakes have feather terminations, single-faceted noncortical platforms; parallel to expanding lateral flake margins, a slight curve at the distal end in long section.
Simple flakes	Flakes with two or fewer dorsal flake scars that do not meet any of the above definitions.
Complex flakes	Flakes with three or more dorsal flake scars that do not meet any of the above definitions.
Undiagnostic, <6.35 mm	Size-grade 4 flakes that do not fit the definitions of biface shaping, notching, microblade, or uniface modification flakes (other flake classes are not coded for G4 flakes).

Results of Experiments

Primary decortication flakes and shatter were produced only in core reduction experiments. Only one alternate flake was produced in experiments, probably because we used rounded cobbles, not tabular pieces. Biface thinning and shaping flakes were experimentally produced only during biface manufacture with larger proportions of these flakes produced in bifacial thinning than in bifacial edging. Biface shaping/pressure flakes are usually associated with the later stages of bifacial production, such as final pressure flaking. We produced a few of these flakes during bifacial edging and thinning because we used pressure flaking to prepare platforms.

Complex and simple flakes (see Table 9-4) were produced in all technologies, but in different proportions. Simple flakes are much more common in core reduction than in biface reduction. There are slightly smaller proportions of complex flakes in the biface reduction experiments than core reduction because of the large proportion of bifacial thinning flakes (which by definition have complex surfaces) and undiagnostic flakes <6.35 mm. Thus, the relative proportions of flake technological classes vary between reduction technologies.

The proportion of flakes with cortex within each size grade also varies between technologies. Unprepared core reduction has the largest proportion of cortical debris, followed by prepared core reduction. Bifacial edging and bifacial thinning have little cortex because flake blanks with little or no cortex were used in experiments.

All reduction technologies are dominated by the smallest flakes. This is a mechanical consequence of conchoidal fracture. There are always more small pieces than large pieces. There is a steady progression, however, in the increase in the proportion of the smallest flakes from unprepared core reduction through bifacial thinning.

Though the size distribution of flakes is an important technological variable, it cannot be used in isolation to determine the technological make-up of archaeological debris aggregates. There are two reasons for this caution. First, archaeological flake debris collections consist of complex mixes of many different technologies. Second, the mode of refuse disposal has a major effect on the size distribution of artifacts in archaeological sites. As discussed below, many of the smallest flakes have

probably been removed from archaeological samples due to refuse disposal patterns, site formation processes, or recovery biases. Therefore, analyses of the archaeological collection must control for size biases (Root 2004).

Archaeological Flake Debris

The analyzed archaeological sample consists of 11,480 flakes and shatter, including all debris from 1997 Rainshadow Research excavations and debris from one, 1-by-1-m unit excavated by the U.S. Forest Service in 1994 (unit 40.5N 51.5W). We analyzed the archaeological flake debris according to the same analytic methods used for the experimental debris (see Root and Reid 1998:Appendix A).

Size Biases

Size distributions offer insight into site formation processes and excavation biases. Size is an important technological variable, but it must be combined with other technological data to make accurate inferences about technology (Root 2004). The size distributions of flakes from Pataha Canyon confirm that size biases are present, and must be accounted for in technological analyses.

Most flakes are in the smallest size class (<6.35 mm). Obsidian, chert, and chalcedony consist almost entirely of small flakes (Table 9-5). The basaltic andesite collection contains only 64.7 percent flakes smaller than 6.35 mm, for a ratio of flakes smaller than 6.35 mm (size-grade 4) to those larger than 6.35 mm (size-grades 1-3) of only 1.83:1 (6,956:3,793). The percentage of basaltic andesite flakes smaller than 6.35 mm in the excavated collection is considerably smaller than in any of the experimental replications. The smallest experimental percentage is for unprepared core

Table 9-5. Inventory of Flake Debris by Size and Grouped Raw Material Class, Pataha Canyon Site.

Size Grade	Basaltic Andesite		Obsidian		Chert and Chalcedony		Rhyolite		Total
	n	%	n	%	n	%	n	%	
G1	89	0.8	0	0.0	0	0.0	0	0.0	89
G2	746	6.9	0	0.0	10	1.5	0	0.0	756
G3	2,958	27.5	2	3.5	100	14.9	2	40.0	3,062
G4	6,956	64.7	55	96.5	559	83.6	3	60.0	7,573
Total	10,749	100	57	100	669	100	5	100	11,480

G1: >25.4 mm G2: <25.4 & > 12.7 mm
 G3: <12.7 & > 6.35 mm G4: <6.35 & > 2.54 mm

reduction with 72.9 percent of flakes smaller than 6.35 mm. The archaeological collection contains relatively large proportions of biface thinning and biface shaping flakes. This indicates that biface manufacture was an important activity, and furthermore that the percentage of small flakes should exceed that of unprepared core reduction. Therefore, it is likely that small flakes (<6.35 mm) produced during pre-contact tool manufacture are underrepresented due to biases from geologic mechanisms or refuse disposal patterns. Because the obsidian, chert, and chalcedony flakes are predominantly small, differential removal of some small flakes creates less of a technological bias than in the basaltic andesite flake collection.

Comparable size biases can result from refuse disposal. People usually clean-up work areas, especially on sites with long occupation spans. However, when people clear work areas, small objects are usually left. They are overlooked, too difficult to pick up, or filter down into subsurface sediments. Deposits of secondary refuse (debris removed from its place of production) are skewed toward larger objects. Deposits of primary refuse (debris left where it was produced) include both small and large items. Areas that are cleaned up lack larger items, but smaller debris remains (Schiffer 1987). Sites with short occupation spans, and especially lithic workshops, seem unlikely to experience much secondary refuse disposal. Geologic mechanisms, such as slope wash or site flooding, can also redeposit artifacts. Depending on landscape position, these can either concentrate or remove small artifacts. Given the sheet flooding and gulying parts of the site experienced in 1996, it is likely that small flakes were removed from excavated areas at Pataha Canyon by such processes in the past. This size bias must be taken into consideration in technological analyses. Nevertheless, the chert, chalcedony, and obsidian samples consist primarily of small flakes, suggesting that size biases are not present, or are at least less pronounced, for these materials.

