Chapter 6

Chemical Identification of Activity Areas in the Keatley Creek Housepits

William D. Middleton

Introduction

Soil phosphate analysis has been used by archaeologists since 1926 (Arrhenius 1963) to locate sites and determine their extent. Although this has proven to be a useful technique (Arrhenius 1963; Cavanagh et al. 1988; Conway 1983; Eidt 1985; Konrad et al. 1983; Lillios 1992; Lippi 1988; Sjoberg 1976; Woods 1977, 1984), archaeological applications of soil chemistry have only recently ventured beyond this fairly simple application. Recent work has demonstrated that many compounds and elements other than phosphates also serve as indicators of past human behavior, and that these are especially effective in domestic contexts (Barba 1985, 1988; Barba et al. 1987; Barba and Ortiz 1992; Manzanilla and Barba 1990; Middleton 1994; Middleton and Price 1996).

In this study, multi-element characterization by inductively coupled plasma-atomic emission spectroscopy (ICP/AES), atomic absorption spectroscopy (AAS), and colorimetry of acid extracts of soils is used to analyze soils from the floors of housepits at the Keatley Creek site. These analyses aid the interpretation of structure function and patterns of activity within the structures. Two floors from one structure (HP 9), and a single floor from three other structures (HP's 3, 7, and 12) were extensively analyzed, as well as soils from a variety of reference profiles from undisturbed and minimally disturbed contexts.

Results show that the soils from the structures were chemically distinct from local, undisturbed soils and that there was clear patterning in the chemical residues in these floors. Temporary and permanent hearths and discrete activity areas were identifiable and these patterns can be seen to vary somewhat between the floors. The chemical data complement that of lithic, faunal, and paleobotanical analysis and observations made during the excavation to strengthen the interpretation of the organization of activities within the Keatley Creek housepit.

Methodology

A total of 253 samples were analyzed for the study. These samples were collected over several field seasons from floors, specific features, and reference profiles. Floor samples were not, however, uniformly collected, so in a number of cases portions of the floors remain uncharacterized. Samples from the reference profiles and HP 9 were analyzed by ICP/AES at the Laboratory for Archaeological Chemistry, while the samples from HP's 3, 7, and 12 were analyzed by a combination of AAS and colorimetry by Pacific Soil Analysis Inc. Several reference samples were collected, from immediately adjacent to a structure and from up to 50 m distant from a structure.

The samples were originally analyzed blind, with only x-y coordinate provenience, interpreted, and the results sent to the excavator (Brian Hayden). He reported a high degree of correspondence between the chemical analysis, other analyses, and field observations. Further data was then provided and interpretation of the chemical analyses completed.

Analysis

The samples for ICP/AES were prepared by oven drying the samples at 105°C for 48 hours, pulverizing the dried sample in a Coors porcelain mortar, screening the sample with a 2 mm geological screen to remove all particles larger than sand, and extracting .2 g of the sample in 20 cc of 1N HCl for two weeks at room temperature. The extracts were analyzed by ICP/AES, and scanned for twelve elements: Aluminum (Al); Barium (Ba); Calcium (Ca); Iron (Fe); Potassium (K); Magnesium (Mg); Manganese (Mn); Sodium (Na); Phosphorous (P); Strontium (Sr); Titanium (Ti); and Zinc (Zn). The concentration of these elements was measured in parts per million (ppm) and these concentrations converted to base ten logarithms for interpretation. The methodology is based on Burton and Simon's (1993) acid extraction method for ceramic characterization. The two week, room temperature extraction gives the technique a very good reproducibility (better than ±5%: Burton and Simon 1993).

This is not a total compositional analysis, but a partial extract of mobile elements. The partial extract is preferable to total compositional analysis because as a sediment is developed into a soil, it is characterized by changes in the availability of mobile elements and compounds, due both to the weathering of these elements from the parent material and the incorporation of new materials from both human and natural sources. The chemical composition of the parent material is not, per se, of foremost interest in this case, and can actually obscure the relationships of interest (see Linderholm and Lundberg [1994] for a more complete discussion of and comparison between partial extraction and total compositional analysis of soils). The values reported for P are equivalent to Eidt's (1985) total P.

The samples from HP's 3, 7, and 12 were not analyzed by the author, but by Pacific Soil Analysis Incorporated. The data were provided to the author by the excavator (Brian Hayden) for comparison with the data from HP 9. Samples were analyzed using a peroxide-sulfuric acid digest. Of the twelve elements used in the author's study, only phosphorus, potassium, calcium and magnesium were measured by PSAI. Phosphorus was measured colorimetrically, calcium, magnesium, and potassium were measured by atomic absorption spectroscopy. Concentrations of the four elements were reported as percent by weight. Although different extraction techniques, quantification techniques, and reporting units are used, and the data are not as precise as those from ICP/AES, the relative patterns are still comparable to the ICP/AES analyses.

Data Presentation and Interpretation

For preliminary analysis of the housefloors, log ppm or percent concentrations of each element were surface plotted for each floor level by x-y coordinates. Profile samples were coded by depth below surface and elemental concentrations were plotted as a function of depth for comparison with the floor levels.

Surface plots were visually examined for patterning in elemental concentrations, with particular attention given to element groups that have been determined through ethnoarchaeological studies (conducted by the author and other researchers) to be useful in identifying activity areas. The foremost of these, identified through ethnoarchaeological studies (Middleton 1994; Middleton and Price 1996), are Ca and Sr serving as indicators of high activity under roofed areas protected from weathering, and P and K serving as indicators of ash, hearths, firing, or perhaps other activities. P is also a general indicator of organic matter content (Birkeland 1974; Buol et al. 1989; Catt 1990).

Samples from the floors were compared by sample provenience and position in the solum with the

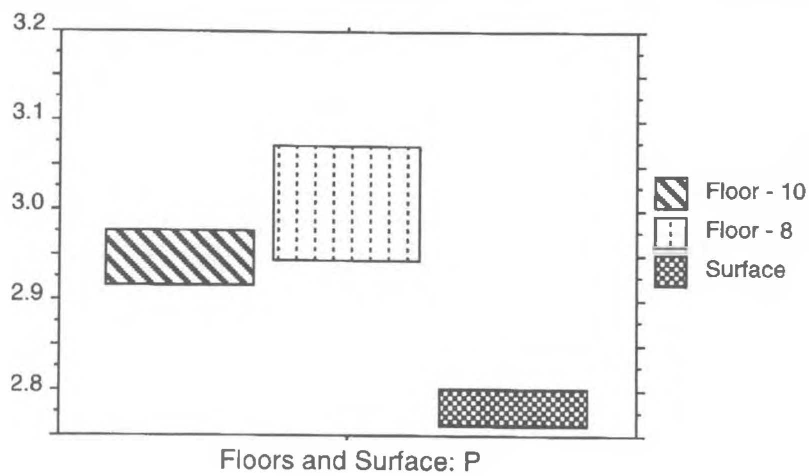

Figure 1. Phosphorus values (log ppm) from the floors of HP 9 and the prehistoric surface.

reference profiles to assess the integrity of the archaeological chemical residues. Principal component analysis was performed on elemental concentrations for each floor to separate major vectors of variation and further elucidate patterning.

Once more detailed information was obtained on the identification of features encountered during the excavation, floor samples were designated as hearth, food preparation area, general activity area, or covered area as specified by the excavator, and these designations tested by cluster and discriminant analysis.

Integrity of Anthropogenic Chemical Residues

Soils develop in a sediment as a function of natural processes and factors over time (e.g., Jenny's [1941] five factor model: a soil develops as a function of climate, organisms, relief, parent material, time, and local factors: also see Johnson and Watson-Stegner 1987; Simonson 1978). In human occupation sites human activity can dominate these natural processes to the extent of creating a new soil, and this new soil can persist, leaving indications of the activities that impacted its formation. Human influenced soils (anthropogenic or anthropic soils) are usually clearly distinguishable from their natural, undisturbed counterparts. Differences in the content of a number of naturally occurring soil constituents can distinguish the differences between natural and anthropogenic soils.

