CHAPTER EIGHT

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Folsom Hearth-Centered Use of Space at Barger Gulch, Locality B

This chapter concerns organization and use of hearth space at a Folsom residential site in the mountains (Middle Park) of north-central Colorado. Based on ethnoarchaeological and ethnographic observations of hunter-gatherer camps, it has been well established that hearths frequently served as focal activity loci (Binford 1978, 1983; O'Connell, Hawkes, and Blurton Jones 1991; Walters 1988; Yellen 1977). Fires not only aided in the performance of specific activities (e.g., cooking, wood working, or mastic preparation) but also provided micro-environmental enhancements in heat and light that often made areas adjacent to hearth features preferred working environments. Prehistorically, this pattern is evident in the form of hearth-centered activity areas, identified by high-density clusters of artifacts and bone in association with hearth features (e.g., Audouze and Enloe 1997; Gamble 1991; Leroi-Gourhan and Brézillon 1966, 1972; Simek 1984, 1987;

Stapert 1989, 1990, 1991–1992, 2003; Stevenson 1985, 1991). Yet with few exceptions, hearth-centered activity areas are uncommon from Folsom contexts, and those that have been proposed (e.g., Frison 1982; Jodry 1999; Jodry and Stanford 1992; Smith and McNees 1990) are only minimally described, with the sole exception of possible hearth-centered activity areas at the Mountaineer site (Stiger 2006). This observation serves as the primary inspiration for this study, in which we describe spatial patterning in a high-density Folsom hearth-centered activity area from Locality B of the Barger Gulch site in Middle Park, Colorado.

Although it is safe to assume Folsom peoples utilized fire, clear, unambiguous archaeological evidence of hearth features from Folsom contexts are rare. In fact, substantially more hearths are likely known from middle Paleolithic contexts (e.g., Gamble 1999:255–260; Simek 1987; Stapert 1990; Weiner et al. 1995) than from the entire sample of excavated Folsom sites. Certainly, in contrast to the comparably aged Magdalenian record of Western Europe, there are, as of yet, no Folsom Pincevents or Verberies with well-preserved and meticulously excavated stone-ringed or gravel-lined hearths surrounded by intact patterned distributions of stones and bones. While numerous factors are likely contributors, the scarcity of Folsom hearths may be in part a product of excavation bias. For example, it seems likely that excavated portions of the Lindenmeier site must have contained cultural fire features, but only scant evidence of the presence of hearths is provided in the available literature (Wilmsen and Roberts 1984:60). In discussing Frank Roberts's field notes, Wilmsen (Wilmsen and Roberts 1984:24) reported: "More serious limitations are imposed by absence of data for some classes of material remains. Roberts noted the presence of charcoal in many squares, but he gave no information about relative densities and rarely recorded the presence of hearths or firepits." Poor excavation quality (by modern standards) and limited documentation, therefore, may contribute to the relative archaeological scarcity of Folsom hearths, although this problem is certainly not unique to Folsom archaeology.

The record for recently excavated Folsom sites is more clearly documented but remains plagued by ambiguous and disparate lines of evidence. Table 8.1 presents a compilation of proposed hearth features from Folsom contexts. By our estimate, a minimum of twenty-six possible hearth features have been identified. Although this is a fairly large number considering the number of Folsom campsites that have been excavated, in only a few cases do the authors report the presence of a hearth or hearths with confidence (e.g., Dibble and Lorrain 1968; Frison 1982, 1984; Hofman 1995). Folsom hearths are often indicated by either very shallow charcoal-stained pits or surface stains of charcoal, such as those reported from Agate Basin (Frison 1982) and Rattlesnake Pass (Smith and McNees 1990). In other cases they are identified as clusters of burned artifacts, bone, or both, such as those at Bobtail Wolf (Root 2000) and Cattle Guard (Jodry 1999; Jodry and Stanford 1992). Ash is rare, only reported from Waugh (Hofman 1995) and Bonfire Shelter (Dibble and Lorrain 1968). Oxidation is only reported for the Hanson site in association with numerous possible hearth features (Frison

Table 8.1. Hearths Reported from Folsom Contexts.

Site (Locality)	*n hearths*	*Size (cm)*	*Pit Depth (cm)*	*Burned Artifacts or Bone*	*Oxidation*	*Charcoal*	*Ash*	*References*
Agate Basin (Area 2)	1	≈30 (diam.)	8	?	N	N	N	Frison 1982:39–45
Agate Basin (Area 2)	1 poss.	?	na	?	N	N	N	Frison 1982:39–45
Agate Basin (Area 3, Lower Folsom Comp)	1	≈75 (diam.)	6	?	N	Very Little	N	Frison 1982:71
Agate Basin, Area 3 (Upper Folsom Comp)	1	≈ 75 (diam.)	13.1	Y	N	N	N	Frison 1982:74
Bobtail Wolf (Block 2, Late Folsom Comp)	3 poss.	?	na	Y	N	N	N	Root 2000:120
Bobtail Wolf (Block 4, 2000:183–184 Late Folsom Comp)	1 poss.	?	na	Y	N	N	N	Root, MacDonald, and Emerson
Bobtail Wolf (Block 6, Early Folsom Comp)	1 poss.	?	na	Y	N	N	N	Root and Emerson 2000:213
Big Black (Block 2, Late Folsom Comp)	1 poss.	?	na	Y	N	N	N	William 2000:246
Big Black (Block 2, Early Folsom Comp)	1 poss.	65 × 40	na	N	N	Y	N	William 2000:145–149
Bonfire Shelter	1	≈60 (length)	<2	?	?	Y	Y	Dibble and Lorrain 1968:30–33
Carter/Kerr-McGee	1	65 × 83	6	Y	N	Y	N	Frison 1984:300
Hanson	Many poss.	?	?	Y	Y	Little	N	Frison and Bradley 1980:9–10

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Table 8.1—*continued*

Site (Locality)	*n hearths*	*Size (cm)*	*Pit Depth (cm)*	*Burned Artifacts or Bone*	*Oxidation*	*Charcoal*	*Ash*	*References*
Indian Creek (Upstream Local)	1	?	?	N	N	Y	N	Davis and Greiser 1992:266
Lindenmeier	2	?	?	?	?	?	?	Wilmsen and Roberts 1984:60
Mountaineer	1 poss.	55–60 (diam.)	10	N	N	Y	N	Stiger 2006:325
Mountaineer	1 poss.	≈50–60 (diam.)	?	Y	N	?	N	Stiger 2006:324
Rattlesnake Pass	1	≈60 (diam.)	na	Y	N	Y	N	Smith and McNees 1990:275–276
Rattlesnake Pass	1	≈300 × 100	na	?	N	Y	N	Smith and McNees 1990:275–278
Stewart's Cattleguard	4–7	?	na	Y	N	N	N	Jodry 1999:262–324; Jodry and Stanford 1992
Waugh	1	60 × 100	N	N	?	Y	Y	Hofman 1995:425–428

and Bradley 1980:9–10) and for Rattlesnake Pass (Smith and McNees 1990:275–276) and may be indicated by the "baked sediment" and "fire-scorched earth" reported for hearths from Waugh and Bonfire, respectively (Hofman 1995:425; Dibble and Lorrain 1968:33). Finally, only one hearth feature ringed with stones has been reported, the "interior hearth" at Mountaineer (Stiger 2006). At this site, the Folsom occupation occurs on a weathered bedrock surface littered with large stones, and it is unclear that the proposed hearth stones truly served that purpose (Stiger 2006:figure 9).

Based on this brief survey of Folsom hearth data, we agree with Hofman (1995:429) that Folsom hearths were most likely surface features, and, like Jodry and Stanford (1992:155), we suggest that Folsom hearths are unlikely to be preserved in many open-air contexts because ash and charcoal are easily dispersed by wind and water. If fire features oxidize underlying sediments, then reddening should be preserved in uneroded contexts, but given the rarity of oxidation, even this more reliable indicator of burning cannot be depended upon. Unfortunately, we suspect that if Folsom hearths were placed under the same scrutiny as many claims for the controlled use of fire from the lower Paleolithic (e.g., Weiner et al. 1998), very few cases would stand up to muster. This is not because we believe Folsom people did not make and use hearths; we accept as a foregone conclusion that Folsom hunter-gatherers were masterful fire producers and users. Nor are we arguing that many of the hearths that have been reported are not cultural fire features. Instead, we suggest that in many cases the identification of Folsom hearth features may, by necessity, have to rely on less reliable indicators of burning, such as the spatial clustering of burned cultural materials and associated artifact distributions. While natural post-occupational burning, as well as cleaning and dumping of hearth contents potentially complicate the identification of hearth features through spatial data, the very nature of the Folsom archaeological record suggests that reliance on clear visual evidence encountered during excavation (e.g., soil oxidization and stone features) is not sufficient. Quite simply, it seems logical to assume that Folsom peoples utilized hearths but that evidence attesting to their use is less readily identifiable than in other archaeological contexts.

After a brief description of the Folsom deposits at Barger Gulch, Locality B, we discuss methods employed to identify the presence of a hearth at the site. Next, we compare the composition of the lithic assemblages associated and not associated with the hearth. The final series of analyses looks at fine-grained spatial patterns in the hearth area aimed primarily at exploring whether the hearth was situated in an inside or an outside space. Our goals are to provide detailed spatial analysis and interpretation of a single Folsom hearth and its related activity areas to provide insight into the spatial organization of Folsom residential site occupations, to provide a methodological framework for identifying hearth features applicable to other Folsom archaeological contexts, and to establish a record of quantitatively defined hearth features suitable for multi-site and multi-feature comparison.

BARGER GULCH, LOCALITY B

The Barger Gulch site includes a series of archaeological localities adjacent to Barger Gulch, a perennial, spring-fed southern tributary of the Colorado River in Middle Park, Colorado (Surovell et al. 2003; Waguespack et al. 2002). We have identified eight Paleoindian localities in the northern portion of the drainage near its confluence with the Colorado. In 1988, Naze (1994) investigated an additional Folsom occupation at the Crying Woman site, approximately 3.5 km upstream from our work. The high density of Paleoindian archaeology associated with Barger Gulch is mimicked by the Middle Park region as a whole, where more than seventy-five Paleoindian sites or localities are known (Naze 1986; Kornfeld 1998, personal communication; Kornfeld and Frison 2000).

Locality B of the Barger Gulch site (herein referred to as BGB) is a shallowly buried Folsom campsite situated on a high eastern terrace of Barger Gulch, approximately 30 m above current stream level at an elevation of 2,323 m (7,620 ft) above sea level. Throughout the 2002 field season we excavated a total of 51 m^2, including a 40 m^2 contiguous excavation block. The excavated lithic assemblage totals 19,658 artifacts, including over 150 flake tools, 35 cores and core fragments, 14 bifaces, 8 preforms, 40 channel flakes, and 13 Folsom projectile points. The projectile point assemblage is dominated by basal fragments, with only one tip recovered to date. The assemblage is dominated by local Troublesome Formation Chert (a.k.a. Kremmling Chert), representing 98.6 percent of all items. Nonlocal raw materials include Trout Creek Chert available approximately 90 km to the south and Black Forest Petrified Wood, outcropping approximately 150 km to the southeast.

The cultural materials vary in depth from surface exposure to approximately 75 cm beneath the surface, and because the site sits on a relative topographic high, the archaeological deposits have likely never been deeply buried. Roots, rootlets, and krotovinas are regular occurrences in the deposits, and considerable vertical artifact dispersal is present. The occupation surface, identified by a peak in vertical artifact densities, has been dispersed in places as much as 40 cm upward and 30 cm downward (Surovell et al. 2005). Therefore, some post-depositional artifact movement is evident, and by no means would we consider the cultural deposits a "living floor."