Raw Materials

Fourteen raw material classes were identified (Table 9-6). The most common toolstone is of coarse basaltic andesite, procured either at the site itself or in nearby Iron Springs Canyon or Pataha Canyon. We assume that all of this material was

locally gathered. Fifty-seven obsidian flakes were recovered, and these are certainly nonlocal. Two flakes from 1994 tests are from Dooley Mountain and Whitewater Ridge. In total, 669 flakes of chert or chalcedony were excavated. To study reduction technology and raw material use in detail, we defined 11 types of chert and chalcedony based on color and translucency (Table 9-6). Chert includes opaque, dense, microcrystalline siliceous toolstones. We use the common definition of chalcedony, and include all semitransparent (clear) to highly translucent microcrystalline silicate rocks that are white, gray, brown, or red. We distinguished chert and jasper from chalcedony subjectively based on translucency. Cherts and chalcedonies are often grouped together for analysis (as is also done here). The purpose of separating these materials is to attempt to differentiate toolstones that might have distinct reduction technologies and are probably from different geologic sources. The geologic sources for these material are uncertain, but they likely were procured from interbasalt formations and from nearby river valleys, such as the Tucannan, Snake, and Grande Ronde. Another cherty outcrop 5.5 km southwest of the site includes olive, gray, and black materials. Similarly colored cherts from excavations may be from this local source. The red and green cherts, as well as the chalcedonies may come from more distant sources. The only other raw material identified in the flake collection is rhyolite, represented by only five flakes.

Though it is always the dominant material, the proportion of basaltic andesite debitage decreases through time. Conversely, the proportions of chert, chalcedony, and obsidian steadily increase through time (Table 9-7). The increases in chert and chalcedony include all varieties, both the probable near-local brown, gray, and black varieties, and red, green, and clear varieties that are probably from more distant drainages. The increase in the proportion of obsidian is similar in magnitude to the increase in chert and chalcedony. Though the proportion of basaltic andesite is lowest in the Piqúnin-Harder analytic unit (AU1), the numbers of flakes in the Piqúnin-Harder (AU1) and Tucannon-Late Cascade unit (AU2) are about the same. The number of chert and chalcedony flakes, however, increases by a factor greater than nine, and obsidian increases by a factor of 27. The use of local basaltic andesite did not decrease during the latest

Table 9-6. Chert and Chalcedony Types Listed by Technological Class, Pataha Canyon Site.

Raw Material	Primary		Biface		Biface			Uniface	Other
	Decort.	Shatter	Thinning	Shaping	Alternate	Complex	Simple		
Black chert	0	0	0	15	0	1	0	0	11
Black-orange chert	0	0	0	8	0	1	2	1	7
Clear chalcedony	0	0	0	7	0	4	1	0	15
Gray, brown chert	0	1	2	37	1	9	7	1	49
Green chert	0	0	0	1	0	0	0	0	2
Orange jasper	0	0	0	1	0	0	0	0	2
Red chalcedony	0	2	1	44	1	8	2	0	62
Red jasper	2	5	6	22	0	13	12		43
Red/white	0	2	0	7	0	4	4	0	44
Variegated chert									
Tan, brown Chalcedony	0	0	1	56	0	7	0	1	42
White, pink chert	0	1	0	42		4	0	2	42
Total	2	11	10	240	2	51	28	3	319

Table 9-7. Pataha Canyon, Flake Debris Summary, Raw Materials by Analytic Unit.

Raw Material	Piqúnin, Harder (AU1)		Tucannon, Late Cascade (AU2)		Pre-5600 B.P. (AU3)		Pre-5600 B.P. (AU4)	
	n	%	n	%	n	%	n	%
Andesite	4,661	87.8	4,687	98.6	1,361	98.9	40	100.0
Chert-chalcedony	591	11.1	64	1.3	14	1.0	0	0.0
Obsidian	54	1.0	2	0.1	1	0.1	0	0.0
Rhyolite	5	0.1	0	0.0	0	0.0	0	0.0
Total	5,311	100.0	4,753	100.0	1,376	100.0	40	100.0

occupations. Rather, the use of a transported tool kit increased dramatically late in time. The latest site occupants carried chert, chalcedony, and obsidian tools with them that they repaired and resharpened on the site.

Production Technology

Technological classification of flakes and analogies to the experimental replication provide the basis for inferring production technology. A summary of the technological classification of the 11,480 analyzed flakes is presented by analytic unit in Table 9-8. These data are presented without regard to raw material, which is discussed below. Shatter and primary decortication flakes are diagnostic of core reduction. The proportions of most technological classes are about the same among all analytic units, except for the increase in biface thinning, and especially bifacial pressure flakes during the latest occupations (AU1). These changes are directly related to the increased use of chert, chalcedony, and obsidian late in time. There was little initial manufacture of the non-basaltic tools at Pataha Canyon. Production technologies evident in each analytic unit are discussed below.

