

UC Merced

Journal of California and Great Basin Anthropology

Title

Flaked Stone Tool Patterning as a Means for Inferring Fremont Obsidian Procurement and Exchange

Permalink

<https://escholarship.org/uc/item/8v9634v1>

Journal

Journal of California and Great Basin Anthropology, 28(1)

ISSN

0191-3557

Authors

Andrews, Bradford W.
Greubel, Rand A.

Publication Date

2008

Copyright Information

Copyright 2008 by the author(s). All rights reserved unless otherwise indicated. Contact the author(s) for any necessary permissions. Learn more at <https://escholarship.org/terms>

Peer reviewed

Flaked Stone Tool Patterning as a Means for Inferring Fremont Obsidian Procurement and Exchange

BRADFORD W. ANDREWS

Department of Anthropology, Pacific Lutheran University, Tacoma, WA 98447-0003

RAND A. GREUBEL

Alpine Archaeological Consultants, Inc., P.O. Box 2075, Montrose, CO 81402-2075

The Hunchback Shelter (42BE751), located in the southeastern Great Basin, yielded a considerable amount of data on the prehistoric use of the site. Located adjacent to the Wild Horse Canyon and Schoo Mine obsidian sources, evidence indicates that Hunchback Shelter functioned as a camp where Archaic to Formative (Fremont) knappers produced both bifaces and expedient flake cores. The intent of these procurement visits appears to have shifted over time. Furthermore, the Fremont visits appear to be consistent with comparative evidence from Five Finger Ridge, a major Fremont village. These findings have important implications for understanding the relationship between procurement behavior and settlement structure, and the relative importance of biface versus core technologies during the Fremont period.

LOCATED IN THE SOUTHEASTERN Great Basin of Utah (Fig. 1), the Hunchback Shelter (42BE751) is a rockshelter that was intensively occupied during the Archaic-Formative Transition (A-F Transition; A.D. 100 to 650) and the Fremont (A.D. 650 to 1250) periods. This study represents an organizational approach to lithic technology, which seeks to define the socioeconomic context of flaked stone tool production and distribution (Carr 1994a:1; Jeske 1992; Kardulias and Yerkes 2003; Kuhn 1991, 1994; Larson 1994; Nelson 1991:57; Pecora 2001; Rasic and Andrefsky 2001; Shott 1989; Torrence 1989; Wenzel and Shelley 2001). It addresses prehistoric cultural dynamics by examining how economic and social variables influenced the structure of stone tool production during the A-F Transition and Fremont periods. Specifically, the study considers whether behavioral trends in obsidian procurement at the Hunchback Shelter are consistent with a diachronic shift in settlement behavior in the southeastern Great Basin.

Throughout the greater Fremont culture area, Madsen and Simms (1998) have argued that settlement and subsistence practices between A.D. 100 and 1250 exhibited considerable variation (see also Janetski 1998; Madsen 1989; Marwitt 1980). Groups ranged from

residentially mobile foragers to more logistically-based, semi-sedentary or sedentary forager/farmers. Some people may have oscillated between these two extremes in response to local climatic variations; alternatively, people practicing both lifestyles may have interacted symbiotically (Madsen 1989; Madsen and Simms 1998; Simms 1986). In either case, groups were small and fairly mobile.

Although Fremont groups over time are generally characterized as small-scale and behaviorally diverse (Madsen 1989:67), a distinct shift in settlement and subsistence occurred in localized portions of the southeastern Great Basin. By at least A.D. 900, the archaeological record indicates the appearance of larger village sites significantly dependent on agriculture (Coltrain and Leavitt 2002:454; Talbot 1995, 2000:226). This development is coincident with what is referred to as the Medieval Warm Period (Broecker 2001; Jones et al. 1999; Whitlock and Bartlein 1993). At this time, climatic conditions became more favorable for food-production in some areas (Coltrain and Leavitt 2002:456; Euler et al. 1979), making agriculturally-based population aggregation a viable settlement strategy. The resulting communities like Paragonah and Five Finger Ridge