Villa (1982:282) has shown that vertical dispersal of artifacts with relatively little horizontal displacement is possible, and numerous patterns and analyses indicate that this is the case at BGB. For example, at the scale of individual excavation units, the assemblage is statistically identical through vertical space with respect to the proportion of lithic artifacts exhibiting burning, platforms, and cortex (Surovell et al. 2000). Also, across all excavation units, the number of artifacts found in upper excavation levels positively correlates with the number of artifacts from lower levels (Surovell et al. 2003; Waguespack et al. 2002). When combined with several vertical artifact refits cross-cutting stratigraphic levels, it is clear that artifacts from upper levels are derived from lower levels, and because

8.1. Two conjoining biface fragments in situ within the main excavation block. Inset shows both faces of the complete, conjoined biface. Inset is not shown to scale.

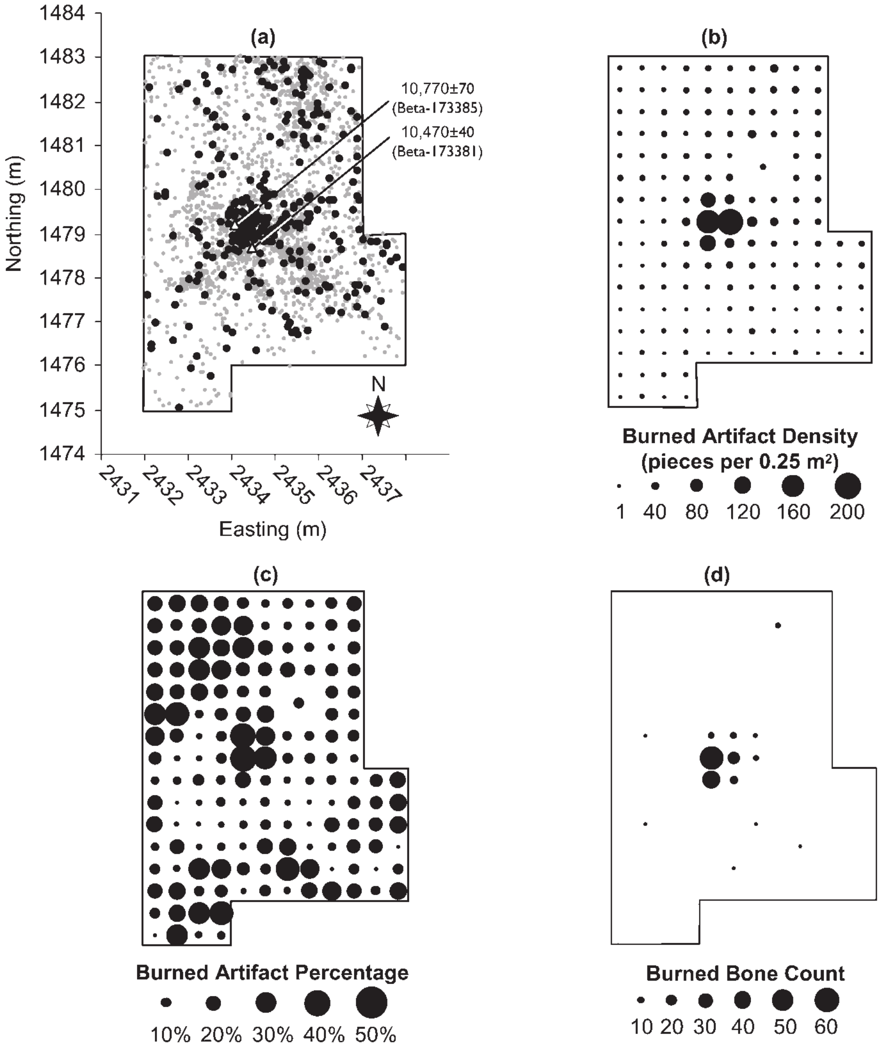
these patterns are detectable at the scale of excavation units, horizontal movement associated with vertical dispersal was likely on the scale of centimeters or decimeters rather than meters. Many additional spatial pattterns suggest that spatial relations remain intact. For example, we have recovered a tightly constrained cluster of nonlocal raw material related to a projectile point manufacture event (see Figure 8.11). This cluster includes more than 200 artifacts, of which more than 95 percent are smaller than 1 cm in maximum length. These tiny marginal pressure flakes should be very susceptible to lateral post-depositional movement, and yet they appear to have remained in place. Figure 8.1 shows two conjoining biface fragments recovered lying literally one on top of another, presumably how they were left when the site was abandoned.

In addition, by comparison of the lithic assemblage from BGB to Folsom assemblages from Agate Basin, Carter/Kerr-McGee, and Krmpotich, Surovell (2003) has shown that a single occupation is present, eliminating the possibility of an overlapping palimpsest of multiple site occupations. Based on high artifact densities, an overwhelming dominance of local raw material in the assemblage, and evidence attesting to the manufacture, use, resharpening, and discard of chipped-stone tools, we have argued that the site represents a long-term occupation, one that likely persisted for a period of multiple weeks to three months (Surovell 2003; Surovell et al. 2003; Waguespack et al. 2002). Although we have yet to recover any direct seasonality indicators, we have suggested that BGB represents a cold-season occupation where site inhabitants took advantage of the congruence of lithic raw material, water, fuel, and high densities of large ungulates wintering in the valley bottom (Surovell et al. 2003; Waguespack et al. 2002). Because the site appears to represent a single occupation, has excellent spatial integrity, and has produced large numbers of artifacts, it provides an excellent opportunity to examine the organization of Folsom spatial behavior at a very fine scale.

IDENTIFYING THE HEARTH

While there is clear evidence of burned cultural materials in the site assemblage, during excavations at BGB no unambiguous hearth features were identified. Burned lithics are found in virtually every excavation unit, flecks of charcoal are scattered throughout the deposits, and calcined bone fragments have been recovered. In the southeastern portion of our excavations, we have encountered somewhat linear concentrations of charcoal that we suspect represent burned roots from natural fires and occasional small, round clasts of what appear to be oxidized sediments. Based on temporal clustering in the population of charcoal radiocarbon dates (n=13), we have identified at least five natural burn events dating between 9,420 ± 50 and 6,880 ± 50 radiocarbon years before present (RCYBP) that passed over or near the excavation area following the Folsom occupation (Surovell et al. 2003). Given the number of natural burn events recorded in the deposits, the interpretation of the spatial distribution of burned material is by no means straightforward, but we nonetheless remain confident in our identification of at least one hearth feature preserved within the excavation block. Multiple lines of evidence support this contention. The hearth is identified on the basis of the spatial congruence of Folsom-age charcoal radiocarbon dates and high counts and frequencies of burned artifacts and bone.

From our 40 m^2 primary excavation block, we have mapped 2,857 chipped-stone artifacts. Figure 8.2a shows the distribution of burned piece-plotted artifacts overlain on all artifacts. Although burned artifacts are scattered throughout the excavations, a cluster, approximately 1.2 m in diameter, is present at approximately N 1479.25, E 2434.25. The cluster is also apparent in the distribution of small items recovered from screening (Figure 8.2b). This "hot spot" contains the greatest densities of burned artifacts and corresponds spatially to the highest artifact densities in the site. Excavation units (screened through ⅛" mesh) within 1 m of the hearth contain between 600 and 1,500 artifacts per m^2. While this pattern is typical of a hearth-centered activity area, whereby cultural debris becomes concentrated in work areas adjacent to hearth features, it could also be argued that more burned artifacts are present in this area simply because more artifacts are present. In other words, if the concentration of burned materials is a product of natural burn events, which resulted in a consistent proportion of all artifacts exhibiting signs of heat exposure, then units with more artifacts will necessarily contain greater numbers of burned artifacts. This possibility can be addressed



8.2. Distributions of burned materials from main excavation block of Barger Gulch, Locality B: (a) piece-plotted burned artifacts (black) mapped overlaid on all piece-plotted artifacts (gray). The positions of two charcoal samples yielding Folsom-aged radiocarbon dates are shown as white triangles. (b) Burned artifact density for all artifacts, including screen items by excavation unit or quad. (c) Percentage of burned artifacts for all artifacts by excavation unit or quad. (d) Counts of burned bone fragments by excavation unit or quad.

through the use of burn percentages as opposed to counts. If the concentration is a result of cultural burning, then the proposed hearth area should also contain relatively high percentages of burned artifacts.

When we look at percentages of burned artifacts across the excavation block, two patterns emerge (Figure 8.2c). First, the greatest burning percentages correspond exactly to our proposed hearth area. Second, immediately adjacent to the proposed hearth area, burn percentages are extremely low, but they increase in all directions in more distant areas. The zone of relatively low burn percentages takes on an oval shape, trending from southwest to northeast with dimensions of roughly 4 × 3 m. Given its regularity we argue that it is not likely to have been produced by differential fuel loads or heat intensities from natural fires.

Two additional lines of evidence provide support for the presence of a hearth in this area. Two charcoal samples recovered from the hearth area produced Folsom-age radiocarbon dates (10,470 ± 40 [Beta-173381] and 10,770 ± 70 [Beta-173385] RCYBP) (Figure 8.2a). Second, the highest counts of burned bone are also clustered within the proposed hearth area (Figure 8.2d). We are unable to estimate burned bone percentages because we have recovered very few unburned pieces of bone. However, we have argued elsewhere (Surovell et al. 2003; Waguespack et al. 2002) that enhancement in apatite crystallinity resulting from burning (Person et al. 1996; Shipman, Foster, and Schoeninger 1984; Stiner et al. 1995; Surovell and Stiner 2001) was the primary process responsible for the preservation of most of the bone from the site. If we are correct, then the burn event(s) recorded by burned bone most likely occurred during or shortly after the occupation, prior to the inferred loss of most of the faunal assemblage by mineral dissolution, subaerial weathering, or both.

Using multiple independent lines of evidence, we have identified the presence of a hearth at BGB based solely on post-excavation spatial analysis. During excavation we did not observe a pit, oxidation, or ash in this area. Dispersed flecks of charcoal were present, but this is true of the entire excavation area. Admittedly, spatially constrained dumping of hearth contents could also produce these patterns, but, as is shown later, many spatial patterns associated with the BGB hearth are similar to patterns recognized for hearth-centered activity areas from Paleolithic contexts. Perhaps the best verification of these patterns and interpretations will be replication of them from other Folsom contexts.