Piqúnin, Harder Phase (AU1). The technological classification of flakes for the

Piqúnin-Harder Phase occupations are summarized in Table 9-8. On-site reduction of basaltic andesite included core reduction, biface manufacture, and flake tool manufacture. Primary decortication flakes and shatter occur in proportions similar to those produced by experimental core reduction. Simple and complex flakes occur in roughly equal proportions, suggesting that debris from both core reduction flakes and debris from later stage reduction are present. The presence of cortical alternate flakes suggests that tabular basaltic andesite cobbles were sometimes used for core reduction or flaked directly into bifacial tools. Only two bipolar flakes were recovered. Bipolar flakes are occasionally produced in freehand core reduction (Root 1992, 1997), and these probably reflect errant blows.

The importance of biface manufacture is shown by a high proportion of percussion bifacial thinning flakes. Over three percent of the collection consists of bifacial thinning flakes, about twice the proportion produced during experimental biface manufacture. Skill level is reflected in the proportion of biface thinning flakes, with larger proportions reflecting increased skill (Root 1992). This strengthens our suspicion that our own experiments were conducted at a lower skill level

Table 9-8. Pataha Canyon, Flake Debris Summary, Technological Class by Analytic Unit.

Technological Class	Piqúñin, Harder (AU1)		Tucannon, Late Cascade (AU2)		Pre-5600 B.P. (AU3)		Pre-5600 B.P. (AU4)		Total
	n	%	n	%	n	%	n	%	
Primary Decortication	90	1.7	81	1.7	24	1.7	2	5.0	197
Shatter	72	1.4	32	0.7	14	1.0	0	0.0	118
Biface thinning	157	3.0	114	2.4	27	2.0	4	10.0	302
Bifacial pressure	474	8.9	115	2.4	43	3.1	0	0.0	632
Notching	1	0.01	0	0.0	0	0.0	0	0.0	1
Alternate	42	0.8	32	0.7	8	0.6	0	0.0	82
Bipolar	2	0.03	2	0.04	2	0.1	0	0.0	6
Uniface modification	23	0.4	13	0.3	8	0.6	0	0.0	44
Simple conchoidal	222	4.2	154	3.2	47	3.4	5	12.5	428
Simple, other flakes	522	9.8	493	10.4	110	8.0	10	25.0	1,135
Complex conchoidal	276	5.2	119	2.5	49	3.6	3	7.5	447
Complex, other flakes	538	10.1	475	10.0	110	8.0	6	15.0	1,129
Other size-grade 4	2,892	54.4	3,123	65.7	934	67.9	10	25.0	6,959
Total	5,311	99.9	4,753	100.0	1,376	100.0	40	100.0	11,480

than those of the Pataha knappers, who likely had long practice working the tough material. The proportion of biface shaping flakes is even greater than that of thinning flakes. These are predominately late stage pressure flakes indicating production of tools such as bifacial knives or dart point preforms. The relatively large proportion of biface thinning and shaping flakes indicates that production of bifacial blanks and preforms was the most important reduction activity at the site. A single apparent notching flake may have resulted from production of a serrated blade edge, possibly during resharpening, rather than from notching. There are also 17 uniface modification flakes, which indicate production or resharpening of unifacial flake tools. Their presence indicates production or maintenance of basaltic andesite flake tools at the site. However, neither here nor in the earlier deposits did we recover any of the “unifacial elongates” (Womack 1977:131-137) or “large stylized scrapers” (McPherson et al. 1981:625) that form distinctive subindustries in early Holocene deposits at workshops elsewhere in the region.

The chert, chalcedony and obsidian flake debris contrasts notably with the basaltic andesite debris. The largest single diagnostic category of all these materials is bifacial shaping flakes. These were produced during pressure flaking of thin bifacial tools such as knives and dart points. Most small flakes that are not classified as bifacial pressure flakes are undiagnostic flakes smaller than 6.35 mm. Most of these are probably from pressure flaking, but lack platforms and therefore are classified as undiagnostic. Thus, the dominant reduction technology with these materials was

pressure flaking, probably during resharpening and reworking. The few bifacial thinning flakes are relatively small and may have been produced in later stage manufacture or maintenance. There are six uniface reduction flakes, indicating flake tool modification. There are a few chert primary decortication flakes and shatter, indicating that cobble testing or core reduction did occasionally occur. Both primary decortication flakes and most of the shatter are red chert. This suggests that small cores were part of transported tool kits, or perhaps that a nearby source is present.

Tucannon, Late Cascade Phase (AU2). The technological flake profiles of the Tucannon-Late Cascade occupations are broadly similar to the later occupations (Table 9-8). The major differences are decreases in the proportions of biface thinning and biface shaping flakes, and an increase in the proportion of undiagnostic flakes smaller than 6.35 mm. The total number of basaltic andesite flakes are about the same in both analytic units. The absolute decrease in the number of biface flakes indicates a decreased importance of middle and late stage biface manufacture. Decreasing late stage biface reduction should result in a decrease in the proportion of small flakes (< 6.35 mm). Therefore, the increase in small undiagnostic flakes is unexpected. It may reflect the downward movement of small flakes due to disturbances from burrowing animals. The chert, chalcedony, and obsidian collections from these occupations are also technologically similar to the later occupations. Flakes of these materials were produced almost exclusively from rejuvenation and reworking of bifacial tools and projectile points.

Pre-5600 RCYBP (AU3 and 4). The earliest occupations also display the smallest flake densities, suggesting decreased amounts of basaltic andesite tool production. The overall distribution of basaltic andesite technological classes is essentially the same as in the overlying Tucannon-Late Cascade Phase occupations. The major change is an increase in small undiagnostic flakes. Again, this may reflect the downward movement of small artifacts from postdepositional disturbance. The sample size of Analytic Unit 4 ($n = 40$) is too small to reliably infer the relative importance of reduction activities, but there is no evidence to indicate significant changes from Analytic Unit 3. There are only a few chert and chalcedony flakes, and a single obsidian pressure flake. This small sample indicates infrequent resharpening of tools of these materials. During the earliest occupations, people apparently relied almost exclusively on the local basaltic andesite.