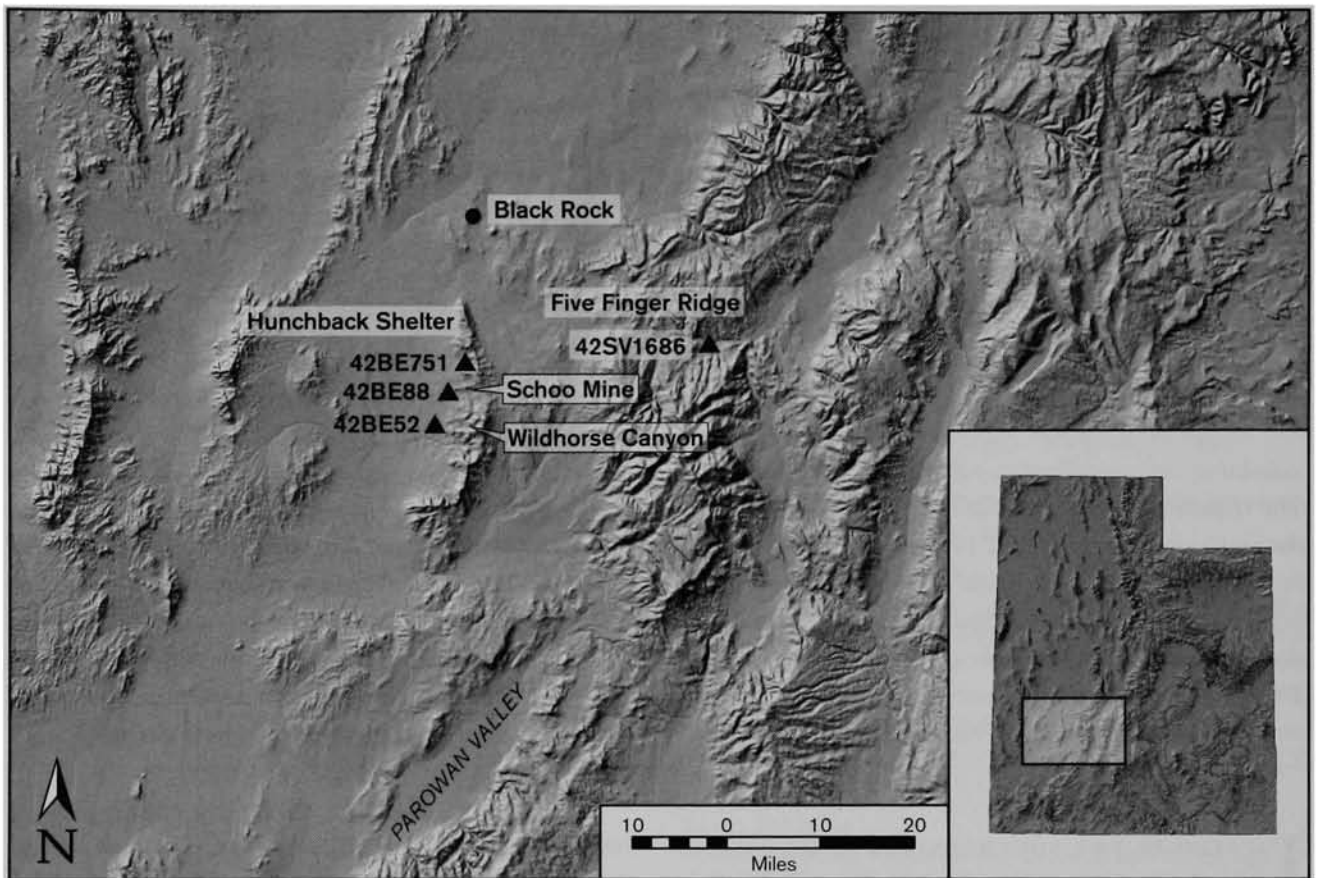


Figure 1. Location of sites and areas discussed in the text. (Map by Sage Wall)

did not necessarily displace or subsume the smaller social groups characteristic of the earlier A-F Transition period. They did, however, represent a fundamental change in lifestyle throughout this particular region. Although primarily dependent on agriculture, these villagers continued to logistically acquire local resources available in their catchments (Simms 1986).

With this shift in settlement and subsistence in mind, our discussion explores whether data from Hunchback Shelter indicate a behaviorally compatible change in the use of this site. The shelter's prehistoric occupants were undoubtedly involved in the acquisition of toolstone because it is located near the Wild Horse Canyon and Schoo Mine obsidian sources (Fig. 1). Accordingly, this study examines two questions. First, do the A-F Transition period flaked stone artifacts from the shelter predominantly indicate more residential, longer-term occupations because the shelter was used for more than just toolstone acquisition? Such behavior would be expected of smaller residentially (forager) or logistically

(collector) mobile groups (*sensu* Binford 1980) present in the area during the A-F Transition. Second, were the succeeding Fremont occupations relatively brief logistical visits focused on acquiring obsidian tools for sedentary village communities? Such behavior would have been an efficient means for procuring valuable, non-local obsidian in relatively large quantities. This hypothesis presupposes that some of the Fremont period villages in the southeastern Great Basin were socially complex enough to support a degree of economic interdependence (see Greubel and Andrews this issue).