For this comparison, though, it is necessary to sample an undisturbed land surface contemporary with the anthropogenic soil, or at least an associated, culturally sterile context. As stated above, reference profiles were collected from units adjacent to housepits and from up to 50 m distant from the nearest housepit. This ensures a minimally disturbed, contemporary land surface with which the archaeological soils can be compared.

Soil P has long been used by archaeologists as an indicator of past human activity (Arrhenius 1963; Eidt 1973; Solecki 1951) and by soil scientists as a pedogenic indicator (Birkeland 1974, 1984; Buol et al. 1989). A major route for the incorporation of P in soil is as a constituent of organic matter, which typically has a high rate of incorporation in anthropogenic soils (Cook and Heizer 1962, 1965; Stein 1992). Anthropogenic soils should have higher levels of P than their natural counterparts, and this is the case with both floors from HP 9 compared with an undisturbed soil profile (profile 7, taken 50 m west of HP 90: Fig. 1).

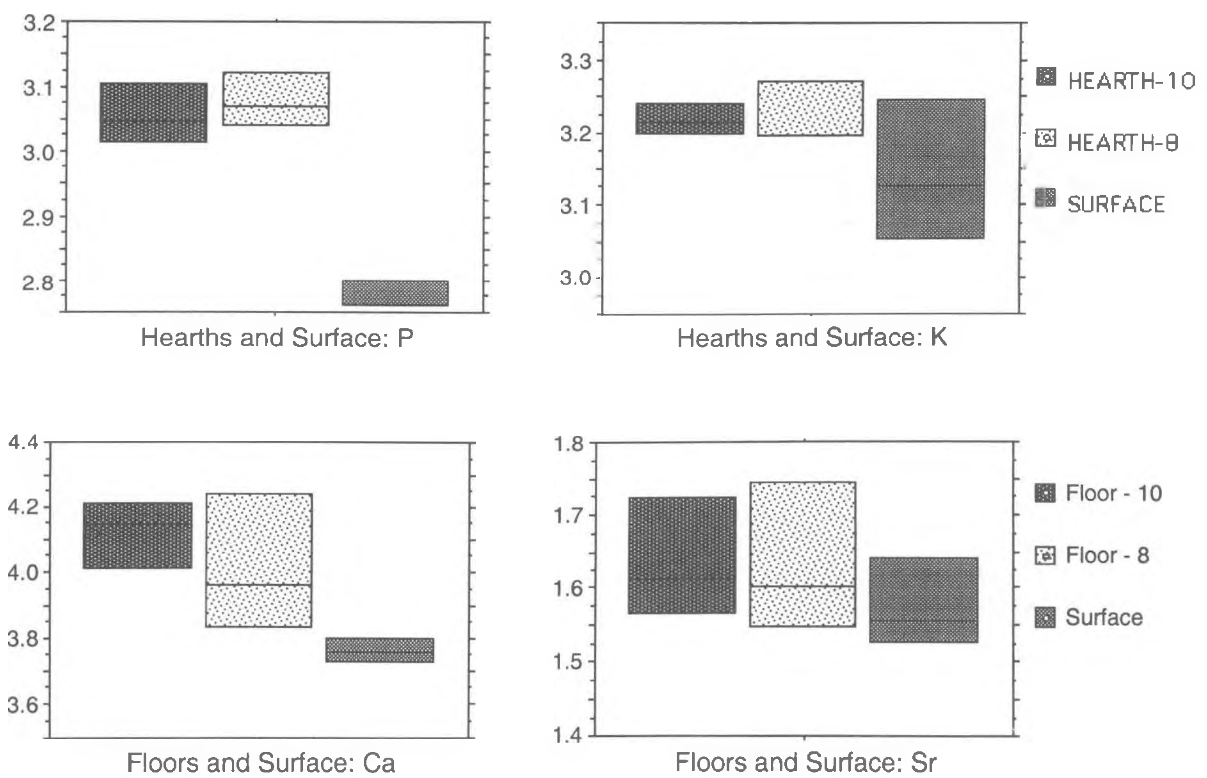

Figure 2. Values (log ppm) for phosphorus and potassium from the hearths of HP 9 and the prehistoric surface, and for calcium and strontium from the floors of HP 9 and the prehistoric surface.

Another major addition to anthropogenic soils is Ca (Cook and Heizer 1962, 1965; Griffith 1980, 1981; Heidenreich and Navatril 1973; Heidenreich and Konrad 1973; Heidenreich et al. 1971; Middleton 1994; Middleton and Price 1996). There are several mechanisms for the incorporation of Ca into anthropogenic soils, but none are yet clearly elucidated. Sr, as a related alkaline earth element, follows the behavior of Ca, and also occurs in elevated concentrations in house floors, though at a lower magnitude than Ca (Middleton 1994; Middleton and Price 1996). It can be seen that Ca and Sr are also higher in the HP 9 floor levels than in undisturbed soils (Fig. 2).

Finally, there are a number of elements (particularly K and P) introduced into anthropogenic soils primarily through wood ash (Heidenreich et al. 1971; Middleton 1994; Middleton and Price 1996; Scotter 1963; Tarrant 1956). These can be seen to be much higher in the hearths of HP 9 than in the reference profile (Fig. 2).

With these patterns established it is clear that the anthropogenic soils have remained distinguishable from the local natural soils. The chemical residues encountered in the anthropogenic soils should, then, be interpretable as accurate indicators of the behavior that contributed to their formation.

Results

Results of all analyses are presented in the Appendix. The soils from each floor showed distinct patterning in their chemical residues, and there were some differences in the patterning between the floors. These differences suggest that the floors had a somewhat different spatial organization.

Housepit 9, Stratum 10

HP 9 is a small structure (20.5 m^2) with two distinct occupation floors. The lower floor (Stratum 10) dates to the Plateau Horizon; the later floor (Stratum 8) dates to the early Kamloops Horizon (see Vol. III, Chap. 8). Stratum 10 is characterized by several patterns—concentrations of high values for K, Mn, P and Zn near the center of the floor, high levels of P in the south-eastern section of the floor, incompletely overlapping semi-circular concentrations of Al, Fe, Mg around the perimeter of the floor (primarily to the southeast of the center), and high levels of Ca in the southwestern half of the floor.

The excavators reconstruct the floor as having been divided into a hearth area, food preparation and general activity areas, a cache pit, and an area covered by a bench/sleeping platform (Fig. 3).

As wood ash contributes a number of elements to soil, particularly K, Mn and P, it seems likely that the concentrations of these elements near the center of the floor accurately reflect the location of a hearth (Figs. 4 &

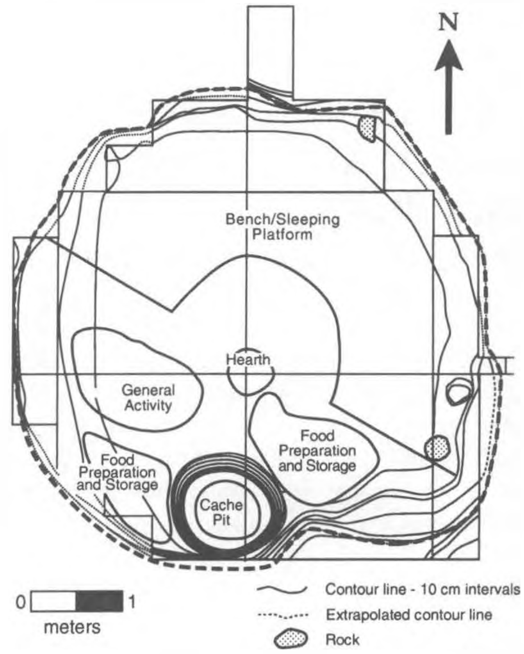

Figure 3. Excavator's reconstruction of HP 9, Stratum 10. Dashed line is for orientation of chemical plots.