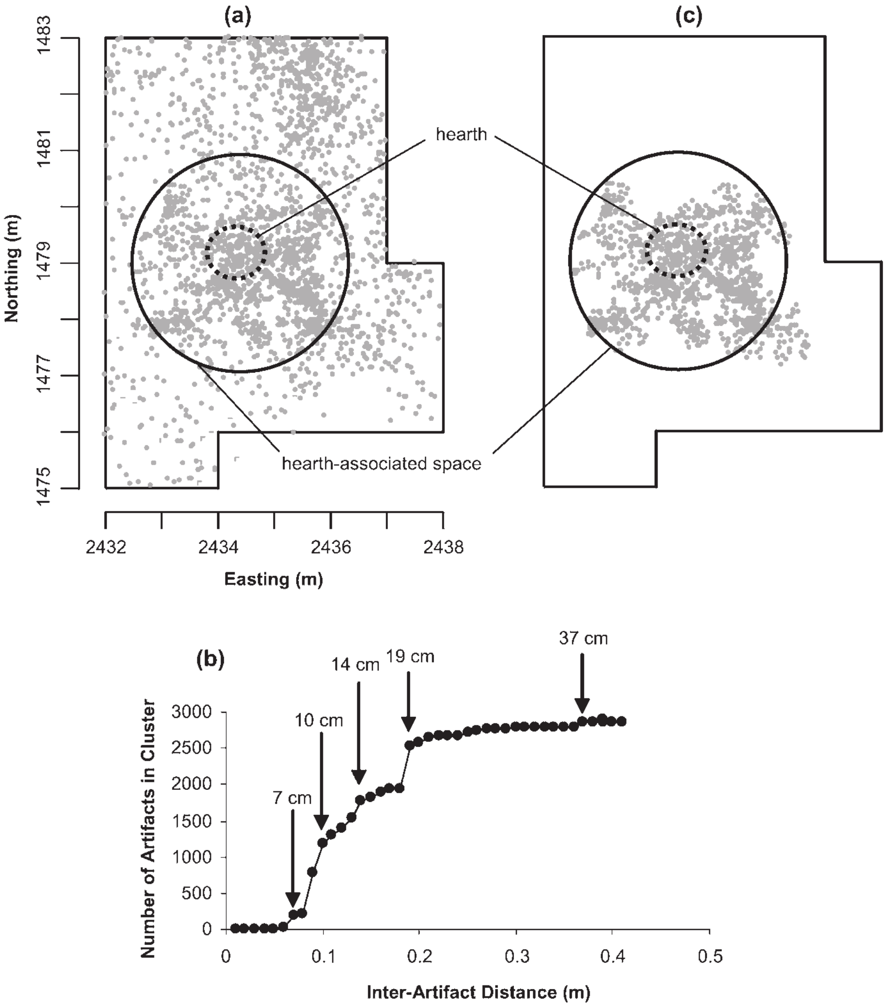
HEARTH-CENTERED USE OF SPACE, PART I: ARTIFACT REPRESENTATION

If spatial variation in the density of lithic materials is in part a reflection of people preferentially organizing their activities around sources of heat and light, we would expect artifact densities in hearth-centered activity areas to be higher than in areas more distant from hearth features. In this section, we first compare artifact densities by artifact type (e.g., debitage, tools, cores, points and performs, and bifaces) for zones associated and not associated with the hearth based on relative excavation areas. We then compare relative frequencies of artifact types for these two areas to determine if certain artifact classes are preferentially discarded in association with the hearth.

To perform these analyses, it is first necessary to define the hearth activity space. To do so, we rely primarily on visual inspection, a somewhat questionable technique but one that has proved useful for identifying coarse spatial patterns (Gregg, Kintigh, and Whallon 1991; Rigaud and Simek 1991). We then verify the "reality" of visually identified clusters using a simple algorithm similar to that used in nearest neighbor analysis (Carr 1984; Whallon 1973, 1974). From Figure 8.3a, two clusters of relatively high artifact densities are present within the excavation block. One of these clusters, in the center of the block, is associated with the hearth, and the second cluster is located in the northeastern portion of the block. We define the hearth activity space as a circle, with a radius of 1.93 m centered on the point E 2434.38, N 1479.00. This circle encompasses the majority of the hearth-associated cluster (Figure 8.3a).

Although numerous clustering techniques are available for partitioning point scatters into groups (e.g., Carr 1984; Koetje 1987; Simek 1984; Whallon 1984), the problem we face differs from the goals of traditional cluster analysis. As opposed to trying to define independently derived artifact clusters, we are instead attempting to define a cluster related to a particular point in space, the center of the hearth. A simple algorithm using inter-artifact distances was developed. The algorithm finds the total chain or web of artifacts lying within a particular distance of each other, beginning with the artifact lying closest to the center of the hearth (E 2434.25, N 1479.25). For example, if the inter-artifact distance is set to 12 cm, the program begins by finding all artifacts within a 12 cm distance of the artifact closest to the hearth center. It then finds all artifacts within 12 cm of those artifacts initially identified. This process is continued until no more artifacts can be added to the cluster. By plotting the inter-artifact distance versus total number of artifacts captured in the cluster, inflection points in the graph, where the slope of the curve dramatically drops, can be used to identify clusters of artifacts relatively isolated in space. If very few artifacts are added to the cluster when the maximum inter-artifact distance is increased, the cluster is more likely to be a true cluster rather than an artifact of the analysis, since a substantial spatial gap likely exists between the captured point scatter and the remaining points. A similar method for identifying good cluster solutions is used in K-means cluster analysis (e.g., Jodry 1999; Koetje 1987; Simek 1984).

When this algorithm is applied to the lithic scatter within the BGB excavation block, five inflection points are present in the curve relating inter-artifact distance to the number of artifacts in the cluster (Figure 8.3b). The cluster defined by a 14 cm inter-artifact distance corresponds well with that defined by visual inspection, although it extends slightly farther to the southeast (Figure 8.3c). It also excludes a number of artifacts in the northern and southern portions of our circular hearth-associated area. Nonetheless, the general correspondence of the two areas suggests that the area we have subjectively defined provides a reasonable approximation of the hearth-associated space.



8.3. (a) Plan map of excavation block showing the position of the hearth and the spatial area defined by visual inspection as in association with the hearth. (b) Maximum inter-artifact distance versus the number of artifacts included within the defined hearth-centered cluster. Five inflection points in the graph, marked by arrows, represent best clustering solutions. (c) Plan map of excavation block showing correspondence between the defined hearth-associated space and the hearth-centered cluster defined using a 14 cm maximum inter-artifact distance.

The hearth-associated space encompasses 11.7 m^2, and the non-hearth-associated space includes 28.3 m^2. Based on excavation area alone, it is expected, therefore, that 29.3 percent of artifacts will be associated with the hearth, and 70.7 percent of artifacts will be outside the hearth area. Table 8.2 shows counts of piece-plotted artifacts for each spatial unit.

Table 8.2. Chi-Square Test Comparing Artifact Type Counts for Areas Associated and Not Associated with the Hearth Based on Relative Excavation Areas.

Artifact Type	*Hearth-Associated Obs (Exp)*		*Not Hearth-Associated Obs (Exp)*		*Sum*
Debitage	**1,689**	**(783.7)***	990	(1895.3)*	2,679
Flake tools	**66**	**(33.1)***	47	(79.9)*	113
Cores	8	(8.8)	**22**	**(21.2)**	30
Points and preforms	**7**	**(4.1)**	7	(9.9)	14
Bifaces	**11**	**(5.3)***	7	(12.7)*	18
Sum	1,781		1,073		2,854

$\chi^2 = 1530.75$, df = 4, p << 0.001

Notes: Expected values calculated on the basis of relative excavation areas.
* Statistically significant deviation from the expected value following Everitt (1977:46–48). Values in bold face are those where a particular artifact class is overrepresented.

Artifact distributions are highly nonrandom, providing strong support for the presence of a hearth-centered activity area ($\chi^2 = 1536.2$, df = 4, p<<0.001). Contrary to expectations, 62.4 percent of piece-plotted artifacts are located *within* the hearth-associated space. By calculating adjusted standardized residuals, it is possible to identify which cells deviate significantly from their expected values (Everitt 1977:46–48). According to this analysis, all artifact classes are significantly overrepresented in the hearth area, with the exception of cores and projectile points–preforms (Table 8.2). Observed core frequencies almost perfectly match their expected frequencies. Points and preforms are present in greater frequencies than expected, but this difference is not statistically significant.

To directly compare the composition of lithic assemblages in the hearth area with those outside the hearth area, the analysis was repeated, but with expected values calculated based on the relative frequencies of artifacts in each area. Table 8.3 shows the observed and expected artifact counts for areas inside and outside the hearth-centered activity area. Artifact type frequencies differ significantly ($\chi^2 = 18.5$, df = 4, p = 0.001). Two artifact classes differ significantly from their expected values, debitage and cores (Table 8.3). Relative to other artifact classes, debitage is slightly overrepresented in the hearth-centered activity area, while cores are extremely underrepresented.

From these two analyses, one pattern is repeated—cores break from the trends defined by other artifact classes. Based on excavation area, they are present in their expected frequencies in the hearth area, but based on total artifact counts, they are dramatically underrepresented. This is particularly intriguing considering that debitage, a product of core reduction, is overrepresented. The discrepancy between cores and debitage could suggest that although cores were preferentially reduced in the hearth area, they were rarely discarded there. However, cores are not the only producers of debitage. Much of this debitage could have been produced by the reduction of bifaces as well, which are also overrepresented. This situation raises the possibility that there are relatively few cores compared

Table 8.3. Chi-Square Test Comparing Artifact Type Counts for Areas Associated and Not Associated with the Hearth Based on Artifact Counts.

Artifact Type	*Hearth-Associated Obs (Exp)*		*Not Hearth-Associated Obs (Exp)*		*Sum*
Debitage	**1,689**	**(1671.8)***	990	(1007.2)*	2,679
Flake tools	66	(70.5)	**47**	**(42.5)**	113
Cores	8	(18.7)*	**22**	**(11.3)***	30
Points and preforms	7	(8.7)	**7**	**(5.3)**	14
Bifaces	11	(11.2)	**7**	**(6.8)**	18
Sum	1,781		1,073		2,854
χ^2 = 18.5, df = 4, p = 0.001					

Notes: Expected values calculated on the basis of relative artifact counts.

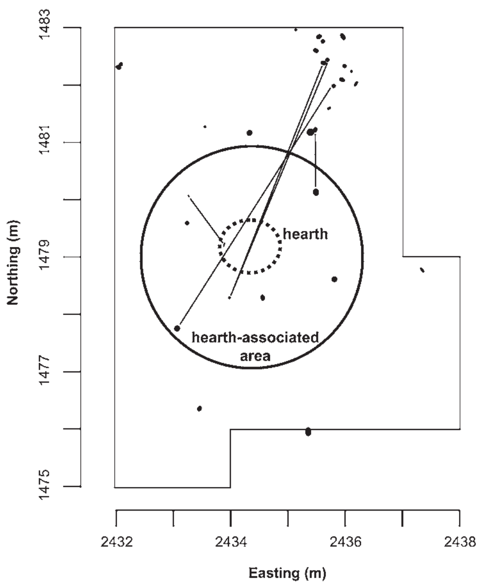
* Statistically significant deviation from the expected value following Everitt (1977:46–48). Values in bold face are those where a particular artifact class is overrepresented.

to flakes in the hearth zone because most of the hearth-related reduction was bifacial. Although debitage is also produced by tool edge maintenance, we are relying solely on piece-plotted artifacts (predominately pieces larger than 1 cm in maximum dimension), so we are confident that the majority of debitage included in the analysis was the product of primary reduction.

To distinguish between these possibilities, the debitage assemblage was apportioned into three categories: bifacial thinning flakes, core reduction flakes, and indeterminate flakes (those that could not be confidently assigned to either of the other two categories). If cores were discarded where they were reduced, then cores and core reduction flakes should show similar distributions. If cores were secondarily discarded, their distributions should be incongruent.

In Table 8.4 we present two chi-square tests comparing the frequencies of cores and core reduction flakes and bifaces (including points and preforms) and bifacial thinning flakes (including channel flakes). In this analysis cores are again underrepresented in the hearth area, while core reduction flakes are overrepresented. These differences are highly significant (χ^2 = 12.93, df = 1, p = 0.0003). In contrast, bifaces and bifacial thinning flakes do not show significantly different distributions (χ^2 = 1.10, df = 1, p = 0.294). This analysis demonstrates that although cores were commonly reduced in the hearth area, they were predominately discarded, stored in a different location, or both. In fact, the majority of the cores recovered cluster together in the northeastern portion of the excavation block (Figure 8.4). Four sets of conjoined core fragments link core specimens from the hearth area to this northeast core cluster (Figure 8.4), establishing the movement of cores between these two areas.