Summary of Flake Debris Analysis

All stages of bifacial tool manufacture are represented in these data. However, the final stages of basaltic andesite projectile point manufacture occurred rarely, if at all, at Pataha Canyon. Several resharpened basaltic andesite tools were recovered, indicating that some late stage debitage resulted from tool maintenance rather than initial manufacture. Primary decortication flakes and shatter of basaltic andesite are common and were produced during core reduction. Though the flake analysis did not distinguish prepared from unprepared core reduction, core analyses indicate both kinds of core were flaked on the site. Stoneworkers reduced flake blanks into percussion-flaked bifacial blanks and then into pressure-flaked bifacial tools. There is no evidence that notched dart or arrow points made of basaltic andesite were finished on the site. Most pressure-flaked basaltic andesite implements were probably bifacial cutting tools. Both replicative and laboratory experiments found that the Pataha basaltic andesite is a tough stone, difficult to shape into pressure-thinned dart or arrow points. The few andesitic projectile points we recovered may well be from more siliceous and tractable fine-grained volcanic sources. The predominance of chert and chalcedony projectile points also suggests that the local basaltic andesite was not selected for point manufacture. Unifacial

modification flakes indicate that people made or resharpened basaltic andesite retouched flake tools at the site. During all occupations, chert, chalcedony, and obsidian flake debris indicate that Pataha occupants brought finished bifacial tools of these materials to the site, where they were resharpened and reworked. This indicates on-site use of tools such as bifacial knives and perhaps the repair of weaponry following hunts.

Biface Stages of Production

At Pataha Canyon, we classified all bifaces according to the stages of production defined by Callahan (1979). Stage 1 tools are flake blanks or tested tabular cobbles; stage 2, bifacial edging (Figure 9-7a, b, f); stage 3, initial thinning (Figure 9-7c, d, e); stage 4 secondary thinning; and stage 5, final shaping and edge alignment by pressure flaking. Flenniken and others (1991) have documented the staged production of basaltic tools at the Teal Spring site. Their work provides a comparative contrast to Pataha Canyon. Thus, at Teal Spring flake blanks were produced elsewhere and imported to the site. The flakes were then reduced into bifacial blanks suitable for manufacture into dart points or bifacial implements. A few blanks were made into point preforms, but most were exported from the site for use elsewhere.

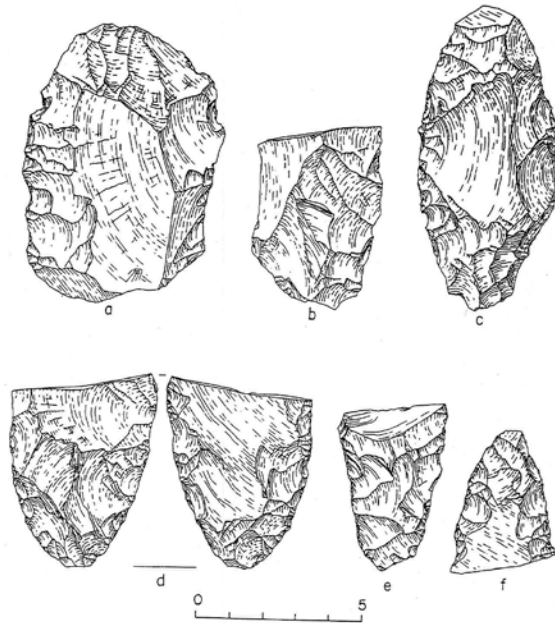


Figure 9-7. Pataha Canyon bifaces:
(a, b, f) Stage 2 bifacial tool blank;
(c, d, e) Stage 3 bifacial blanks.

Core Technology

We classified cores by technological types. As with other aspects of tool morphology and technology, we found significant changes between early and late occupations (Table 9-9). Unprepared cores are large pebbles and small cobbles of basaltic andesite with irregular flake removals and unprepared platforms (Figure 9-8c, f). Flake blanks were removed in an opportunistic manner, often from several platforms. Flake scars vary in size and orientation, leaving an unpatterned form. Flake initiations are Hertzian or bending with stiffness-controlled propagations, indicating freehand percussion (Cotterell and Kamminga 1987). Unpatterned, unprepared cores were principally used to produce blanks for unpatterned flake tools.

they became too small to produce large flake blanks.

Four other prepared cores have platforms prepared by grinding or faceting, but without any of the characteristics of the more specialized bifacial flake cores (Figure 9-8d, e). The two complete cores are also small. Like the bifacial cores, they were extensively reduced and discarded because of their small size. The average negative flake scar length is only 48.5 mm. Two broken prepared cores retain evidence for removal of relatively large flake blanks (Figure 9-8d, e). Of the 22 basaltic andesite bifaces that retain evidence of blank form, 20 were made on flake blanks and only two on tabular cobbles. Thus, all evidence indicates that most bifaces were made on flake blanks, probably from such prepared cores.

Table 9-9. Cores by Technological Class and Analytic Unit, Pataha Canyon.