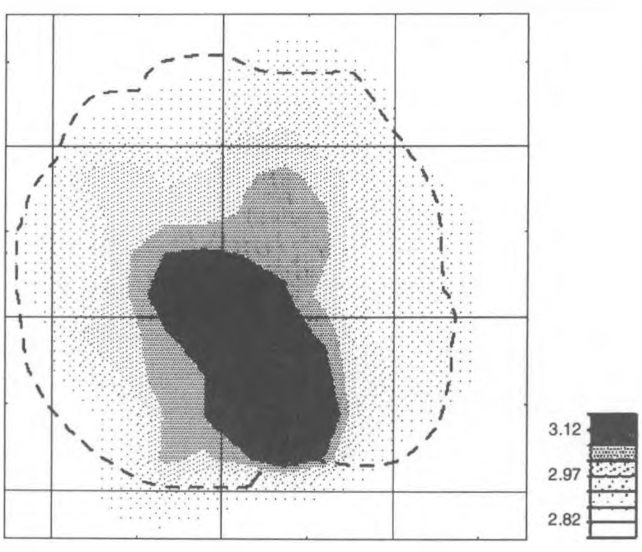

Figure 4. Concentrations (log ppm) of phosphorus, HP 9, Stratum 10.

5). This area, in fact, had the strongest signature for firing of any of the floors examined, and interestingly, contained the only stone lined (apparently permanent) hearth uncovered in the excavations (see Vol. III, Chap. 8).

The high levels of P (Fig. 4), and the semicircular concentrations of Al and Fe in the southeastern portion of the structure correspond to the food preparation area identified by the excavators. While elevated P is easily explained as reflecting the greater input of organic matter (in the form of food preparation residues), the correspondence of Al and Fe is not easily explained. Elevated levels of Mg, while partially overlapping with Al and Fe, are more concentrated in the part of the floor identified as a general activity area

The elevated levels of Ca and Sr are found across most of the floor that was not covered by the bench/sleeping platform, with the highest levels in the food preparation and general activity areas (Fig. 6). Based

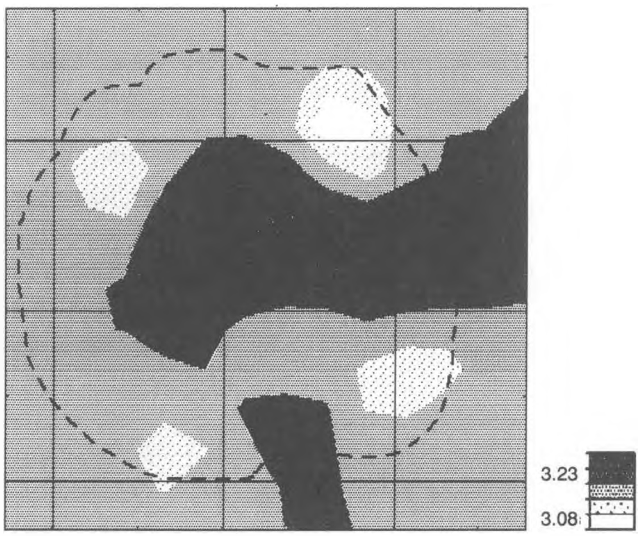

Figure 5. Concentrations (log ppm) of potassium, HP 9, Stratum 10.

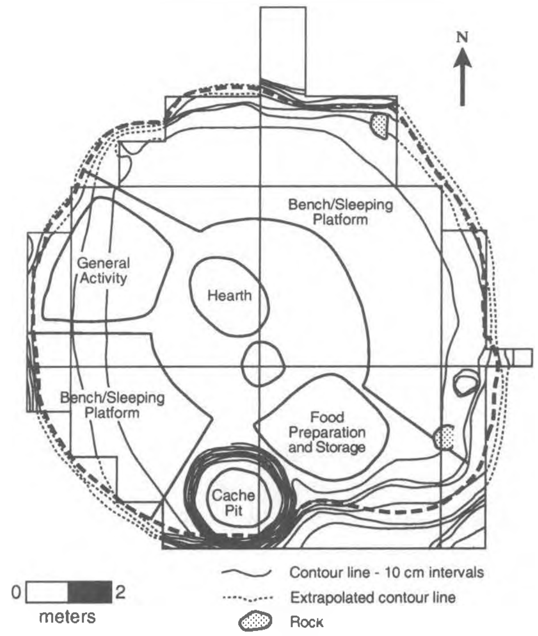

Figure 7. Excavator's reconstruction of HP 9, Stratum 8.

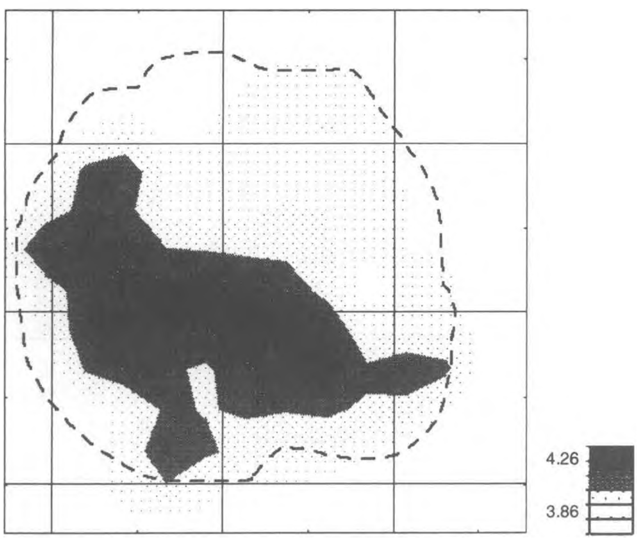

Figure 6. Concentrations (log ppm) of calcium, HP 9, Stratum 10.

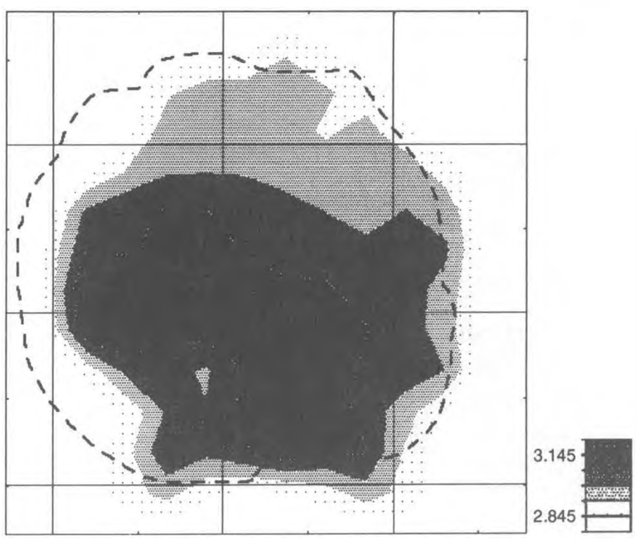

Figure 8. Concentrations (log ppm) of phosphorus, HP 9, Stratum 8.

on ethnographic studies, this is what would be expected in the areas of greatest activity.

Finally, the area covered by the bench/sleeping platform is generally (though not entirely) characterized by lower elemental values than the rest of the floor area, indicating that little material was entering the soil in this covered area (Figs. 4–6).