Numerous studies have shown that cleaning disproportionately affects large items (Bartram, Kroll, and Bunn 1991; Binford 1978; O'Connell 1987; Schiffer 1987; Simms 1988; Walters 1988), as small, unobtrusive items tend to remain in their location of initial discard while large items are often removed from work areas through deliberate cleaning. Cores are on average the largest artifact class



8.4. Map of cores and core fragments recovered from primary excavation area. Lines connect conjoining core fragments.

at Barger Gulch, which raises the question of whether cores have been removed from the hearth area simply because they are large artifacts more susceptible to cleaning activities. To test this hypothesis, the piece-plotted assemblage, excluding cores, was divided into five size classes for each spatial area (Table 8.5) to determine if other large-sized artifacts are also underrepresented in the hearth area.

A chi-square test shows no significant difference in the distribution of artifact size between the hearth and non-hearth areas ($\chi^2 = 5.527$, df = 4, p = 0.237). Therefore, among large artifacts, cores alone are found at higher proportions in the non-hearth-associated space. This provides no support for the cleaning hypothesis, implying that cores were removed from the hearth zone for some other reason.

There are numerous possible explanations for the removal of cores from the hearth area. By their very nature, cores have relatively long use lives and therefore would not necessarily be expected to be discarded at their use location (Bamforth and Becker 2000). A single core, for example, could be reduced at various locations within a site and be discarded at any of its possible use locations. However, the consideration that cores do appear to have been frequently reduced in the hearth vicinity, yet were deposited elsewhere implies that usable cores were removed from the hearth area and stored in a central location. If so, it would be expected that cores outside the hearth zone would be on average larger than those in the hearth area and, furthermore, that they should be spatially clustered. We have already shown that cores in our excavation block do show a distinctly clustered distribution, with fifteen of the thirty cores from the excavation block occurring within an area of roughly 2 m^2 in the northeastern corner (Figure 8.4). Spatial patterns of core mass also support the second prediction. Cores not associated with the hearth average 149 g in mass, while those within the hearth zone average 97 g. This difference is highly significant ($t = 26.6$, df = 28, two-tailed $p << 0.001$).

The preceding analysis identifies clear differences between the artifact assemblage associated with the hearth and the assemblage from the remainder

Table 8.4. Chi-Square Tests comparing (1) Counts of Cores and Core Reduction Flakes and (2) Counts of Bifaces and Bifacial Thinning Flakes for the Areas Associated and Not Associated with the Hearth.

Artifact Type	*Hearth-Associated Obs (Exp)*	*Not Hearth-Associated Obs (Exp)*	*Sum*	χ^2	*p*
Cores	8 (17.6)	**22 (12.4)**	30		
Core reduction flakes	**691 (681.4)**	472 (481.6)	1,163		
Sum	699 494	1,193	12.93	0.0003	
Bifaces, pts, and prefs	18 (20.7)	**14 (11.3)**	32		
BF thinning flakes*	**172 (169.3)**	90 (92.7)	262		
Sum	190	104	294	1.10	0.294

Notes: Expected values calculated on the basis of relative artifact counts.

* Includes channel flakes. Values in bold face are those where a particular artifact class is overrepresented. In the upper test, all deviations from expected values are significant. In the lower test, none of the deviations is significant.

Table 8.5. Chi-Square Test Comparing Artifact Size Class Counts for Areas Associated and Not Associated with the Hearth.

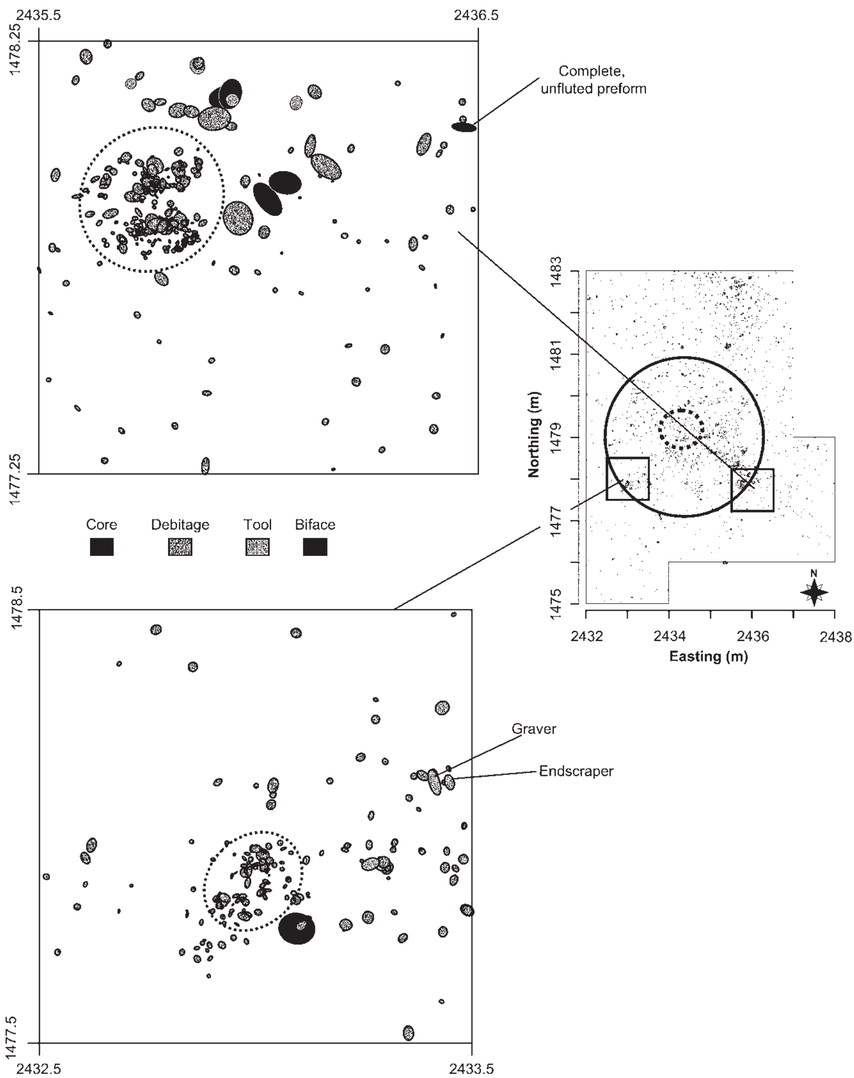
Artifact Size Class	*Hearth-Associated Obs (Exp)*	*Not Hearth-Associated Obs (Exp)*	*Sum*
>1 and ≤2.5 cm	**570 (556.4)**	322 (335.7)	892
>2.5 and ≤4 cm	167 (180.9)	**123 (109.1)**	290
>4 and ≤5.5 cm	**39 (36.2)**	19 (21.8)	58
>5.5 and ≤7 cm	8 (10)	**8 (6)**	16
> 7 cm	5 (5.6)	**4 (3.4)**	9
Sum	789	476	2,854
χ^2 = 5.527, df = 4, p = 0.237			

Notes: Expected values calculated on the basis of relative artifact counts. Values in bold face are those where a particular artifact class is overrepresented. None of the deviations from expected values is significant.

of the excavation area. Based on excavation area, all artifact classes, except cores and projectile points and preforms, are present in greater numbers than expected in the hearth area. Relative to other artifact classes, debitage is overrepresented and cores are extremely underrepresented in the hearth area. The spatial discrepancy between cores and the debitage produced through core reduction indicates that storage-discard of usable raw material nodules was spatially segregated from the area of tool production.

HEARTH-CENTERED USE OF SPACE, PART II: INSIDE OR OUTSIDE

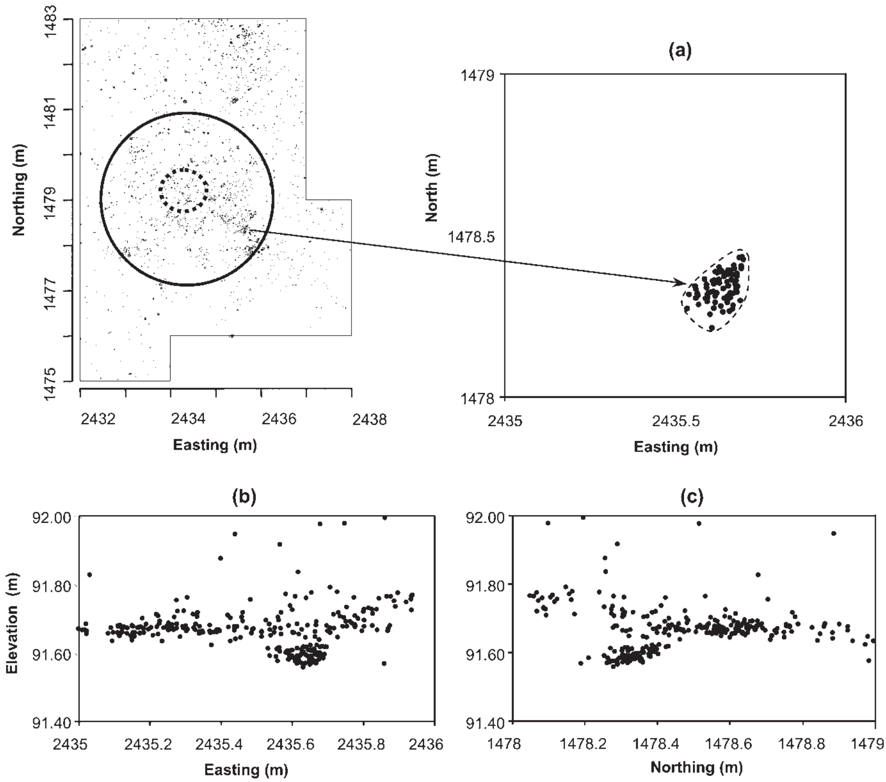
In this section we focus on fine-grained spatial patterns only within the hearth-associated zone. As we have defined it, the hearth area includes 1,538 piece-plotted artifacts. Including screen counts from 50 × 50 cm quadrants, the total hearth-related assemblage includes approximately 8,300 artifacts.



*8.5. Plan maps of two bifurcated flake concentrations southeast (*top*) and southwest (*bottom*) of the hearth.*

General Spatial Patterns

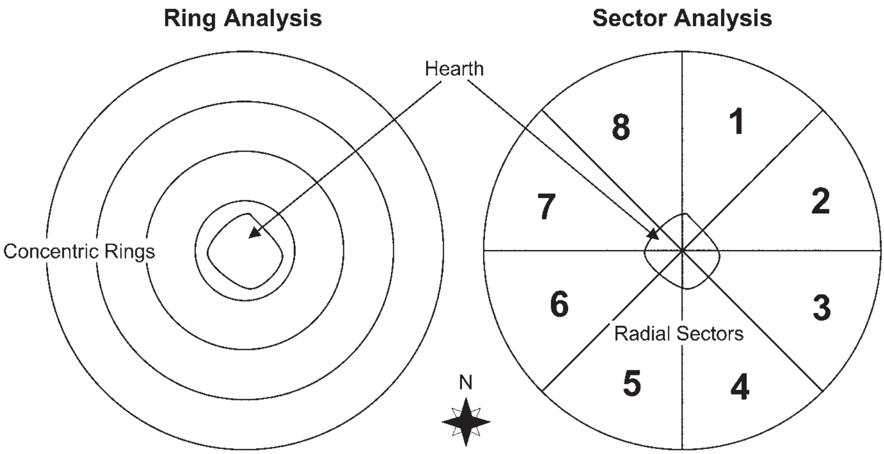
As is evident in Figure 8.3, artifacts are not concentrically distributed around the hearth; instead, they form a distinctive "X"-like pattern. The northern and eastern boundaries of the X-shaped cluster are somewhat smooth and curvilinear, but the southern and eastern boundaries are not (Figure 8.3c). The southeastern and southwestern extremes of the cluster are marked by discrete and bifurcated flake concentrations (Figure 8.5).