Core Technology	Piqúnin, Harder (AU1)		Late Cascade, Tucannon (AU2)		Early (AU 3-4) (pre-5,600 B.P.)		Site Total
	n	%	n	%	n	%	
Unprepared, irregular cores	11	84.6	5	41.7	1	100.0	17
Other unprepared freehand cores	1	7.7	0	0.0	0	0.0	1
Prepared bifacial	0	0.0	4	33.3	0	0.0	4
Other prepared cores	1	7.7	3	25.0	0	0.0	4
Total	13	100.0	12	100.0	1	100.0	26

Prepared bifacial cores occur only in the Late Cascade-Tucannon phase occupations. These cores are characterized by bifacially flaked platforms around only part of a cobble's perimeter (Figure 9-8a, b). The restriction of flaking to only a portion of the tool edge, and the removal of large thin flakes from one face, distinguish this technique from patterned bifacial tool reduction. Though bifacial cores may sometimes be flaked into bifacial tools, the cores from Pataha Canyon were obviously discarded without such modification. The four bifacial cores are small, but extensively flaked. The average negative flake scar length on bifacial cores is 47.3 mm, but this represents the last of many blank removals. The cores were discarded because

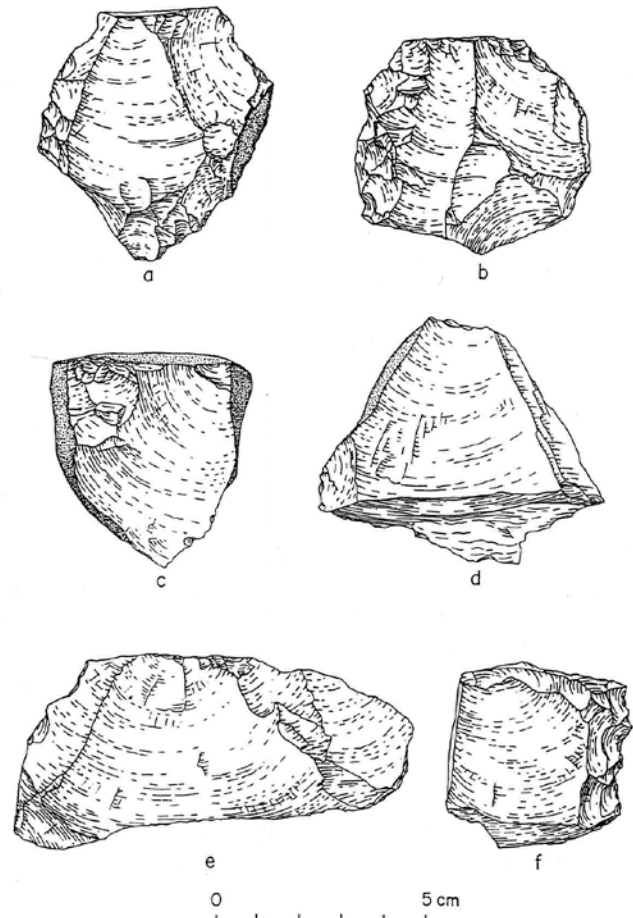


Figure 9-8. Pataha Canyon cores: (a, b) bifacial cores; (c, f) unprepared cores; (d, e) other prepared cores.

Tool Functional Classes by Analytic Unit

In order to better understand these technological patterns, we examined the distribution of tool functional classes within analytic units. The sample from the earliest occupations is small (only eight tools in AU3 and none in AU4), but the patterns of change through time are consistent. Proportions of tool functional classes suggest that early occupations were geared almost exclusively around basaltic andesite procurement and tool manufacture. The latest occupations, however, represent both hunting camps and stone procurement workshops. Functional classification of tools is summarized by analytic unit in Table 9-10.

The middle and early occupations (AU 2, 3, and 4) contain relatively few projectile points. There are no points from the pre-5600 ¹⁴C B.P. horizon, and only 3 percent (n = 2) of the Late Cascade-

Tucannon tools are points. Projectile points increase abruptly during the Piqúnin-Harder occupations, making up 30 percent of the collection.

Over 60 percent of the tools (5 of 8) from the pre-5600 ¹⁴C B.P. unit are bifacial blanks. During the Late Cascade-Tucannon occupations, the proportion of bifacial blanks declines to 50 percent (31 of 62 tools). During the Piqúnin-Harder occupations the proportion drops to 19 percent (19 of 90 tools). There is also a slight decrease in the proportion of cores and tested cobbles from the Late Cascade-Tucannon occupations (22.6 percent) to the Piqúnin-Harder occupations (17.8 percent). Conversely, there is a slight increase in the proportion of all flake tools from the Late Cascade-Tucannon (11.3 percent) to the Piqúnin-Harder occupations (18.9 percent). The increases in the proportions of projectile points and flake tools and the decreases in bifacial blanks and cores all

Table 9-10. Stone Tools by Functional Class and Analytic Unit.

Functional Class (code)	Piqúnin, Harder (AU1)		Late Cascade, Tucannon (AU2)		Early (AU 3-4) (pre-5,600 B.P.)		Site Total n
	n	%	n	%	n	%	
Projectile points (1)	27	30.0	2	3.2	0	0.0	29
Knives							
Knives used on soft materials, short duration (3)	2	2.2	3	4.8	0	0.0	5
Knives used on soft materials, long duration (7)	0	0.0	1	1.6	0	0.0	1
Knives used on hard materials (12)	1	1.1	0	0.0	0	0.0	1
Bifacial knives, nfs (15)	4	4.4	4	6.4	0	0.0	8
Subtotal	7	7.8	8	12.9	0	0.0	15
Indeterminate knives or projectiles (blanks)							
Patterned bifacial tools, unknown function (44)	16	17.8	29	46.8	5	62.5	50
Flake blanks (54)	3	3.3	0	0.0	0	0.0	3
Subtotal	19	21.1	29	46.8	5	62.5	53
Light-duty bone, antler, woodworking tools							
Transverse scrapers used on hard material (17)	1	1.1	0	0.0	0	0.0	1
Utilized and retouched flakes used on hard material (22)	7	7.8	2	3.2	0	0.0	9
Subtotal	8	8.9	2	3.2	0	0.0	10
Unpatterned cutting or flake tools							
Denticulate flake tools (18)	0	0.0	2	3.2	0	0.0	2
Retouched, utilized flakes, variable materials (23)	8	8.9	3	4.8	2	25.0	13
Edge-ground flake (53)	1	1.1	0	0.0	0	0.0	1
Subtotal	9	10.0	5	8.1	2	25.0	16
Core tools: unknown functions (46)	1	1.1	0	0.0	0	0.0	1
Cores and tested cobbles							
Cores (21)	13	14.4	12	19.5	1	12.5	26
Tested cobbles (31)	3	3.3	2	3.2	0	0.0	5
Subtotal	16	17.8	14	22.6	1	12.5	31
Grinding tools							
Hand stones (35)	0	0.0	1	1.6	0	0.0	1
Grinding slabs (36)	1	1.1	0	0.0	0	0.0	1
Subtotal	1	1.1	1	1.6	0	0.0	2
Hammers/anvils							
Hammerstones (29)	0	0.0	1	1.6	0	0.0	1
Heavy-duty woodworking tools							
Adzes (71)	1	1.1	0	0.0	0	0.0	1
Practice pieces (56)	1	1.1	0	0.0	0	0.0	1
Total	90	100.0	62	100.0	8	100.0	160