Statistically, the dominant chemical signature on the floor is the presence of the hearth: principal component analysis strongly reflects the presence of constituents of wood ash with K, Mn, P, and Zn all strongly positively weighted in the first factor and negatively weighted in the second. Both hierarchical and non-hierarchical cluster analysis (Ward's minimum variance and K-means) make a primary distinction between the covered (platform) portion of the floor and all other samples. When clustering on all elements, both techniques have some difficulty in separating the various activity areas, tending rather to make groups from central and more peripheral parts of the floor. When clustering only on the four key elements (Ca, K, P, and Sr), both clustering techniques are much more successful in separating the various activity areas. Using the activity areas designated by the excavator as the independent grouping variable, discriminant analysis distinguished between all floor areas with complete success.

None of the chemical signatures are as sharply bounded as the areas demarcated by the excavators. This is most likely due either to a blurring of the chemical signatures by subsequent soil development, to the division of space within the structure not being static over time or to "scuffage" effects of walking or other activities on the floor displacing soil sediments laterally. Given that the structures are estimated to have been occupied for 20–30 years before roofs were replaced (see Vol. I, Chap. 17), the latter explanation seems more likely.

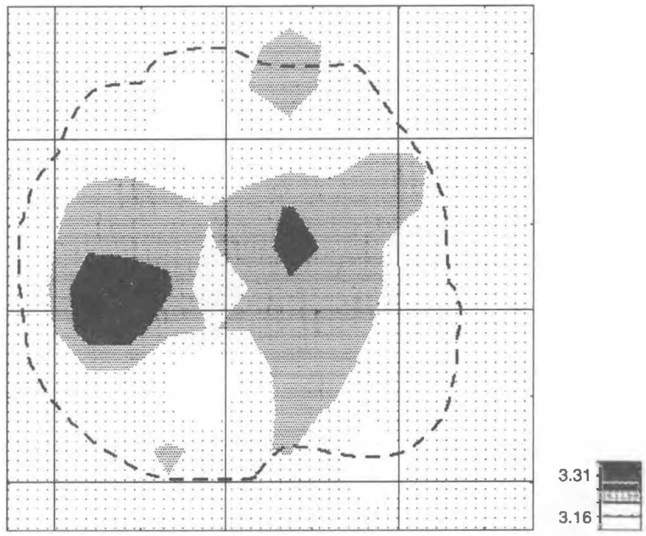

Figure 9. Concentrations (log ppm) of potassium, HP 9, Stratum 8.

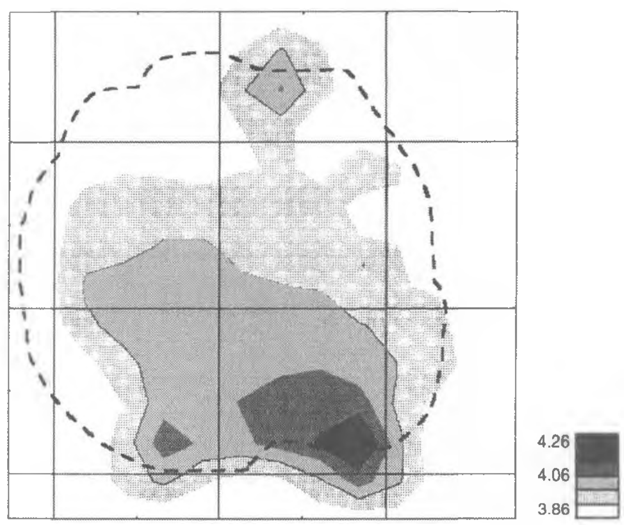

Figure 10. Concentrations (log ppm) of calcium, HP 9, Stratum 8.

Housepit 9, Stratum 8

The later floor of HP 9, Stratum 8, level 1, exhibited somewhat different patterning in the surface plots than Stratum 10. This is probably due in part to Stratum 8 having been formed on burned and mixed roof fill rather than on sterile till (see Vol. III, Chap. 8), but also undoubtedly reflects a somewhat different organization of space than Stratum 10.

Again K, P, Mn, and Zn have high levels near the center of the floor (somewhat west of center), though the highest values for P and K are actually to the west of the hearth. P is also very high in the southwest quarter of the floor. Ca and Sr are both quite high in most of the southwest half of the floor. On this floor, however, there are no anomalous concentrations of Al or Fe.

The excavators' reconstruction of Stratum 8 (Fig. 7) is somewhat (though not substantially) different from Stratum 10. The features are in roughly similar positions, though several are offset from their counterparts in Stratum 10. The same chemical signatures seen in the features of Stratum 10 are, for the most part, also found in the features of Stratum 8.

The hearth area is characterized by high, though not the highest, levels of P and K (Figs. 8 & 9). There is an area slightly to the west of the hearth that has the highest P and K values, suggesting that another hearth had been located at this point, and that the hearth, since it was temporary, did not have a set or consistent location on the floor.

The second area of high levels of P corresponds again to the food preparation or perhaps consumption area (in more or less the same location as in Stratum 10). That there is no corresponding increase in Al or Fe in this area suggests that their correspondence in Stratum 10 was independent of food preparation.

Ca and Sr are both highest on the uncovered part of the floor (lacking a sleeping platform), with the highest levels occurring in the food preparation area. Ca illustrates this pattern most clearly (Fig. 10). The high levels, however, do not extend very far into the general activity area, suggesting that this part of the floor was not as intensively utilized as it was in Stratum 10, or perhaps that it was also covered for part of the occupation of the floor.

Principal component analysis indicates that while the hearth is still an important factor, it is not as strongly weighted as in Stratum 10. The major constituents of wood ash are still heavily weighted, but a number of other elements are as well. Both Ward's minimum variance and K-means cluster analysis again distinguish between the covered (platform) and uncovered portions of the floor, but are not completely successful in separating all of the activity areas. Repeating the analysis with only the four major elements (Ca, K, P, and Sr), improves results somewhat, but not greatly. Discriminant analysis, however, again using the excavators' designations as the independent grouping variable, separated all samples with complete success.

Housepit 12

With 38.5 m^2 of floor area, HP 12 is almost twice the size of HP 9, and its organization seems to be a little more complicated. The distributions of P and K have their highest levels in the north and south central areas of the floor. The concentrations of K, however, are fairly high across the much of the floor, particularly the southern half. The highest concentration of Ca is situated on the northwestern portion of the floor, with fairly low concentrations across the rest of the floor (Figs. 11–13).

The high levels of P and K in the north and south suggest that there may have been at least two hearths in the structure. Both of these areas correspond with high counts of charcoal, but only the northern concentration also corresponds with fire reddening and FCR. The highest concentrations of Ca roughly correspond with the highest concentrations of animal bones. The excavators suggested that the southwestern portion of the floor may have been covered by a platform, as in HP 9, and this area roughly corresponds to an area of high K concentration.

Repeated discriminant analysis tests produced ambiguous results (Fig. 14). Only one hearth was identified, in the northern part of the structure (the area corresponding to fire reddening, charcoal, and FCR). The hearth is associated with food processing areas, and there are also food processing areas in the southeast, and the area in the southern part of the floor that appeared might also be a hearth. General activity areas were identified in the west, central, and eastern portions of the floor, which correspond to high counts of lithics. Finally, the

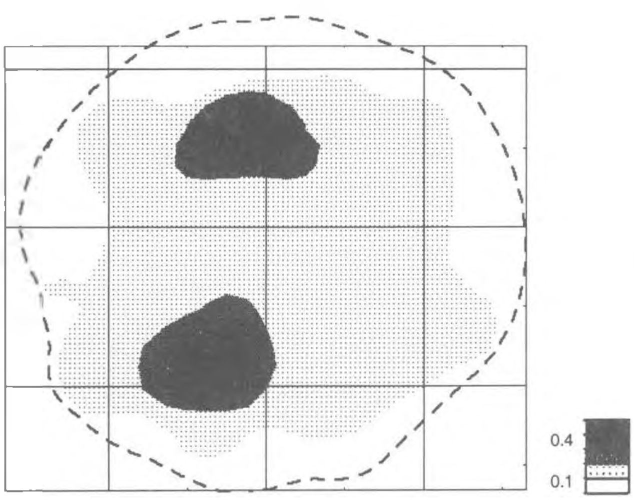

Figure 11. Concentrations (log ppm) of phosphorus, HP 12.