An important distinction is being drawn here concerning Binford's (1980) ecologically-based forager-collector model. This model was explicitly formulated for hunters and gatherers, not for sedentary horticulturalists like the Fremont. But it was also explicitly conceptualized as a continuum; hence, why not extend it to horticultural societies as well (cf. Madsen 1982)? Undoubtedly, Formative groups throughout the greater Southwest acquired various non-local resources by sending out

procurement parties analogous to collector logistical forays. Although horticultural economies differ from those of hunters and gatherers because of a primary dependence on cultivated foods, logistical procurement forays do provision these groups in a similar manner. Consequently, in contrast to the use of Hunchback Shelter for acquiring a wide range of resources during the A-F Transition, were the Fremont occupations primarily *highly specialized* logistical forays explicitly focused on the acquisition of obsidian for larger villages?

In line with this question, we also examine comparative evidence from Five Finger Ridge, a Fremont village, to see if it is consistent with highly specialized logistical forays at sites like Hunchback Shelter during the Fremont period. We argue that the differing percentages of expedient flake core and biface debitage and tools from both sites have important implications for understanding the relationship between Fremont tool-making behavior and what is found in the archaeological record.

The following discussion is divided into five parts. First, we briefly outline our expectations for how flaked stone tool data reflecting residential use of the Hunchback Shelter (A-F Transition period) might differ from those associated with highly specialized logistical visits (Fremont period). Second, we describe the excavations at the Hunchback Shelter. This section is followed by a review of the study methodology. The fourth section discusses the behavioral patterns evident in flaked stone artifacts from the A-F Transition and Fremont components. The final section incorporates evidence from Five Finger Ridge. It outlines the conclusions and implications our study has for understanding the nature of procurement activities during both components and the relative importance of biface versus flake core technologies during the Fremont period.

MODELING EXPECTATIONS

This study is based on the assumption that flaked stone tool procurement and production will vary according to a society's system of settlement and subsistence (Henry 1989; Kelly 1992; Kuhn 1994; Parry and Kelly 1987; Pecora 2001). Once again, for the A-F Transition period, we are interested in whether the data from Hunchback Shelter, located adjacent to a major source of toolstone, indicate a residential use by relatively small-scale,

seasonally mobile forager or collector groups. Residential occupations should exhibit evidence of obsidian tools made for use on-site and for transport elsewhere. Also, for tools used at the site, one might expect to find both expedient implements, like utilized flakes, and more formal implements, such as bifacial projectile points. Expedient tools can be used for a miscellany of on-site domestic activities, whereas formal implements can serve more specialized functions. Implements made for transport away from the site may be optimized to best suit the needs of a group's mobility. For example, residentially-oriented foragers (*sensu* Binford 1980) might produce relatively large bifacial cores, which can be reduced for flake blanks when needed for use elsewhere in their seasonal rounds (Elston 1992a, 1992b; Johnson 1989; Kelly 1988; Nelson 1991). Finally, residential occupations might result in a higher density of lithic remains because these occupations, although seasonal, might be fairly lengthy.

For the Fremont period, we are interested in whether the deposits primarily reflect short-term, intensive, and highly specialized logistical visits bent on making obsidian implements for transport away from the site. In contrast to longer-term residential use, short specialized logistical visits should produce less evidence for on-site tool use. As such, compared to residential occupations, they should have lower ratios of used tools, both expedient and formal, to implements that were being produced for transport elsewhere (e.g., production failures that were not exported). Inherent in our model is the notion that intensive logistical visits were carried out by knapping specialists focused on supplying the aggregate needs of larger village sites (see Greubel and Andrews, this issue). Hence, we would also expect that the implements prepared for transport should be nearly finished in form (Henry 1989:153). Such behavior would decrease the weight of each implement, thereby maximizing the number, or batch size (Cross 1993:75) that could be carried away (Metcalf and Barlow 1992). Evidence for this expectation should be reflected in both the debitage and the degree of processing reflected by production failures. Finally, highly specialized logistical visits might have resulted in lower densities of lithic remains because they were relatively short occupations. With these expectations in mind, we turn now to a description of the Hunchback Shelter excavations and the methods used in our analysis.