indicate a change in the use of the site. Early in time the site was used principally as a toolstone procurement location and lithic workshop. Evidence suggests that hunting and other activities were minor site activities. During the Piqúnin-Harder occupations, however, most tools are projectile points or flake tools, with smaller proportions of bifacial blanks and cores. This suggests that late in time, the site served as a hunting camp, as well as a basaltic andesite procurement and workshop location. On the face of it, decreases in the number of recovered bifacial blanks might be taken as an indication of decreased stone tool production. However, as discussed below, analysis of flake debris indicates that this did not happen.

Estimating Changing Rates of Production

Flake debris can provide an accurate indicator of the kinds and amounts of lithic reduction at a site, because unlike tools, waste flakes are left where they fall (Shott 1994). Quantitative relationships do exist between the number and kinds of tools produced at a place and the number and

technological types of debitage produced (e.g., Root 1992, 1997, 2004). These quantitative relationships are complex, but can be estimated by controlled experiments in lithic reduction.

As discussed earlier, there are probably size biases in the flake collection. Some of the smallest flakes have probably been removed by geologic or cultural processes (<6.35 mm and >2.54 mm). Thus the following exercise employs only flakes larger than 6.35 mm. Experimental production of seven thinned bifaces (stages 3 and 4) produced 25 biface thinning flakes (Table 9-11). Each tool yielded an average of 3.6 biface thinning flakes, with an average of 0.8 thinning flakes produced in bifacial edging and 2.8 biface thinning flakes produced in stage 3 and 4 thinning. We acknowledge that this experimental average is probably smaller than what would have been produced prehistorically because of our lower skill levels as knappers.

Basaltic andesite flakes larger than 6.35 mm from excavations are tallied by technological class and analytic unit in Table 9-12. More biface thinning and shaping flakes were recovered from the Piqúnin-Harder unit than from the Tucannon-Late Cascade unit, even though fewer bifacial

Table 9-11. Experimental Flake Data Tabulated by Technological Class and Size Grade, Size-grade 1-4 (All Flakes Larger Than 2.54 mm.)

Flake Technological Class, Size Grade ¹	Unprepared Core Reduction (6 replicates)		Prepared Core Reduction (2 replicates)		Bifacial Edging (6 replicates)		Bifacial Thinning (7 replicates)	
	n	%	n	%	n	%	n	%
Primary decort. G1	0	0.0	2	0.2	0	0.0	0	0.0
Primary decort. G2	5	0.7	0	0.0	0	0.0	0	0.0
Primary decort. G3	4	0.6	11	1.2	0	0.0	0	0.0
Shatter, G1	1	0.1	0	0.0	0	0.0	0	0.0
Shatter, G2	4	0.6	2	0.2	0	0.0	0	0.0
Shatter, G3	11	1.6	5	0.5	0	0.0	0	0.0
Alternate, G3	0	0.0	1	0.1	0	0.0	0	0.0
Simple flake, G1	2	0.3	2	0.2	0	0.0	0	0.0
Simple flake, G2	22	3.1	17	1.8	2	0.2	0	0.0
Simple flake, G3	82	11.7	108	11.6	42	4.0	26	2.2
Complex flake, G1	6	0.9	3	0.3	0	0.0	0	0.0
Complex flake, G2	17	2.4	28	3.0	4	0.4	4	0.3
Complex flake, G3	36	5.1	50	5.3	81	7.7	57	4.9
Biface Thinning, G1	0	0.0	0	0.0	0	0.0	0	0.0
Biface Thinning, G2	0	0.0	0	0.0	1	0.1	5	0.4
Biface Thinning, G3	0	0.0	0	0.0	4	0.4	15	1.2
Biface Shaping, G3	0	0.0	0	0.0	0	0.0	0	0.0
Biface Shaping, G4	0	0.0	0	0.0	5	0.5	24	2.1
Undiagnostic G4	510	72.9	707	75.6	914	86.7	1,033	88.7
Total	700	100.0	935	100.0	1,054	100.0	1,164	100.0

Table 9-12. Basaltic Andesite Flake Technology by Analytic Unit, Size-Grade 1-3 Only (>6.35 mm).