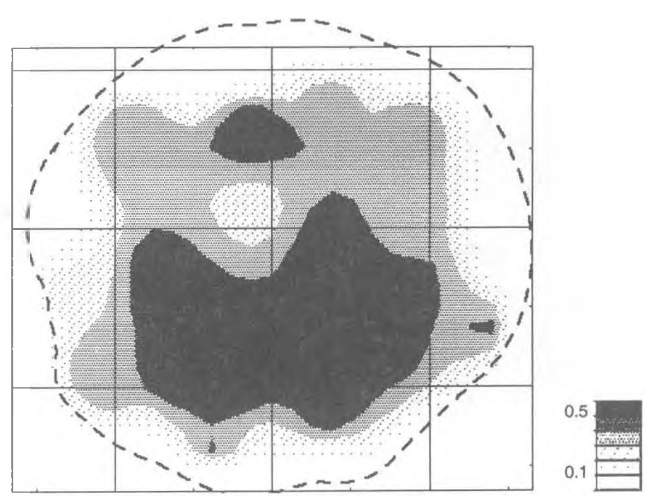

Figure 12. Concentrations (log ppm) of potassium, HP 12.

(possibly) covered portion of the floor was partially distinguishable, with another area on the north-eastern portion of the floor also being identified.

This presents a somewhat chaotic picture of the organization of HP 12. The lack of coherence may indicate that the organization was more transitory/ dynamic than the other housepits, and that a platform over a portion of the floor was moved or installed after the open floor had been utilized for some time or that mats were used instead of platforms for sleeping on.

Housepit 3

At roughly 78.5 m², the floor of HP 3 is almost four times larger than HP 9. Although the patterning in chemical residues is less clear, it appears that the organization of HP 3 was quite different from that of HP 9. The concentrations of Ca and P are semi-circular and circular, with the highest concentrations of P in the southwestern, and northern parts of the floor. The highest concentrations of K are in the southwestern half of the floor (Figs. 15–17) corresponding in a striking fashion to the division of the floor into two distinct activity zones based on stone tool distributions (see Vol. II, Chap. 11).

Given the distribution of Ca, it would seem that activity was most intense along the perimeter of the structure from the northeast, counter clockwise to the south. It also seems likely that there would have been a hearth in the southwest, given the elevated levels of P and K in this region. This corresponds fairly well to the distribution of faunal (fish and animal) remains, charcoal, and areas of fire reddening (see Vol. II, Chaps. 1, 4, 7; Vol. III, Chap. 6).

As an exploratory technique, the samples were schematically divided by activity based on the artifactual data provided by the excavator into hearth, food preparation or consumption, and general activity areas and these designations tested by discriminant analysis. The first several models were not completely successful, so following each test, samples that did not fit were assigned to new groups and re-tested. When a perfect fit was attained, the designations for the samples were plotted back onto the floor for comparison with artifact data (Fig. 18).

In addition to the one, large hearth area already apparent in the southwestern portion of the floor, there is a second hearth in the southeastern portion of the floor. This corresponds to another area of fire reddening and charcoal (a third area of fire reddening and charcoal in the northwestern area of the floor does not show up in the chemistry because there were no samples collected from this area). By far the most prevalent chemical signature is that of food preparation and perhaps consumption, which covers much of the perimeter of the floor. This area corresponds to high counts of bone, particularly fish bone. The third distinguishable signature, of other, general activities, covers the central, eastern, and southeastern portions of the floor. These areas correspond to the excavators' identification of a possible wood or hide working area (central) and light activity area (eastern and south-eastern) on the basis of recovered lithics. These two work areas could not be statistically resolved on the basis of their chemistry.

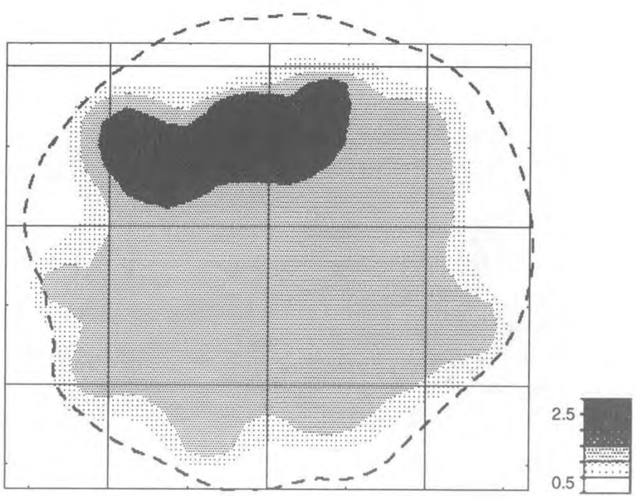

Figure 13. Concentrations (log ppm) of calcium, HP 12.

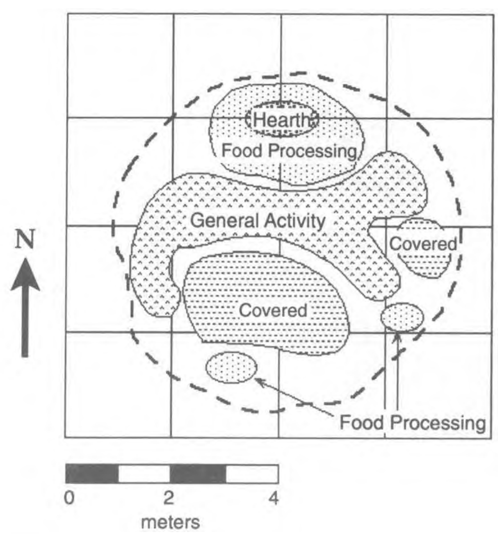

Figure 14. Chemically identified activity areas, HP 12.

Housepit 7

The floor of HP 7 was substantially larger (about 113 square meters) than HP 9, and also appears to have a different organization. Overall, it seems to be organized similarly to HP 3 in exhibiting concentric or perimeter activity zones, but is slightly different in the details. Though not completely overlapping, the highest concentrations of Ca, K, Mg, and P are located around the west, north, and east perimeter of the floor with the southern portion of the floor having lower concentrations (Figs. 19–21) (there were no samples from the central portion of the floor, so this area remains uncharacterized). This distribution corresponds fairly well to the excavators' division of the floor into three basic zones (based on the distribution of lithics): semi-circular inner and outer floor zones around the west, north, and east of the structure surrounding a central zone and separate from the southern sector (see Vol. II, Chap. 11).

Concentrations of P and K are fairly strongly correlated, and their highest concentrations coincide at four locations on the floor: the west central, east central, southwest, and southeast. The distribution of K and P also correspond fairly well with concentrations of fire cracked rock, suggesting that there were at least four frequently used, or principal, hearth locations within the structure. The highest concentrations of Ca are along the west central and eastern perimeters of the floor. These roughly correspond with food preparation or consumption and general activity areas identified by the excavators.

Again, the associations between features, artifacts, and chemistry were explored through repeated discriminant analysis tests, and the final results mapped back onto the floor (Fig. 22). Many more hearths are apparent (eight as compared to two in HP 3) scattered around the perimeter of the floor. Each of these hearths is associated at least with an area of fire reddening, and several with FCR and/or charcoal concentrations. Food preparation and perhaps consumption areas cover a similar proportion and area as in HP 3. These areas correspond fairly well with concentrations of animal bones (see Vol. II, Chap. 7), though they are less extensive in HP 7 than in HP 3. Several of the hearths occur within this area, and there are several areas with no samples, so the area may not actually be as extensive or continuous as it seems.