8.6. Maps of pit feature located to the southeast of the hearth. (a) Plan map. (b) and (c) Cross-sectional back plots.

These clusters fall on the boundary of the hearth zone, each lying approximately 2 m from the hearth center. The flake concentrations are roughly 20–25 cm in diameter, and each contains more than 400 artifacts. We do not know if these concentrations represent primary knapping debris, secondary dumping, or some other process, but given their similar configurations and spatial positions we suspect they were formed by a common process. This pattern may be repeated at the Area 2 Folsom component of the Agate Basin site, where two concentrations of debitage were mapped roughly 1.8 m from the center of a hearth (Frison 1982:figure 2.17). Numerous flake concentrations were also recovered at Bobtail Wolf and are generally interpreted to represent primary knapping debris (Root 2000:101–115).

A third debitage concentration in the hearth zone was recovered from what appears to be a shallow pit (Figure 8.6). The feature was undetectable geomorphologically, as the sediment filling the feature was indistinguishable from surrounding deposits. At the base of the feature, however, was a thin film of clay,



8.7. Schematic representation of divisions of space used in ring and sector analysis.

indicating that prior to being filled, standing water was present in the depression, causing clays to settle downward. The depression was filled with 434 unmodified flakes, 433 of Troublesome Formation Chert (a.k.a. Kremmling Chert) and 1 of Trout Creek Chert. Spatially reconstructed using backplots of artifacts, it is oblong in shape, measuring approximately 30 cm in length, 16 cm in width, and 7 cm in depth. The long axis is oriented southwest to northeast and is vertically separated from the overlying occupation surface by approximately 5 cm of sterile sediment. While caches of artifacts for later retrieval are suggested for other Folsom sites (e.g., Hofman, Amick, and Rose 1990), such features are typically associated with large usable flake blanks, tools, or bifaces. A cache presents an unlikely interpretation given the local availability of lithic raw material and the contents of the pit itself. Consisting of relatively small flakes (the majority are <2 cm in maximum dimension), the feature may represent a small refuse pit where debitage was deposited. It is also possible that the artifacts recovered from the pit washed in from adjacent areas, but, if so, it is difficult to explain the gap of relatively sterile deposits separating the main occupation surface with those recovered from within the pit fill.

Ring Analysis

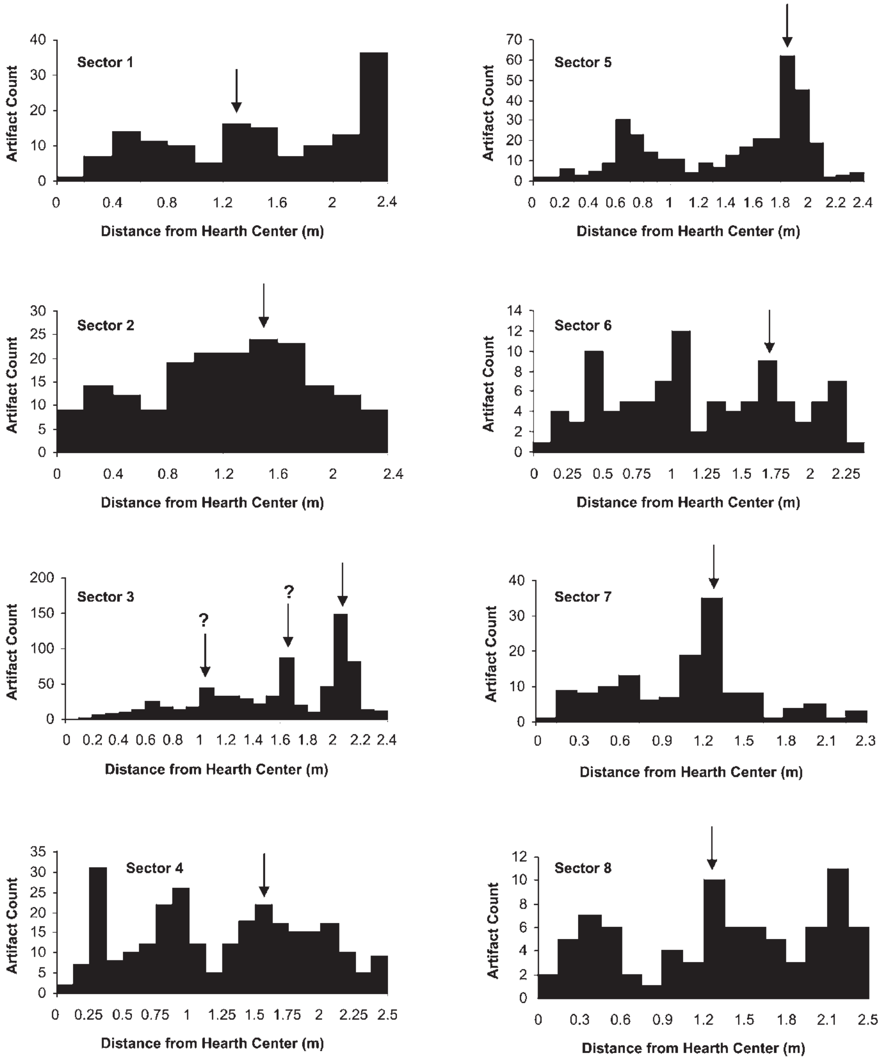
In this and the following section, we perform a series of analyses derived from the work of Dick Stapert (Stapert 1989, 1990, 1991–1992, 2003; Stapert and Johansen 1995–1996; Stapert and Street 1997; Stapert and Terberger 1989). Stapert's approach to the spatial analysis of hearth-centered activity areas is based on polar rather than cartesian space, reflecting the observation that human behavioral activities are typically concentrically oriented around hearths. Stapert refers to the suite of methods he has developed as the "ring and sector" method, whereby hearth-centered space is divided into radial sectors and concentric rings radiating out from the hearth center (Figure 8.7). The primary application of the ring and sector method is to determine whether a hearth was enclosed within a structure.

To perform ring analysis, the number of artifacts within each concentric ring is tallied. Next, a bar graph is made of artifact counts as a function of distance from the hearth center. This analysis can be done for complete rings or, if sufficient numbers of artifacts are present, by individual sectors. The former method is limited because it assumes that hearths are centrally located within perfectly circular structures. By performing the ring analysis for individual sectors, no such assumptions are necessary. Stapert (2003:7) has found that distinct types of distributions are produced by this analysis that can be attributed to the spatial location of hearths inside or outside of structures: "For some 30 palaeolithic or mesolithic sites in Europe analysed so far, we find either diagrams with one peak or diagrams with two or three peaks. . . . Multimodal diagrams seem to be characteristic for hearths inside tents. The tent walls served as a barrier, stopping centrifugal movements. Waste material tended to accumulate against the walls during occupation, thus creating a peak in the ring diagram."

In this framework, a hearth showing a single peak in artifact counts as a function of distance is generally interpreted as an open-air hearth pattern whereby artifacts preferentially accumulate within a drop zone (akin to Binford's [1978, 1983] outside hearth model). In a bimodal distribution, the peak closest to the hearth is interpreted as a drop zone, and the more distant peak is argued to represent artifacts pushed against tent walls, what Stapert (2003:7) calls the "barrier effect." A trimodal distribution is interpreted as indicating a drop zone, tent walls, and a door dump.

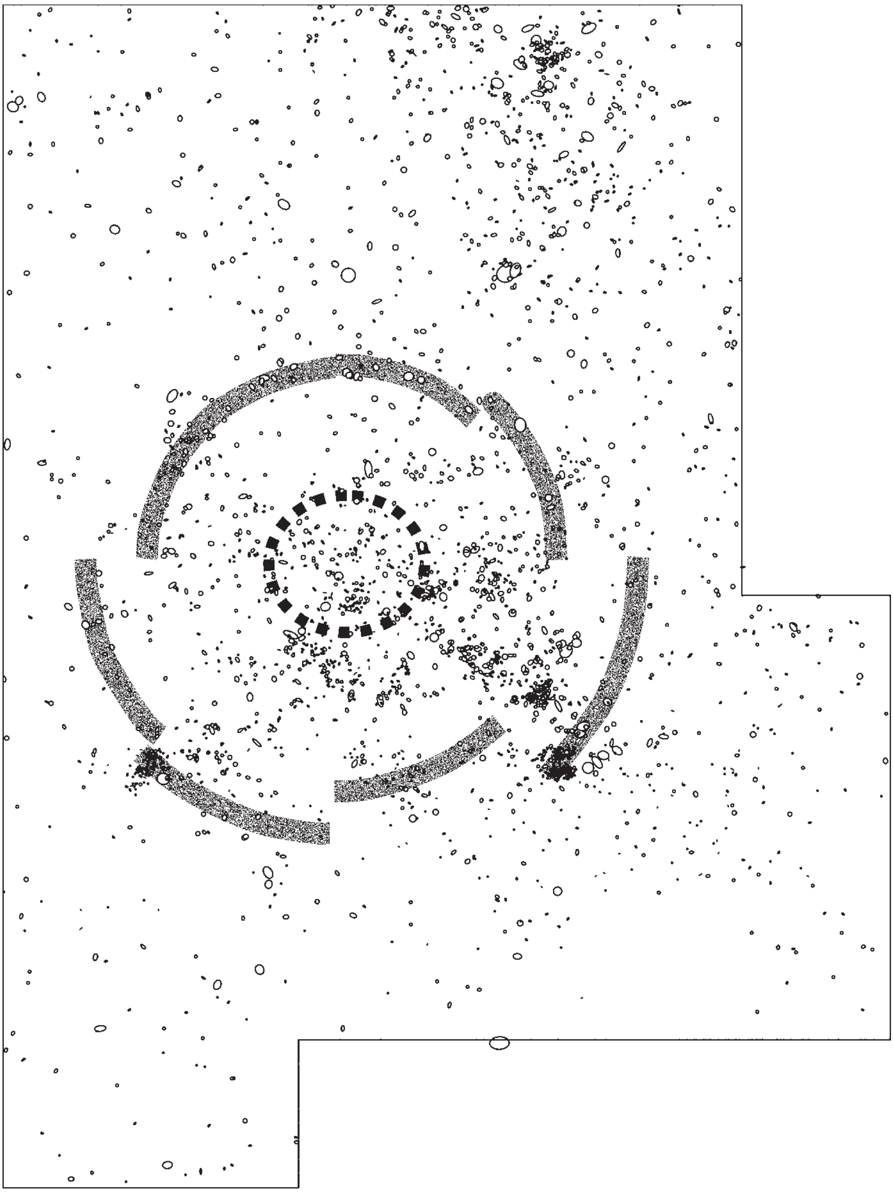
To apply Stapert's method to Barger Gulch, we must first define the hearth center. In the absence of a clear feature, for simplicity we defined the center of the hearth as N1479.25, E 2434.25, the center of the southwest quadrant of the excavation unit N 1479, E 2434. This point was chosen because this particular quadrant contains both the greatest number and the greatest percentage of burned chipped stone and bone. We then divided the space surrounding the hearth into eight sectors, each 45° in width. The space surrounding the hearth was also divided into concentric rings, the width of which varies for each analysis.

Figure 8.8 shows the ring diagrams for each of the eight sectors (as shown in Figure 8.7). Interestingly, all of the ring diagrams are multimodal when viewed at various scales. The diagrams range from showing regular distributions to being fairly noisy, with two to four modes present. Some commonalities, however, exist among all the diagrams. A peak in artifact counts is invariably located near the hearth, generally at distances ranging from 0.3 to 1 m. Following Stapert and Binford (1978, 1983), these modes likely represent drop zones in association with the hearth. The near-hearth mode is followed by a trough in artifact counts, located between 0.6 and 1.2 m, and a second peak 1.3



8.8. Ring diagrams by sector for the hearth area showing artifact counts as a function of distance from the hearth. Arrows represent the postulated position of a "barrier effect," caused by artifacts pressed against the walls of a structure.

to 1.8 m from the hearth center. The ring diagram from Sector 3 is particularly complex. This sector is characterized by the greatest number of artifacts and shows four distinct modes. Three of these modes are within 2 m of the hearth, and the fourth is at a distance of 2 to 2.1 m from the hearth center. The mode at 1.6–1.7 m is caused by the high density of artifacts within the pit feature discussed earlier (Figure 8.6), and the mode at 2–2.1 m is caused by one of the bifurcated artifact clusters (Figure 8.5).