HUNCHBACK SHELTER EXCAVATIONS

Excavation of the Hunchback Shelter (42BE751) has provided an exceptional new data set for examining the Formative period occupation of the southeastern Great Basin (Fig. 1).¹ The shelter is located in the igneous-derived, northern Mineral Mountains at an elevation of 1,926 m. (6,319 ft.), situated underneath a large granite boulder on the south-facing slope of a ridge (Fig. 2). Covering an area of 2,944 m.², the site includes the rockshelter interior, a midden/activity area in front of the shelter, and an adjacent zone with scattered artifacts and features. The nearest known permanent water source is Salt Spring, located about 5.1 km. southwest of the site (Greubel 2005:195).

Rhyolite deposits in the Mineral Mountains contain high quality obsidian that outcrops in several locations near Hunchback Shelter (Eckerle et al. 2005; Nelson 1984; Nelson and Holmes 1979). The Wild Horse Canyon (WHC) and Schoo Mine (SM) localities represent two principal sources of this obsidian (Lipman et al. 1978; Stokes 1986). Numerous WHC and SM artifacts have been found at sites in Utah and adjacent states, demonstrating the prehistoric importance of these sources (Hull and Beville 1994; Jones et al. 2003). Hunchback Shelter is about 10 km. north of the SM source, although water-borne secondary deposits of obsidian can be found within 6.5 km. of the site (Greubel 2005:201).

Data recovery at Hunchback Shelter consisted of an intensive stratigraphic excavation of an area measuring 64 m.². This effort resulted in the removal of 43 m.³ of deposits, which were screened through 1/4-inch mesh. Evidence from calibrated radiocarbon dates indicates that the site was intermittently occupied from 1,730 B.C. until the Protohistoric period, ending sometime around A.D. 1650 (Greubel 2005: Table 3-61). The deposits explored during the excavations were separated into five components that included the Middle Archaic (Component 1, 1,730–1,520 B.C.), Late Archaic (Component 2, 970 B.C.–A.D. 100), A-F Transition (Component 3, A.D. 100–650), Fremont (Component 4, A.D. 650–1250) and Post-Formative Prehistoric (Component 5, post-A.D. 1150).

Hunchback components were defined according to strata and the corresponding radiocarbon dates recovered during the excavations (Greubel 2005:318). The components represent distinct spatial, temporal, artifactual, and geomorphological entities composed of

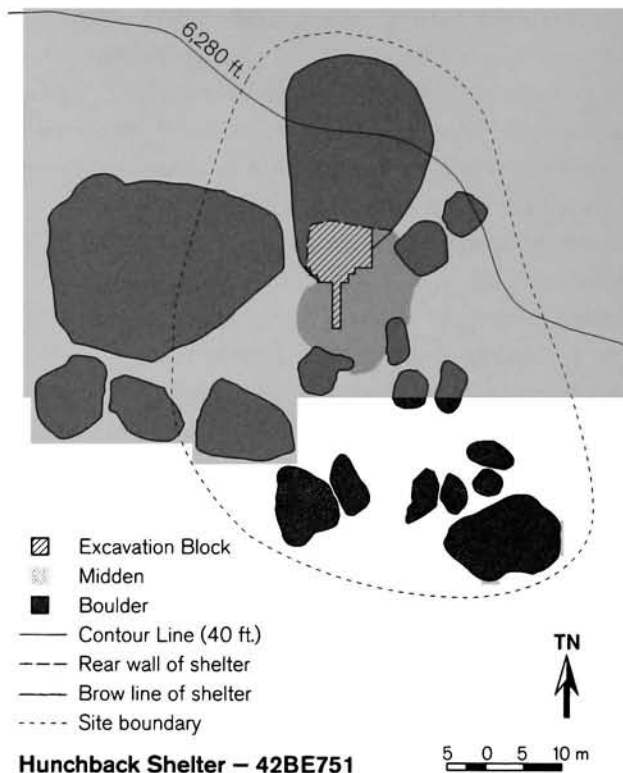


Figure 2. Plan-view of Hunchback Shelter.
(Map by Barb Lockwood)

remains from numerous occupations spanning hundreds of years (Greubel 2005:318). Each component contains multiple analytic units (AUs), consisting of horizontally and vertically specific provenience groupings defined during excavation of the site (Greubel 2005:319). Some AUs may be individual occupations, but this proposition is unclear in most cases because bioturbation and cultural mixing have compromised the shelter's stratigraphic clarity. What the AUs do represent are the most fine-grained, temporally distinct units encountered during excavation. As such, they are used as proxies for individual occupations.