The general activity areas (again, specific activities could not be chemically distinguished) occur in the southwest and southeast of the floor, and do not appear to cover quite as wide an area of the floor as in HP 3. Finally, the south central area of the perimeter was identified by the excavators as a possible elite/ceremonial/sacred area. While only one sample was available from this area, it stands out as chemically distinct from all other areas on the floor.

Discussion and Conclusions

Although it is possible that there has been some diminution of the anthropogenic chemical residues in the Keatley Creek soils, the house floor soils are chemically distinct from corresponding natural soils in the same area. They should, therefore, reflect the human behavior that affected their development to a greater extent than they reflect the local, natural, processes of soil formation.

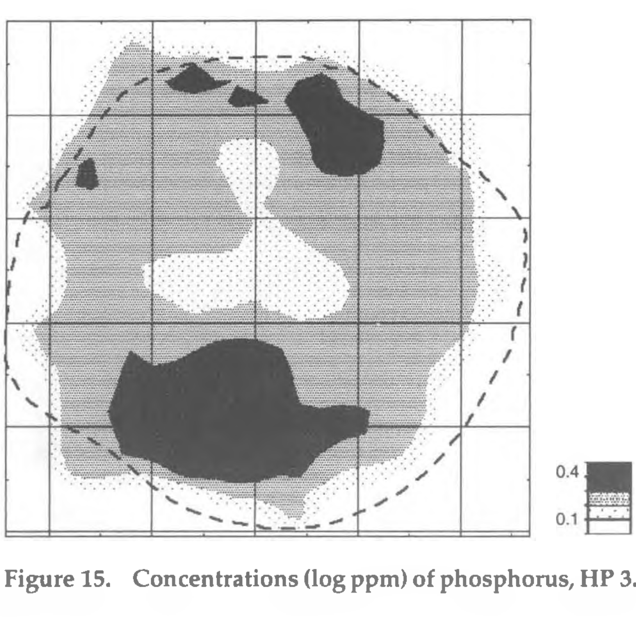

Figure 15. Concentrations (log ppm) of phosphorus, HP 3.

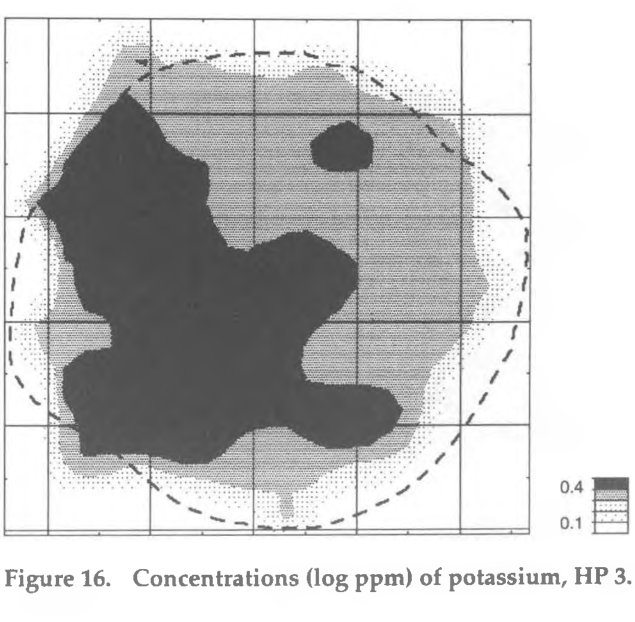

Figure 16. Concentrations (log ppm) of potassium, HP 3.

The chemical signatures that were expected to be encountered based on ethnoarchaeological studies (elevated levels of Ca and Sr in roofed, interior spaces and elevated levels of K and P in Hearth areas) were encountered in all structures (though Sr was not measured for HP's 3, 7, 12). The features identified by the excavators were, for the most part, clearly distinguishable by their chemistry, and there is a high degree of correspondence between the chemical signatures of the features observed on each floor. The major differences between the features are summarized in Table 1. These patterns strengthen the excavator's reconstruction of the spatial organization of housepits.

An important methodological point is that the exploratory techniques used to interpret the data (particularly discriminant analysis) are designed to find and maximize differences between groups. Furthermore, they do not explain or interpret these differences, they simply indicate that the differences can be found. In the case of the Keatley Creek house floors, this is complicated by the fact that hearths and food preparation are the dominant signatures (due to the fact that both contribute very high amounts of material to the soil). It is therefore quite possible that portions of the floor that were only peripheral to these activities have been included with them simply by virtue of their strong signature. Also, if there was any diachronic variation in the organization of these houses, any areas that were ever used for these "strong signature" purposes would probably maintain the chemical signature simply because it is stronger than that of any subsequent or previous activity. Food

Table 1. Characterization of Activity Areas

Area	Signature
Hearth	High Phosphorus, High Potassium
Food Preparation	High Phosphorus, High Calcium, High Strontium
General Activity	High Calcium, High Strontium
Floor	High to Moderate Calcium and Strontium
Cache Pit	High Phosphorus, Low to Moderate Calcium, Strontium, and Potassium
Sleeping Platform	Lower Values for all Elements

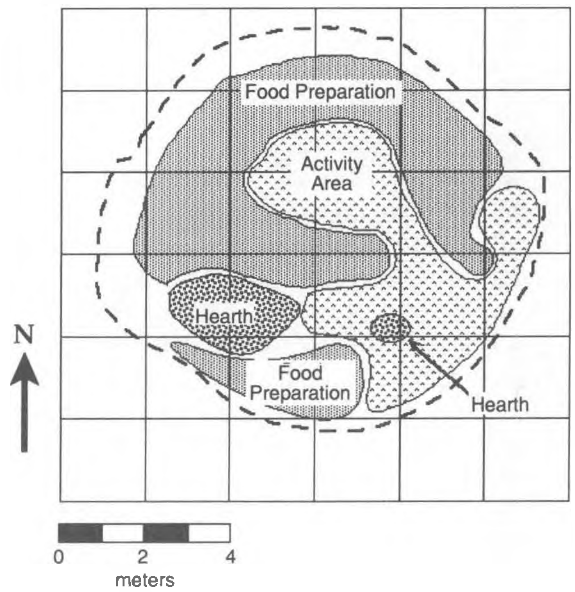

Figure 18. Chemically identified activity areas, HP 3.

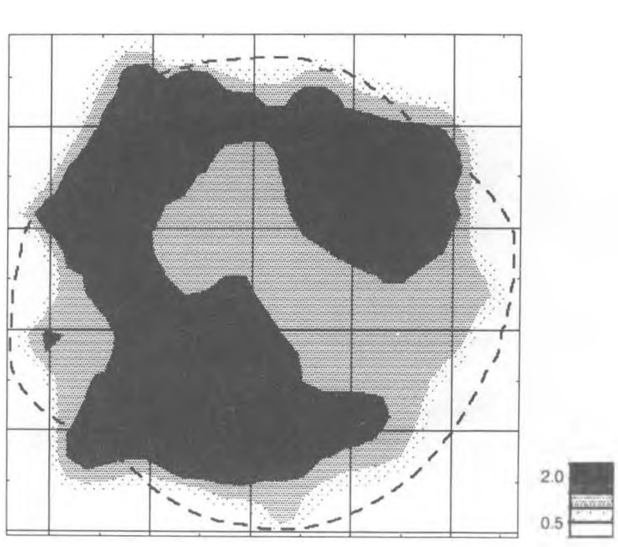

Figure 17. Concentrations (log ppm) of calcium, HP 3.