8.9. Plan map of hypothesized barrier effect. Gray lines show reconstructed locations of possible structural walls. Dashed black line shows location of the hearth.

If modes distant from the hearth center represent artifacts pushed against walls, Stapert's "barrier effect," then an interior hearth is suggested by the ring analysis for individual sectors. To identify the approximate location of a possible wall, for each ring diagram the first mode exceeding 1.2 m was identified (Figure

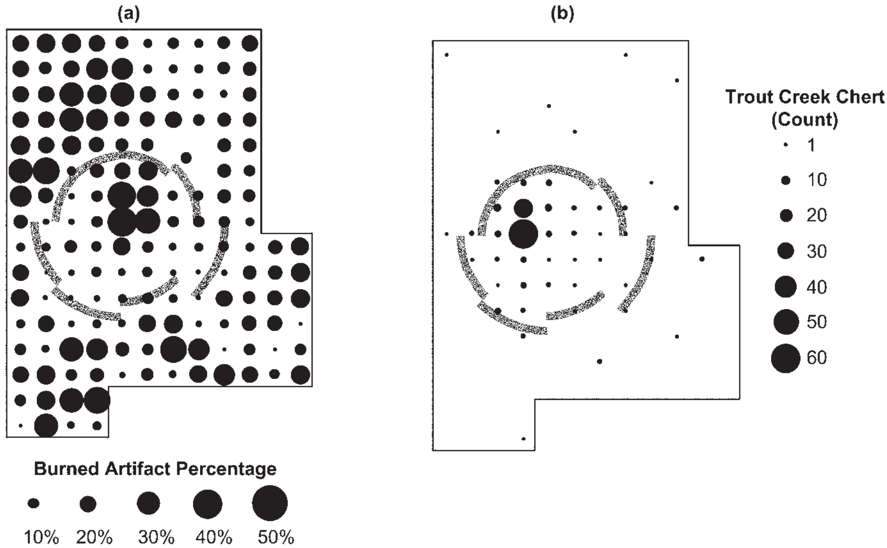
8.8). For Sector 4, the second mode exceeding 1.2 was used because the first mode is caused by the concentration of artifacts in a buried feature. By using the location of each mode, it is possible to reconstruct wall locations for a hypothetical structure (Figure 8.9). Using these estimates, the pit feature falls within the reconstructed walls.

The wall positions for the northern half (Sectors 7–8, 1–2) of the possible structure are consistently located between 1.275 and 1.5 m. On the southern half of the cluster (Sectors 3–6), the reconstructed wall positions are considerably more variable, ranging from 1.56 to 2.05 m from the hearth center. If this reconstruction is correct, the hearth sat within a semicircular structure roughly 3 × 4 m in size.

Two independent spatial patterns correlate well with the hypothesized structure. The oval of relatively low burning percentages discussed earlier is relatively congruent with the space defined by ring analysis (Figure 8.10a). Perhaps more striking is the congruence between that space and a contiguous cluster of Trout Creek Chert (Figure 8.10b). This cluster radiates outward in all directions from two excavation quads (N 1479.25 and 1479.75, E 2433.75), which contain the vast majority of Trout Creek artifacts. The cluster is skewed to primarily to the east and south (opposite of the slope of the ancient ground surface) and fills the space defined by ring analysis. We emphasize that we are not necessarily arguing for the presence of an interior hearth or a structure. Instead, we are proposing that this may have been the case. We have identified repeated spatial patterns, but only one of those, the possible "barrier effect," has any bearing on the existence of a structure. Also, in the next section we present evidence that might suggest that the hearth was located in an exterior space. We remain hopeful that our ongoing refitting analyses will shed additional light on these questions and that further excavation will reveal additional hearth-centered clusters for comparison. Although structures have been proposed for other Folsom sites (e.g., Frison and Bradley 1980; Frison 1982; Jodry 1999; Stiger 2006), the nature of the data available at this point in time is insufficient for meaningful comparison. The size of the possible structure we have identified, however, is consistent with that proposed for Area 2 of Agate Basin (Frison 1982:39–44).

Sector Analysis

Stapert has found that exterior hearths are often characterized by asymmetry in the distribution of tools, with tools concentrating on one side of the hearth, an effect he reasonably interprets to be a result of wind patterns (Stapert 1989, 1991–1992, 2003). People working around hearths typically position themselves on the upwind side to avoid smoke, and if there is a prevailing wind direction, most work will occur on one side of the hearth. Therefore, the distribution of primary refuse around an outside hearth should reflect the distribution of wind. For interior hearths, wind effects should be largely eliminated, and asymmetry associated with interior hearths is typically interpreted to represent division of behavioral activity space (Stapert 1989, 2003; Stapert and Street 1997).



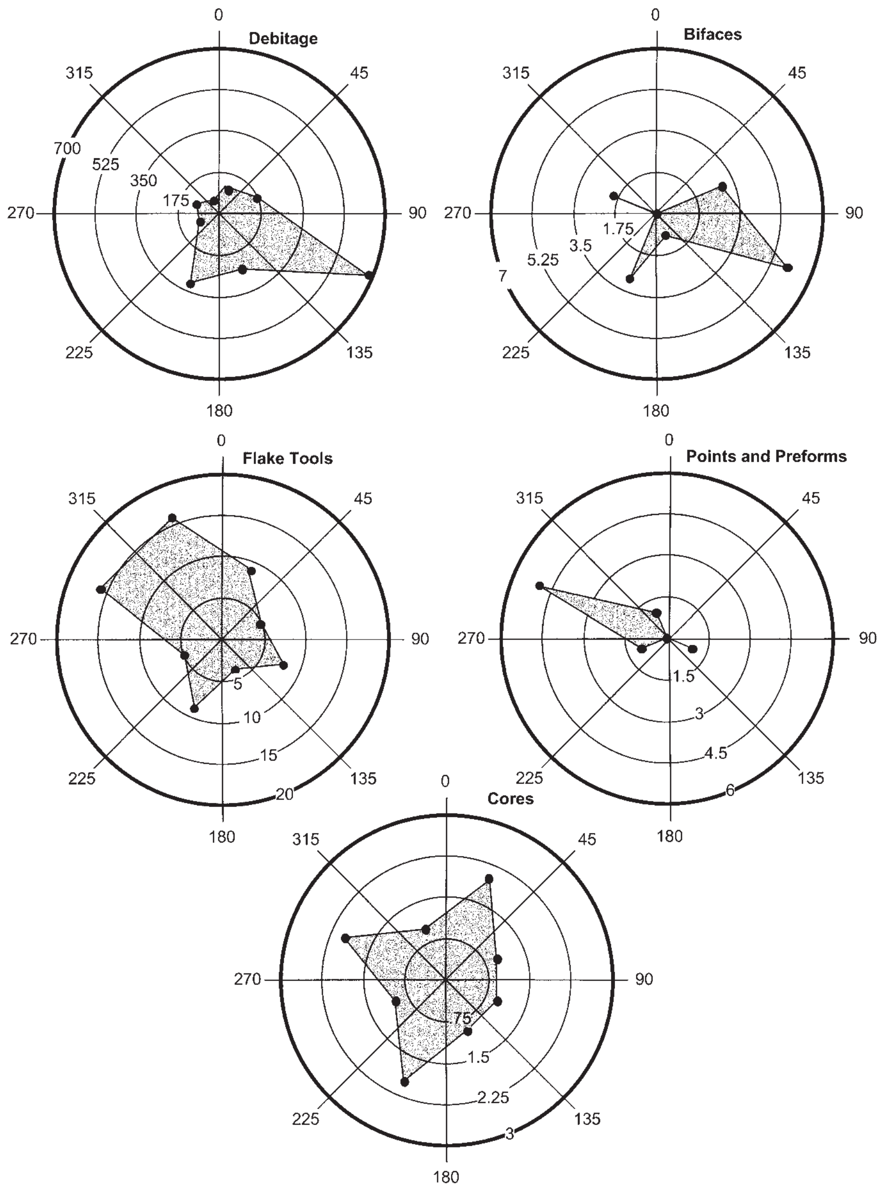
8.10. Plan maps of excavation block showing spatial congruence of the possible shelter reconstructed by ring and sector analysis and (a) an oval area of low percentages of burned artifacts and (b) a contiguous cluster of artifacts manufactured on Trout Creek Chert.

Table 8.6. Artifact Type Counts by Sector.

Sector	*Bearing from Hearth Center (θ)*	*Debitage*	*Flake Tools*	*Points*	*Preforms*	*Bifaces*	*Channel Flakes*	*Cores*	*Sum*
1	0≤ θ<45	107	9	0	0	0	0	2	118
2	45≤ θ<90	174	5	0	0	3	2	1	185
3	90≤ θ<135	684	8	1	0	6	3	1	703
4	135≤ θ<180	256	4	0	0	1	1	1	263
5	180≤ θ<225	320	9	0	0	3	3	2	337
6	225≤ θ<270	90	5	1	0	0	0	1	97
7	270≤ θ<315	105	16	4	1	2	6	2	136
8	315≤ θ<360	58	16	0	1	0	1	1	77

We divided the space surrounding the hearth at BGB into eight radial sectors (Figure 8.7). To perform the sector analysis, all piece-plotted artifacts within 2.25 m of the hearth were included. This distance includes some artifacts, particularly to the north and west, excluded from prior analyses, but their inclusion does not bias the results. Counts of artifact classes by sector are presented in Table 8.6, and radial sector diagrams are shown in Figure 8.11.

The half of the hearth composed of the four contiguous sectors containing the greatest numbers of artifacts was identified for each artifact class. Following Stapert (1989:29), this half of the hearth is referred to as the "richest half" and the opposite side as "the poorest half." Viewing artifact distributions this way



8.11. Sector diagrams of piece-plotted debitage, bifaces, flake tools, points and preforms, and cores. Artifact counts are plotted as the distance from the center of the graph, and artifact sector locations are plotted as the mean angle for the sector. Dark gray areas show the number of artifacts for each radial sector. The light gray areas show the "richest half" for each artifact class, defined as the four contiguous sectors containing the greatest numbers of artifacts.

produces a clear pattern. Debitage and bifaces are concentrated on the southeast side of the hearth, while flake tools, cores, and points and preforms are concentrated on the opposite side, on the northwest or west-northwest side of the hearth. All of these patterns are highly statistically significant with the exception of cores, which do not differ significantly from the expectation of equal association with both halves of the hearth ($\chi^2 = 0.09$, df = 1, p = 0.763). Cores are fairly consistently distributed around the hearth, with one or two present in all sectors.

Therefore, two groups of artifacts can be statistically discerned—those preferentially discarded on the northwest side of the hearth (flake tools and projectile points and preforms) and those preferentially discarded on the southeast side of the hearth (debitage and bifaces). Because of relatively large sample sizes, these patterns are particularly robust for debitage and flake tools, and, therefore, the remainder of the analysis will focus primarily on these two artifact classes. The dichotomous pattern we have identified separating debitage and flake tools is not unique to BGB. For example, in summarizing Leroi-Gourhan and Brézillon's (1972) spatial analysis of Pincevent, Section 36, Level IV(2), Simek (1984:60–61) noted, "Debitage tends to be concentrated with fire-cracked rock, on one side of the three central hearth features. The distributions of ocre (and stone tools) coincide on the opposite side. This pattern is repeated at all three central hearth locations."