Technology	Piqúnin, Harder (AU1)		Tucannon, Late Cascade (AU2)		Pre-5600 B.P. (AU3)		Pre-5600 B.P. (AU4)		Total n
	n	%	n	%	n	%	n	%	
Primary decortication	88	4.7	81	5.4	24	6.1	2	6.7	195
Shatter	62	3.3	31	2.1	14	3.5	0	0.0	107
Biface thinning	142	7.6	113	7.5	27	6.8	4	13.3	286
Biface shaping	31	1.7	17	1.1	8	2.0	0	0.0	56
Alternate	39	2.1	31	2.1	8	2.0	0	0.0	78
Bipolar	2	0.1	2	0.1	2	0.5	0	0.0	6
Uniface	1	0.1	1	0.1	0	0.0	0	0.0	2
Simple	724	38.9	643	42.6	156	39.5	15	50.0	1,538
Complex	771	41.4	589	39.1	156	39.5	9	30.0	1,525
Total, G1-3	1860	100.0	1508	100.0	395	100.0	30	100.0	3,793

blanks were recovered from the late horizon. The figure of 3.6 biface thinning flakes per biface is used to estimate production. No biface shaping flakes larger than 6.35 mm were produced in experiments, and therefore, these flakes are not used in the estimates. There are of course many variables not accounted for by such a procedure, such as skill levels, variation in the number of flakes per tool, and breakage at different stages of production. Nevertheless, the exercise is instructive.

The numbers of unfinished basaltic andesite bifaces and biface thinning flakes recovered from excavations are summarized in Table 9-13. The tools include only those proveniences from which the flake debris was analyzed, including all 1997 excavations and a single 1994 Forest Service excavation unit. An estimate of biface production for each analytic unit is made by dividing the number of recovered biface thinning flakes by 3.6, after subtracting 0.8 biface thinning flakes per recovered stage 2 edged biface (thus accounting for early stage rejects).

The early unit (pre-5600 ¹⁴C B.P.) has a production estimate of only 7.5 bifaces with recovery of five stage 3-4 blanks. The Tucannon-Late Cascade unit has a production estimate of 30.5 thinned blanks, though eight stage 3-4 blanks were recovered. The Piqúnin-Harder unit has an estimate of 39.2 bifacial blanks, with recovery of five stage 3-4 blanks. These production estimates allow an estimate of the number of tools successfully completed in the excavation space and exported from the site. The early analytic unit has an estimate of 2.5 bifaces. In the Tucannon-Late

Cascade unit, an estimated 22.5 thinned biface blanks were successfully completed (30.5 total estimated - 8 recovered). The Piqúnin-Harder unit has an estimated 34.2 completed and exported blanks (39.2 total estimated - 5 recovered).

Thus, although fewer basaltic andesite biface blanks were recovered in excavations from the Piqúnin-Harder horizon than in the earlier deposits, more bifaces were produced than during previous occupations. Fewer broken and rejected blanks were recovered because the Piqúnin and Harder knappers were more efficient, making fewer errors than their predecessors. Analysis of the tool collections might suggest that workshop activities decreased late in time, but flake debris analysis indicates that this is not the case. More basaltic andesite bifaces were made and exported from the site during the latest occupations.

The smaller number of early stage rejects during the late occupations also suggests that those knappers practiced their craft with greater skill than

Table 9-13. Summary of Basaltic Andesite Flakes and Tools and Production Estimates for the Pataha Canyon Site (1997 Excavations and 1994 Unit "65W/00N" Only).

	Piqúnin, Harder	Tucannon, Late Cascade	Pre-5600 B.P.
Recovered edged blanks (stage 2)	1	4	0
Recovered thinned blanks (stage 3-4)	5	8	5
Recovered pressure-flaked preforms (stage 5)	1	1	0
Recovered biface thinning flakes	142	113	27
Estimated bifacial blank production	39.2	30.5	7.5
Potential bifacial blank export	34.2	22.5	2.5

did earlier knappers. Lower error rates imply greater efficiency of tool production. There is less waste of raw materials and less time is spent successfully completing a set number of tools. Increased efficiency in tool production points to changes in the organization of production. Perhaps part-time specialization, linked to increases in production efficiency (Costin 1991:37), is making an appearance at Pataha Canyon. Though full exploration of such a topic is beyond the scope of this chapter, our analyses indicate that lithic workshops in the Blue Mountains are places where such questions can be productively addressed.

One final aspect of tool production in Pataha Canyon concerns the total amount of production that occurred there throughout the past. The above analysis indicates that the excavated sample represents export of several dozen bifacial blanks from the later two analytic units. Though the excavated sample was not random, and statistical estimates of total populations cannot be made, it is likely that several thousand bifaces were made at the Pataha Canyon workshop and transported from the site. Thus, it may be instructive to compare rates of production output at Pataha Canyon with data from the contemporaneous Marshmeadow dacite workshop (35UN74) at Craig Mountain.

The Pataha Canyon site retains a relatively intact area of about 6,000 m². Assuming the average depth of deposits is about 1.25 m, the estimated surviving site volume is 7,500 m³. The total excavation volume for the combined 1994, 1996, and 1997 efforts is 15.075 m³, or about .002 of the site volume. Applying the production estimates presented in Table 9-13 to the site as a whole, and dividing the occupation span into three intervals of 2500 years each, gives us more than 17,000 bifaces produced for export during the Harder/Piquin interval, for an average of about seven bifaces per year. During the late Cascade/Tucannon interval, about 11,200 bifaces were made for export, or about 4.5 per year. During the pre-5300 RCYBP interval, only about 1,200 bifaces were shaped for export, or about one biface every two years.

By comparison, when the debris categories at Marshmeadow are converted to rates of discard by dividing the number of blanks per stratigraphic unit into the number of years represented by the unit, rates of change over time also emerge (Table 9-14). Thus, during the early Cascade phase (SU-2,3), one

production biface or elongate unifacial blank was discarded every 23 years. Between the late Cascade and early Harder phase (SU-4,5), failure and discard rates hovered around one in every eight to ten years, increasing to one in every five years in the Harder-Piquin interval (SU-6). Thus, while the mid- to late-Holocene trend over time parallels the increasing rates of production output calculated for Pataha Canyon, these are rates at which failures accumulated, not rates at which functional workshop products left the site to equip a stone-age population.