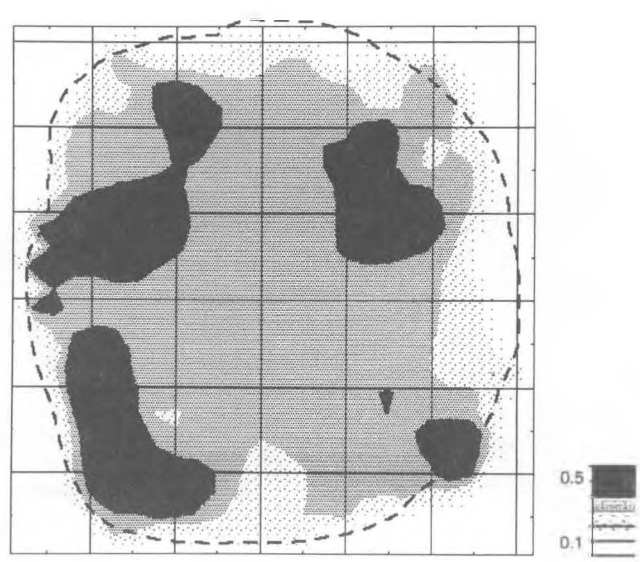

Figure 19. Concentrations (log ppm) of phosphorus, HP 7.

preparation and hearths, then, may be over represented in the chemically identified activity areas.

The differences in the patterning of chemical residues between the two levels of HP 9 correspond quite well to the differences in the spatial organization identified by the excavators. The differences between the levels also indicate that the chemical residues have remained in situ and were not leached from the upper (Stratum 8) to the lower (Stratum 10) floor.

Much of the variation in the chemical signatures suggests that the organization of the floor, though more or less consistent, was not permanently fixed. Temporary features such as hearths could have been placed wherever space permitted or convenience demanded and the sleeping platforms may have been enlarged, reduced, or moved with fluctuations in household size.

The most interesting differences, however, are between the smaller structures (HP's 9 and 12) and larger structures (HP's 3 and 7). The smaller structures are characterized by single hearths and bilateral organization while the larger structures are characterized by multiple hearths and a more radial organization. Activities in the smaller structures seem to be more concentrated in a single location while there are either multiple or fairly extensive activity areas in the larger structures. This supports the suggestion that the larger structures were multi-family dwellings. HP's 3 and 7 are especially interesting in that they appear to have such extensive food preparation and/or consumption areas.

To summarize the results of this study: multi-element chemical characterization of domestic sediments is a useful technique to identify activity areas and interpret the organization of domestic space. Chemical signatures identified in modern earthen floored houses are found in the Keatley Creek house floors. These signatures correspond to artifactual and feature evidence encountered during the excavation of these house floors; and similar house types are found to be similarly organized. The correspondence between these independent lines of evidence supports the interpretations of household organization made by the excavators as well as confirming the basic integrity of the living floors as unmixed, intact deposits.

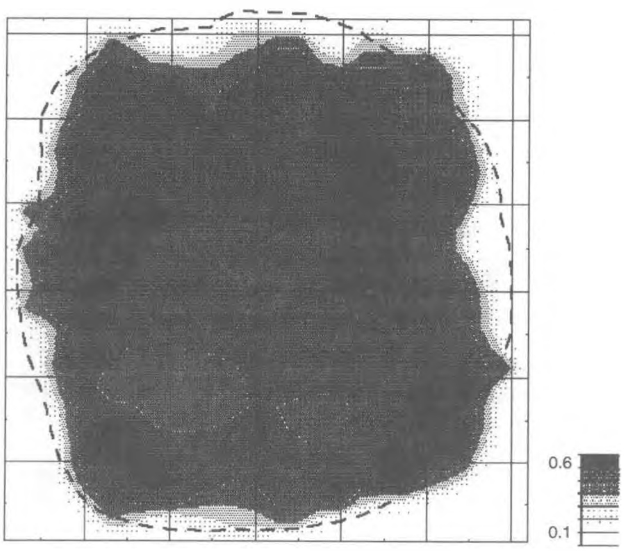

Figure 20. Concentrations (log ppm) of potassium, HP 7.

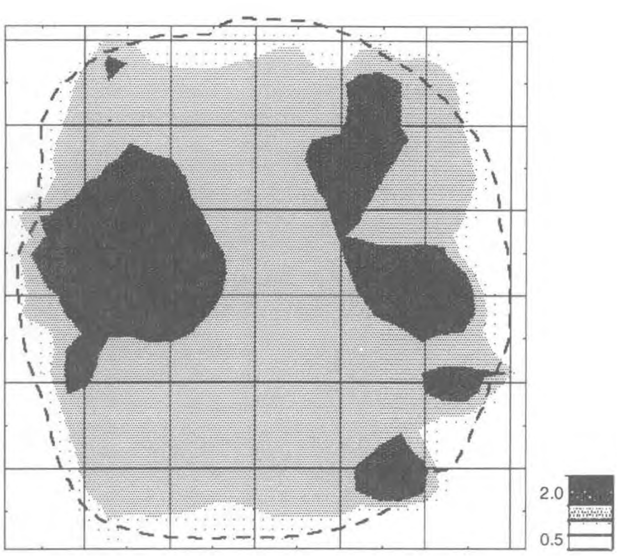

Figure 21. Concentrations (log ppm) of calcium, HP 7.

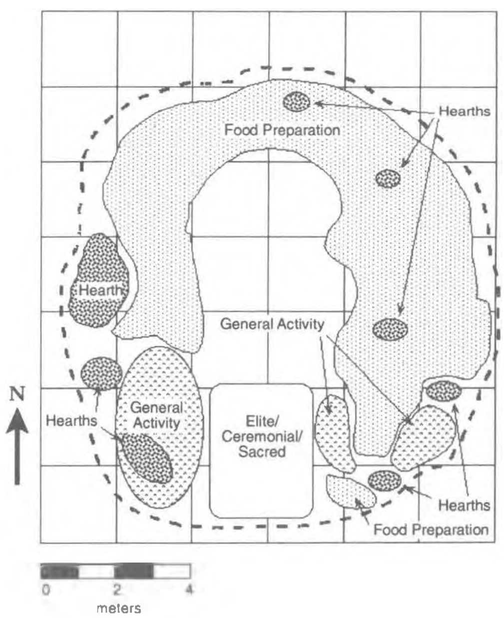

Figure 22. Chemically identified activity areas, HP 7.

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Appendix: Elemental Values and Interpretations for All Samples