Much has been written about the spatial patterns at Pincevent, particularly with respect to the presence of structures (e.g., Binford 1983; Carr 1991; Leroi-Gourhan and Brézillon 1966, 1972; Simek 1984; Simek and Larick 1983), but relatively few studies have addressed the incongruent distributions of debitage and tools. Leroi-Gourhan and Brézillon (1972) provide one explanation. They suggest that the Pincevent hearths are located at the doors of structures. The zones containing high frequencies of tools and concentrations of ochre are interior work spaces. These are abutted by relatively clean areas, interpreted to have been sleeping areas. On the opposite side of the hearth, debitage, bone, and fire-cracked rock are concentrated within an exterior, hearth-associated activity area. At greater distances are refuse zones, where artifacts are found in small piles thought to represent dumps (similar to the flake piles described earlier); and at even greater distances are diffuse refuse zones. In contrast, Binford (1983) and Stapert (1989) have argued that the Pincevent hearths were not associated with structures. Based on Binford's hearth model (1978, 1983) and ring and sector analysis, Stapert (1989) has argued that the sides of the hearth containing the majority of tools at Pincevent represent drop zones, while debitage and other waste is concentrated in a forward toss zone.

Of course, it is impossible to know a priori if debitage, tools, or both were discarded in their locations of production or use, and, of course, both debitage and tools could have been discarded in both primary and secondary contexts. Furthermore, while asymmetrical distributions around hearths are certainly expected for outside hearths in areas with prevailing winds, they might be

Table 8.7. Artifact Size Class Counts by Sector.

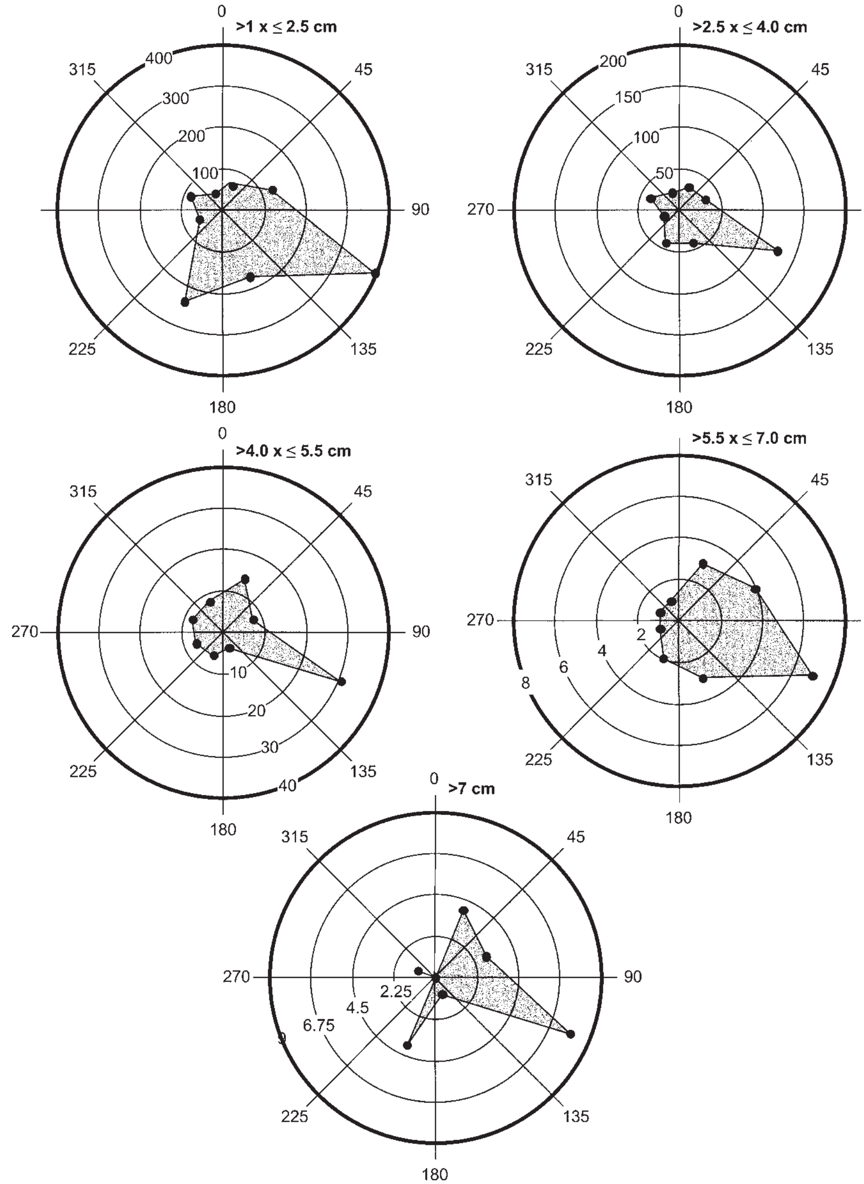
		Size Class					
Sector	*Bearing from Hearth Center (θ)*	*>1 to ≤2.5 cm*	*>2.5 to ≤4 cm*	*>4 to ≤5.5 cm*	*>5.5 to ≤7 cm*	*> 7 cm*	*Sum*
1	0≤ θ<45	64	30	14	3	4	115
2	45≤ θ<90	130	34	8	4	3	179
3	90≤ θ<135	399	129	31	7	8	574
4	135≤ θ<180	175	43	4	3	1	226
5	180≤ θ<225	241	43	6	2	4	296
6	225≤ θ<270	61	20	7	1	0	89
7	270≤ θ<315	85	38	8	1	1	133
8	315≤ θ<360	43	23	8	1	0	75

expected for interior hearths as well. Although the effects of wind are reduced or eliminated inside structures, hunter-gatherers and other mobile peoples commonly divided interior spaces into activity-specific areas (Binford 1983; Cribb 1991; Morgan 1881; Tanaka 1980:27) that could easily have produced asymmetrical patterns such as those observed at Barger Gulch or Pincevent.

If we begin with the hypothesis that the hearth at BGB is an outside hearth, then asymmetry in artifact distributions is likely best explained by prevailing wind direction. Based on sector analysis, three hypotheses are proposed: (1) based on the distribution of tools, prevailing winds were from the northwest, and debitage is concentrated in a forward toss zone; (2) based on the distribution of debitage, prevailing winds were from the southeast, and flake tools are concentrated in a forward toss zone; (3) prevailing winds cycled diurnally and were from both the northwest and the southeast. In this case, both debitage and flake tools were discarded in primary context.

Here we present a simple test of the drop and toss zone hypothesis. If drop and toss zones are present at Barger Gulch, they should be reflected by differences in artifact size distributions. Binford (1978, 1983:152–159) has suggested that toss zones will be dominated by large artifacts removed from work areas. Drop zones will be dominated by small artifacts that do not affect the usefulness of a space. Therefore, if drop and toss zones exist, we would expect to see spatial segregation between large and small items.

Counts of artifacts by size class are presented in Table 8.7, and Figure 8.12 shows radial sector diagrams by artifact size class. For all size classes, the greatest numbers of artifacts were recovered from Sector 3. The richest half for each size class varies from the northeast to the southeast half, with three size classes mimicking the distribution of debitage, the richest half being on the southeastern half of the hearth. Simple visual inspection would suggest that no drop and toss zones are present since all artifact sizes are distributed similarly around the hearth, but significant differences do exist. Based on total artifact counts (Table 8.6), the hearth area was divided into the richest (Sectors 2–5) and



8.12. Sector diagrams of piece-plotted artifacts by size class. Artifact counts are plotted as the distance from the center of the graph, and artifact sector locations are plotted as the mean angle for the sector. Dark gray areas show the number of artifacts for each radial sector. The light gray areas show the "richest half" for each size class, defined as the four contiguous sectors containing the greatest numbers of artifacts.

Table 8.8. Chi-Square Test Comparing Artifact Size Classes for the Richest and Poorest Halves.

		Size Class					
Hearth Half	*Sectors*	*>1 to ≤2.5 cm Obs (Exp)*	*>2.5 to ≤4 cm Obs (Exp)*	*>4 to ≤5.5 cm Obs (Exp)*	*>5.5 to ≤7 cm Obs (Exp)*	*> 7 cm Obs (Exp)*	*Sum*
Richest half	2–5	945 (905)*	249 (272)*	49 (65)*	16 (17)	16 (16)	1,275
Poorest half	1, 6–8	253 (293)*	111 (88)*	37 (21)*	6 (5)	5 (5)	412
Sum		1,198	360	86	22	211,687	

$\chi^2 = 31.32$, df = 4, $p << 0.001$

Notes: Expected values calculated on the basis of relative artifact counts.
* Statistically significant deviation from the expected value following Everitt (1977:46–48). Values in bold face are those where a particular artifact class is overrepresented.

Table 8.9. Chi-Square Analysis of Tools and Large Artifacts.

Hearth Half	*Sectors*	*Flake Tools Obs (Exp)*	*Other Artifacts >2.5 cm Obs (Exp)*	*Sum*
Richest half	2–5	26 (45.4)	**334 (314.5)**	360
Poorest half	1, 6–8	**46 (26.5)**	164 (183.5)	210
Sum		72	498	570

χ^2 =25.91, df = 1, p << 0.001

Notes: Expected values calculated on the basis of relative artifact counts. Values in bold face are those where a particular artifact class is overrepresented. All observed values deviate significantly from expected.

poorest (Sectors 1, 6–8) halves, and artifact size class counts were tabulated for each (Table 8.8).

A chi-square test does provide some support for the drop and toss zone hypothesis (Table 8.8). Artifacts smaller than 2.5 cm are overrepresented on the richest side, and artifacts between 2.5 and 5.5 cm are overrepresented on the poorest half. The largest artifacts, those larger than 5.5 cm, are present in their expected frequencies. This patterning could provide support for a drop zone on the richest half of the hearth (southeastern) and a toss zone on the poorest half (the northwest), but, if so, it is only weakly developed. All artifact size classes are most common within Sector 3, and differences between observed and expected values do not exceed forty artifacts (2 percent of the total sample). Also, the artifacts that should have been the most likely to have been discarded in the toss zone (the largest pieces) are not overrepresented in the poorest half.

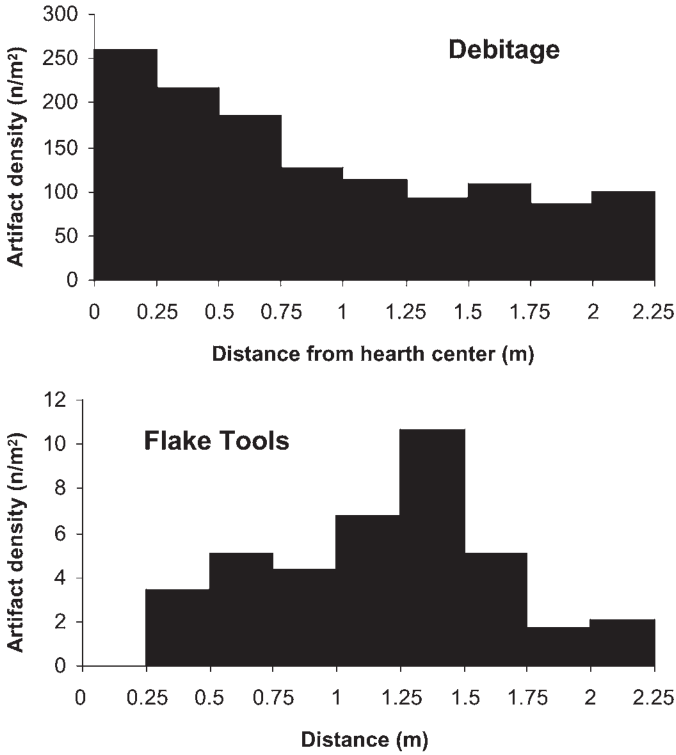
Can artifact size distributions account for the northwesterly concentration of tools? If tools were preferentially discarded on the northwestern side of the hearth within a toss zone, then the distribution of large artifacts and tools should be similar. Table 8.9 presents counts of flake tools and artifacts larger than 2.5 cm (excluding flake tools) for the richest and poorest halves of the hearth.