Table 9-14. Long Term Production Patterns in FGV Blanks at Marshmeadow, 35UN95 (Compiled from McPherson et al. 1981).

Age: RCYBP	Strat. Unit	Debitage	Bifaces	Unifaces	Total Blanks
	1	254			
6700-6100	2	3,198	23	3	26
	3	6,748	69	13	82
4000-3410	4	12,233	62	12	74
3410-2260	5	21,952	103	9	112
2260- 690	6	32,584	185	26	211
	7	17,971	88	12	100
	8	10,825	38	1	39
	Totals:	105,765	568	76	644

Summary and Conclusions

The Pataha Canyon site served as a basaltic andesite procurement location and workshop, and as a field camp for upland hunting during the mid- and late Holocene. The site is the source of a moderate-quality basaltic andesite with evidence of two major reduction trajectories. First, knappers selected large pebbles and small cobbles of basaltic andesite for use as unprepared cores. They struck flake blanks several centimeters long from these cores. These were fashioned into unpatterned retouched and utilized flake tools. Knappers also selected larger cobbles for manufacture of bifacial cores and other prepared core types. They struck large flake blanks from these prepared cores, probably 8–9 cm long, from which they fashioned bifacial blanks and preforms. These percussion-flaked bifacial blanks were a major item of export from the site. Experimental replications indicated that this stone is difficult to flake. Most recovered projectile points are chert, chalcedony, and obsidian, and it is likely that the Pataha basaltic andesite was seldom used for projectile point manufacture. Instead, the bifacial blanks were probably transported from the site to other locations

where they were made into bifacial knives or other types of bifacial tools that required little flaking beyond the percussion-flaked blank forms to finish them for use. Production estimates suggest that production efficiency increased during the latest occupations, when knapping error rates decreased. This suggests that changes in the organization of production occurred, and that part-time specialist knappers may have been present during the latest occupations.

The site must always have been available as a hunting camp as well as a workshop. However, late in time the emphasis on hunting grew. Increasing numbers and proportions of broken arrow and dart points litter the Piqúnin and Harder phase levels. Most of them are chert, chalcedony, and obsidian, in contrast to the general preponderance of basaltic andesite. Furthermore, most of the chert, chalcedony, and obsidian debitage consists of biface pressure flakes. Thus, broken projectile points were reworked on the site and some preforms were chipped into new tools to replace the broken ones. Use-wear analysis indicates that flake tools were used to work hard-surfaced wood, bone, or antler (Reid and Root 1998). These flake tools probably served to repair hafts during retooling, and for other wooden or bone tool manufacturing needs. The growing abundance of chert, chalcedony, and obsidian tracks an increased use of transported tool kits late in time.

The Grande Ronde Basalt Formation is the single most extensive exposure of the Columbia River Basalt Group in the Tri-State Uplands. Basaltic andesite toolstones in this formation exhibit geochemical homogeneity but variable fracture toughness. The Pataha Canyon workshop is one of many similar sites where production biface industries flourished at different times in the middle and late Holocene. The toolstone at Pataha Canyon occurs in small package sizes and is difficult to work. Nevertheless, evidence for changing rates of production derived from a replicative systems analysis of the lithic debris suggest that these sites have the potential to inform on larger regional processes.

For example, the activity shift between AU1 and AU2 coincides with an organizational shift in hunting and gathering that is evident at a broad regional level between about 3,500 and 2,500 years ago. Present evidence suggests that this development follows and is not contemporaneous

with the first pithouse settlements in the region. It is manifested by the appearance of sites in upland settings that display evidence of labor investment and regular seasonal reutilization. These sites probably functioned as field camps for hunters operating out of nearby winter villages in the canyons. Locally, the dissimilar toolstone raw material profiles at the winter village of Hatiuhpuh at the mouth of the Tucannon may mask functional linkages to such upland camps and workshops as Teal Spring, Kelly Camp, and Pataha Canyon.

Table 9-15. Raw Material Profile of Bifacial or Retouched Tools from the Hatiuhpuh Settlement (45WT134) Opposite the Mouth of the Tucannon River (Data from Brauner et al. 1990:167-175).

Tool Category	Crypto-crystalline Silicates	Fine-grained Volcanics	Obsidians
Bifacial blanks and fragments	81 (94%)	1	4
Projectile Points	35 (67%)	12 (23%)	5 (10%)
Knives	5 (100%)	0	0
Drills	11 (92%)	0	1
Gravers and perforators	9 (100%)	0	0
Scrapers	51 (89%)	4	2

Thus, of the 81 bifacial blanks recovered at the winter village, only one was made from an FGV toolstone, while nearly a quarter of the 53 projectile points were (Table 9-15). All of the 52 cores from the village were made from microcrystalline silicates. The FGV projectile points from Hatiuhpuh were dart points typical of the late Cascade/Tucannon/early Harder phases. However, technological data from Pataha Canyon argues against this nearby source having provisioned these Hatiuhpuh hunters. We suspect that the high-silica andesites and dacites of the Saddle Mountain Formation that came under exploitation in the early Holocene at Stockhoff, Marshmeadow and Pilcher Creek may have continued to be valued for projectile points, even after the less tractable basaltic andesites went into production later in the Holocene.

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An earlier version of this chapter profited from comments of the volume editors.

We dedicate this chapter to the memory of Sarah Margaret Moore, who died on August 27, 2012. Her elegant line drawings have contributed here and elsewhere to a better understanding of Northwest lithic technology.

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