House Pit	Location	North	East	P	Ca	Mg	K
HP12	Bench	3.25	2.75	0.15	1.41	0.57	0.44
HP12	Bench	2.25	3.25	0.35	1.31	0.60	0.55
HP12	FoodPrep	1.25	3.25	0.15	1.50	0.68	0.42
HP12	Bench	1.75	4.75	0.15	1.31	0.57	0.45
HP12	Activity	3.75	4.75	0.17	1.03	0.59	0.45
HP12	Bench	2.75	4.75	0.13	1.41	0.53	0.47
HP12	Activity	3.25	5.75	0.13	1.13	0.68	0.42
HP12	FoodPrep	2.75	6.75	0.17	1.50	0.68	0.44
HP12	Activity	2.25	1.75	0.15	1.13	0.66	0.38
HP12	Activity	3.25	1.25	0.11	1.22	0.65	0.26
HP12	Activity	4.25	3.75	0.11	1.31	0.67	0.26
HP12	FoodPrep	5.25	2.25	0.17	1.69	0.61	0.39
HP12	Hearth	5.25	3.75	0.41	2.53	0.63	0.48
HP12	Bench	4.25	5.75	0.15	1.41	0.57	0.34
HP12	FoodPrep	5.75	4.75	0.15	1.78	0.82	0.36
HP12	Activity	5.25	5.75	0.15	1.22	0.61	0.35
HP3	FoodPrep	4.75	6.75	0.17	1.22	0.93	0.44
HP3	FoodPrep	6.25	7.75	0.26	1.59	0.75	0.38
HP3	FoodPrep	7.25	7.75	0.33	1.78	0.75	0.41
HP3	Hearth	2.25	7.75	0.31	1.59	0.80	0.44
HP3	Activity	3.25	7.75	0.22	1.41	0.66	0.36
HP3	FoodPrep	1.25	6.75	0.31	1.59	0.72	0.39
HP3	FoodPrep	0.25	6.75	0.28	1.59	0.68	0.41
HP3	FoodPrep	4.25	5.75	0.20	1.69	0.78	0.46
HP3	Activity	5.75	4.75	0.22	1.13	0.68	0.42
HP3	FoodPrep	4.75	4.75	0.17	1.50	0.68	0.41
HP3	FoodPrep	5.25	5.75	0.20	1.50	0.83	0.40
HP3	Activity	6.25	5.75	0.20	1.41	0.91	0.35
HP3	FoodPrep	7.75	4.75	0.22	1.59	0.83	0.38
HP3	FoodPrep	6.75	4.75	0.22	1.50	0.80	0.41
HP3	Activity	7.25	5.75	0.17	1.41	0.79	0.38
HP3	FoodPrep	3.75	4.25	0.24	1.50	0.62	0.44
HP3	Hearth	2.75	4.75	0.37	1.59	0.64	0.43
HP3	Hearth	3.25	5.75	0.37	1.78	0.83	0.45
HP3	Hearth	1.75	4.75	0.41	1.97	0.69	0.45
HP3	FoodPrep	1.25	5.75	0.35	1.78	0.73	0.39
HP3	FoodPrep	4.25	9.75	0.24	1.50	0.75	0.37
HP3	FoodPrep	5.25	9.75	0.24	1.50	0.69	0.36
HP3	FoodPrep	6.25	9.75	0.26	1.59	0.82	0.37
HP3	FoodPrep	7.25	9.75	0.20	1.69	0.80	0.33
HP3	FoodPrep	4.25	3.75	0.20	1.59	0.75	0.41
HP3	FoodPrep	5.75	2.75	0.24	1.69	0.72	0.46
HP3	FoodPrep	4.75	2.75	0.22	1.50	0.78	0.41
HP3	FoodPrep	5.25	3.75	0.20	1.59	0.76	0.42
HP3	FoodPrep	6.25	3.75	0.22	1.59	0.67	0.45
HP3	FoodPrep	6.75	2.75	0.31	1.78	0.83	0.44
HP3	FoodPrep	7.25	3.75	0.24	1.69	0.83	0.42
HP3	Hearth	2.25	3.75	0.33	1.50	0.72	0.42
HP3	FoodPrep	3.75	2.75	0.26	1.41	0.69	0.39
HP3	Hearth	2.75	2.75	0.28	1.50	0.66	0.45
HP3	Hearth	3.25	3.75	0.31	1.59	0.84	0.40
HP3	FoodPrep	1.75	2.75	0.28	1.69	0.82	0.41
HP3	Activity	4.75	10.75	0.20	1.31	0.57	0.32

House Pit	Location	North	East	P	Ca	Mg	K
HP3	FoodPrep	8.25	5.75	0.31	1.59	0.88	0.39
HP3	FoodPrep	8.75	4.75	0.33	2.06	0.90	0.37
HP3	FoodPrep	9.25	3.75	0.33	2.06	0.80	0.46
HP3	FoodPrep	8.75	7.25	0.33	1.69	0.82	0.38
HP3	FoodPrep	6.25	1.75	0.28	1.97	0.84	0.47
HP3	FoodPrep	3.75	1.75	0.28	1.78	0.68	0.40
HP7	Foodprep	4.25	7.75	0.31	1.13	0.68	0.59
HP7	Activity	2.25	7.75	0.35	1.22	0.52	0.49
HP7	Activity	3.25	7.75	0.33	1.03	0.51	0.44
HP7	Activity	3.75	2.75	0.41	1.31	0.49	0.43
HP7	Hearth	2.75	2.75	0.57	1.50	0.41	0.66
HP7	Activity`	3.25	3.75	0.28	1.03	0.39	0.47
HP7	Activity	4.25	3.75	0.37	1.31	0.59	0.46
HP7	FoodPrep	5.25	3.75	0.37	1.59	0.86	0.57
HP7	Hearth	5.75	9.25	0.39	1.59	0.57	0.64
HP7	FoodPrep	4.75	8.75	0.33	1.22	0.68	0.54
HP7	FoodPrep	3.75	8.75	0.41	1.41	0.73	0.59
HP7	FoodPrep	2.75	8.75	0.37	1.41	0.61	0.60
HP7	FoodPrep	8.75	6.75	0.33	1.41	0.53	0.56
HP7	FoodPrep	9.25	7.75	0.41	1.59	0.73	0.59
HP7	FoodPrep	8.25	9.75	0.44	1.41	0.68	0.59
HP7	Hearth	9.75	8.75	0.48	1.97	0.74	0.60
HP7	FoodPrep	8.75	8.75	0.46	1.50	0.78	0.62
HP7	FoodPrep	9.25	9.75	0.28	1.41	0.81	0.58
HP7	FoodPrep	10.25	7.75	0.37	1.31	0.62	0.57
HP7	Hearth	11.75	6.75	0.37	1.41	0.51	0.64
HP7	FoodPrep	10.75	6.75	0.35	1.50	0.66	0.54
HP7	FoodPrep	9.25	1.75	0.39	1.50	0.67	0.57
HP7	FoodPrep	11.75	2.75	0.39	1.88	0.83	0.56
HP7	FoodPrep	10.75	3.75	0.46	1.50	0.64	0.53
HP7	FoodPrep	10.75	2.75	0.28	1.50	0.80	0.58
HP7	FoodPrep	10.25	9.75	0.31	1.41	0.75	0.45
HP7	FoodPrep	11.75	8.75	0.24	1.50	0.64	0.50
HP7	FoodPrep	10.75	8.75	0.26	1.69	0.67	0.55
HP7	FoodPrep	11.25	9.75	0.33	1.50	0.61	0.53
HP7	FoodPrep	8.75	10.75	0.31	1.31	0.68	0.57
HP7	FoodPrep	4.25	11.75	0.35	1.69	0.76	0.54
HP7	FoodPrep	5.75	10.75	0.26	1.97	0.66	0.57
HP7	FoodPrep	4.75	10.75	0.26	1.31	0.61	0.56
HP7	FoodPrep	6.25	1.75	0.35	1.59	0.79	0.61
HP7	Hearth	7.75	0.75	0.46	1.69	0.57	0.55
HP7	Hearth	6.75	0.75	0.55	1.88	0.68	0.62
HP7	Hearth	7.25	1.75	0.52	1.88	0.68	0.64
HP7	Hearth	4.25	1.75	0.50	1.59	0.69	0.61
HP7	Hearth	5.75	0.75	0.48	1.59	0.62	0.59
HP7	Hearth	3.75	10.75	0.31	1.78	0.63	0.65
HP7	Activity	2.75	10.75	0.52	0.17	0.49	0.61
HP7	Hearth	1.75	2.75	0.50	1.13	0.42	0.60
HP7	Activity	0.75	2.75	0.44	1.22	0.53	0.55
HP7	Hearth	1.25	3.75	0.52	1.41	0.57	0.63
HP7	Hearth	1.75	9.25	0.33	2.25	0.70	0.62
HP7	FoodPrep	1.75	6.75	0.28	1.31	0.72	0.54
HP7	Elite	0.75	6.75	0.35	4.78	0.63	0.59
HP7	FoodPrep	1.25	7.75	0.35	1.41	0.68	0.62