A chi-square test shows that tools and large artifacts have significantly different distributions ($\chi^2 = 25.91$, df = 1, $p << 0.001$). With respect to the distribution of flake tools, large artifacts are significantly underrepresented on the poorest half of the hearth. In other words, although large artifacts are present in greater frequencies than expected compared to the assemblage as a whole, compared to flake tools, large pieces are present in relatively small numbers. Therefore, artifact size differences between the richest and poorest halves alone cannot explain the northwesterly distribution of tools. There must be some other explanation, one unrelated to artifact size. This finding, we suggest, eliminates the possibility of both drop and toss zone hypotheses, unless one were to argue that only or primarily tools were tossed.

The directionally distinctive distribution of tools and debitage relative to the hearth cannot be explained solely by a simple drop and toss zone, which suggests that debitage and tools may have been discarded in their locations of use and production, respectively. If the hearth was located within an exterior space, one explanation is that winds most commonly blew from two opposing directions, northwest and southeast. Interestingly, winds in mountainous regions such as Middle Park often do cycle diurnally, and wind direction can be controlled by topography and valley orientation to a greater degree than atmospheric circulation (Banta and Cotton 1981; Whiteman 1982; Whiteman and McKee 1982). On calm nights, winds typically blow down valley axes. During the day, winds can blow upslope or in the direction of the prevailing winds above ridgetops. Therefore, the observed archaeological pattern could be a result of tool production and tool use occurring preferentially at different times of the day.

Barger Gulch sits within the greater valley of the Williams Fork (oriented southeast-northwest) near its junction with the Colorado River valley (oriented east-west). If winds cycled diurnally within the valley of the Williams Fork, they might be expected to blow from southeast to northwest from late evening to early morning and the reverse during the day. If so, it is possible that tool manufacture primarily took place in the evening, nighttime, or early morning, and tool use primarily occurred during the day. Unfortunately, we have been unable to locate any wind data from Middle Park, but because topography is the dominant control on mountain valley winds, wind patterns observed today should in theory be similar to those of the late Pleistocene. Therefore, it may be worthwhile in the future to collect wind data from the site. On the other hand, if this pattern is a product of wind direction, the same directional biases should be evident in other possible exterior hearth-centered activity areas at BGB (see Stapert 1989:30–34).

Alternatively, if the hearth was inside a structure, we may be seeing segregation of internal space, where reduction primarily took place on the southeast side of the hearth and discard and use occurred to its northwest. Patterns in tool discard location provide some support for this hypothesis. Here we performed a modified ring analysis. Rather than simply counting artifacts in concentric rings around the hearth, we calculated concentric artifact densities, taking into account the increasing area of successive rings. A comparison of the densities of flake tools and debitage concentrically around the hearth indicates that they are



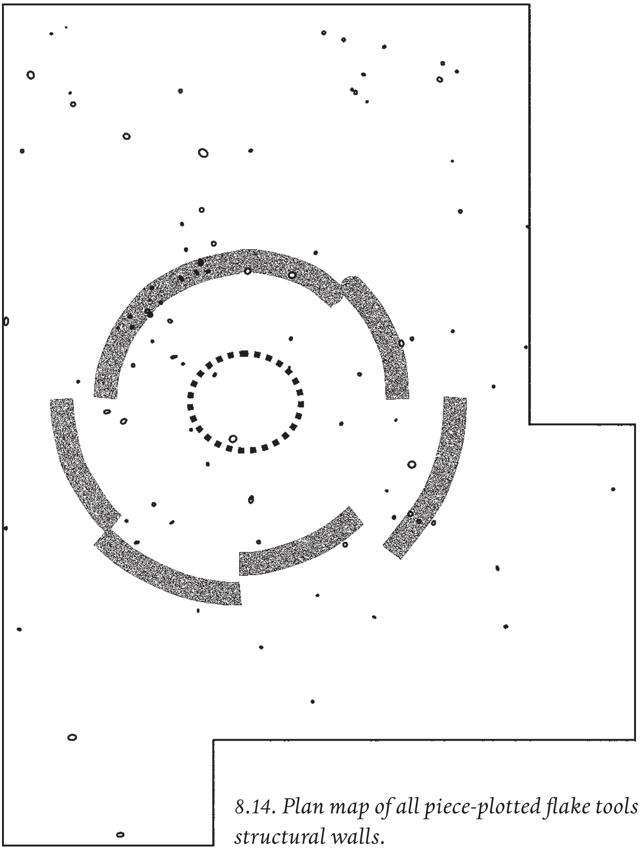
*8.13. Modified ring diagrams for piece-plotted debitage (*top*) and flake tools (*bottom*) showing the concentric densities of each artifact class as a function of distance from the center of the hearth.*

characterized by significantly different distributions (Kolmogorov-Smirnov test, $z = 1.538$, $p = 0.018$) (Figure 8.13).

Concentric debitage densities are maximized near the hearth center and drop smoothly at greater distances from the hearth. In contrast, concentric flake tool densities are very low directly adjacent to the hearth and peak at a maximum of 10.7 tools per m^2 at a distance of 1.25 to 1.5 m from the hearth center, highlighting again that the discard of debitage and the discard of flake tools were governed by different processes. A comparison of the distribution of flake tools to the possible wall positions reconstructed by ring analysis (Figure 8.14) shows excellent spatial congruence of the reconstructed wall segment and a high-density arc of tools in Sectors 7 and 8. If the hearth was inside a structure, then tools appear to have been preferentially discarded in a cluster against the northwestern wall.

SUMMARY

We began this chapter with a simple spatial analysis of burned materials from BGB. The spatial congruence of burned bone, lithics, and Folsom-age radiocarbon



8.14. Plan map of all piece-plotted flake tools mapped onto reconstructed structural walls.

dates pointed to the presence of a hearth undetected during excavations. Analyses of artifact frequencies in the hearth- and non-hearth-associated areas further suggested the existence of a distinct hearth-centered activity area marked by high artifact densities. Unlike most other artifact classes, cores were not preferentially discarded in the hearth area despite being frequently reduced there. We suggest that cores were intentionally discarded and possibly stored in areas away from the hearth.

Within the hearth area, a series of spatial analyses was performed aimed primarily at addressing the question of whether the hearth was located within an interior or an exterior workspace. Bimodality in ring diagrams indicated the possibility of a structure roughly 4 × 3 m in size, with the hearth located on its northwest side. A discrete, contiguous cluster of Trout Creek Chert and an area of low burning percentages surrounding the hearth are spatially congruent with the hypothesized structure.

Using sector analysis, patterns in the discard of various artifact classes were identified. Debitage and bifaces appear preferentially discarded on the southeast side of the hearth, and flake tools and projectile points and preforms were preferentially discarded to its northwest. We argue that if the hearth was in an exterior space, wind direction, the presence of drop and toss zones, or both are the most likely explanations for these patterns. Alternatively, if the hearth was in an interior space, this pattern could emerge if different activities were preferentially performed at different locations within that space. In comparing the distribution of artifact sizes for both sides of the hearth, some support was found for the presence of a drop zone on its southeast and a toss zone on its northwest side. However, by comparing the hearth-centered distributions of large artifacts and flake tools, we demonstrated that size differences and, therefore, drop and toss zones alone do not sufficiently explain the preferential discard of tools on the northwest side. Two competing hypotheses remain. The preferential discard of different classes on opposite sides of the hearth can be explained by (1) a bimodal distribution in prevailing winds for an exterior hearth, or (2) the division of activity space inside a structure.

Distinguishing between these two hypotheses may be difficult. One simple approach could use spatial patterns in lithic refits to attempt to find further support for a barrier effect. Another approach might involve the excavation of a number of additional hearth-centered activity areas. For a series of contemporaneous exterior hearths, asymmetry in radial distributions of artifacts should consistently show preferential work, discard, or both on the same side of the hearth. Therefore, if a second contemporaneous hearth-centered activity area was excavated and artifacts were found to concentrate on a different side of the hearth, we could say with some confidence that at least one of these hearths sat within a structure.

Obviously, many questions remain regarding the organization of activities around the hearth at BGB. We have managed to identify a number of clear spatial patterns but have derived relatively few solid interpretations of these patterns, which returns us to the observation made at the start of this chapter. After almost eighty years of Folsom research, very few unequivocal examples of Folsom hearths and structures are known. Because both structures and hearths modify the physical landscape of archaeological sites, they should have predictable effects on archaeological spatial patterning. Hearths will leave evidence of burning beyond their direct products (e.g., charcoal and ash), and structures have walls, which should impede the movement of artifacts across space. Perhaps, then, we should be looking for hearths and structures not only in the ground but also in spatial patterning and associations among recovered artifacts.

Of course, if we assume (as we do) that hearths and structures were a component of Folsom residential occupations, by finding evidence of structures and hearths one could argue that simply establishing the presence of such features does not extend our knowledge of Folsom lifeways. However, abundant ethnoarchaeological and archaeological data have shown that the spatial associations within and between such features provide important opportunities to discern the nature of economic and social relationships among site occupants (e.g., Binford 1991; Boismier 1991; Enloe and David 1992; Gould and Yellen 1987; Henshaw 1999; Stapert 2003; Waguespack 2002; Whitelaw 1983, 1991; Yellen 1977). The identification of structures and hearth features is only the first step in this process. Jodry's (1999) work at Cattle Guard provides one excellent example of the utility of such data, and we hope the spatial analyses presented in this chapter will spur additional research in these areas. The hearth-associated spatial patterns observed at BGB provide one empirical framework potentially applicable to the identification of hearths and structures in other sites.

EPILOGUE

Since we originally wrote this manuscript in December 2003, we have spent two more seasons at the site. We have increased our excavations to 87 m^2, and the assemblage totals more than 50,000 pieces. We have also partially excavated two additional hearth-centered activity areas. The results of this new work do not substantially change any of our findings in this chapter. The center of the first hearth sits at approximately N 1481.6, E 2437.3 and shows typical hearth morphology, a charcoal-stained pit feature with associated sedimentary oxidation. This feature was at least 63 × 57 cm in length and width and 14 cm in depth. The presence of a hearth in the northeastern corner of the Main Block implies that some of the artifacts we considered to be unassociated with a hearth may in fact be within a separate hearth-centered activity area. Within a new excavation area we call the "East Block," the second hearth sits 15.5 m to the ESE of the central hearth in the Main Excavation Block, its center lying at N 1474.60, E 2449.01. Much like the central hearth in the Main Block, this feature did not show clear hearth morphology but was identified on the basis of very weak charcoal staining and strong clustering in burned lithics and bone.

While excavation and analyses of these areas are ongoing, spatial patterns associated with the East Block hearth appear similar to those of the hearth-centered activity area described in this chapter. From the little we have excavated, spatial patterns associated with the northeastern hearth-centered activity area in the Main Block appear to differ. While our agnosticism with regard to the presence of a structure in the center of the Main Block has not changed, we are optimistic that further excavation of these new areas will shed additional light on this issue. For example, artifacts appear to cluster preferentially to the north of the East Block hearth, suggesting that *at least* one of these hearths was in an inside space, assuming, of course, that they are contemporaneous. Also, from our preliminary analysis, it seems likely that we will eventually be able to identify classes of hearth-centered activity areas on the basis of repeated spatial patterning.

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