As stated, this discussion focuses on the A-F Transition and Fremont components. The A-F Transition component (A.D. 100–650) is represented by six AUs, distributed throughout the shelter interior and the midden deposits south of the browline (Greubel 2005:Table 3-62). During the Archaic period, weathering of the ceiling increased the habitable area inside the shelter. The prehistoric inhabitants also expanded the interior living space by excavating several pits. Although additional interior space enhanced the sheltering

potential of the rockshelter during this period, evidence for thermal features and fire-cracked-rock (FCR) was limited. It is unclear, therefore, whether the shelter was intensively occupied during winter months. The groundstone artifacts and evidence of seeds and fruits available in the summer and fall suggest that most A-F Transition occupations at Hunchback may have taken place during warm-weather months. A total of 10.6 m.³ of excavated deposits were attributed to the A-F Transition period, containing a total of 16,228 flaked stone artifacts (Table 1; note that this table also shows artifact densities that are discussed later).

Table 1

DENSITIES OF FLAKED STONE ARTIFACTS PER COMPONENT AND ESTIMATED DENSITY BASED ON VOLUME EXCAVATED

Component	No. of Flaked Stone Artifacts ^a	Volume Excavated (m ³)	Estimated Density (m ³)
A-F Transition ^b	16,228	10.60	1,530.9
Fremont	13,496	9.16	1,473.3

^aIncludes Debitage, Flaked Stone Tools, and Flake Cores

^bArchaic-Formative Transition

The Fremont component (A.D. 650–1250) is represented by 21 AUs distributed over an area similar to the A-F Transition materials (Greubel 2005: Table 3-62). Stratigraphically, these deposits are considered the “purest” of the components because they were least affected by natural and cultural mixing of the strata. Like the A-F Transition occupations, substantial winter use of the shelter is questionable given the limited evidence for thermal features and FCR. Moreover, groundstone and evidence for summer and fall plants suggest that most Fremont period use of the site also took place during warm-weather months. A total of 9.16 m.³ of excavated deposits are attributed to the Fremont period, containing a total of 13,496 flaked stone artifacts (Table 1).

METHODS

Debitage

It is no surprise that more than 99% of the flaked stone material at Hunchback Shelter is obsidian given the site’s proximity to the WHC and SM obsidian sources. Technological classification of the entiredebitage

(n=75,409) required that it be sampled because of its size and the time constraints imposed on analysis. What constitutes an adequate sample for descriptive purposes is a widely debated topic in archaeology (Drennan 1996:79). For our analysis, a random sample of 12.4% (n=9,344) was selected from the total assemblage of 75,409 flakes.² This sample was selected from every collection provenience. As such, it is of adequate size for defining the broad patterns evident in thedebitage per component. The sample certainly exceeds what some researchers have suggested is sufficient for the purposes of similar studies (Manheim and Rich 1981).

Advances in flaked stonedebitage studies over the last 30 years have resulted in numerous techniques of analysis (Ahler 1989; Andrefsky 1998; Magne 1989, 2001; Parry and Kelly 1987; Stahle and Dunn 1982; Sullivan and Rozen 1985). Nevertheless,debitage is still generally understudied by many archaeologists (Fish 1981:375; Flenniken 1984:192; Odell 1989:163; Shott 1994:70). Although analytical approaches vary widely in emphasis, there is no single best method for classifying every assemblage (Andrefsky 2001:13; Magne 2001:22). The Hunchbackdebitage was classified according to analytic categories representing knapping stages in a reduction continuum. This approach is both technological and behavioral, because the stage transitions represent shifts in the techniques and decisions of prehistoric knappers, and thereby provide an understanding of how stone tools were made (Sheets 1975:372).

In strict terms, reduction sequences do not proceed in stages. Staging is an analytical technique for organizing continuous data into ordered units (Sheets 1975; Stahle and Dunn 1982). Knapping is continuum mechanics: you cannot skip a step in the process. As a result, every flake represents a stage (Flenniken 1984). Stages are not real, but prehistoric flake tool-producing behavior was, and byproducts of such activities reflect the behavior responsible for the sequential reduction of raw material into usable implements. Furthermore, the stage approach does not require that every flake be correctly identified. Individual flakes provide limited information for at least two reasons; any reduction sequence will result in a minority of flakes that are not characteristic of the stage during which they were removed, or will produce flakes that are diagnostic of other reduction strategies

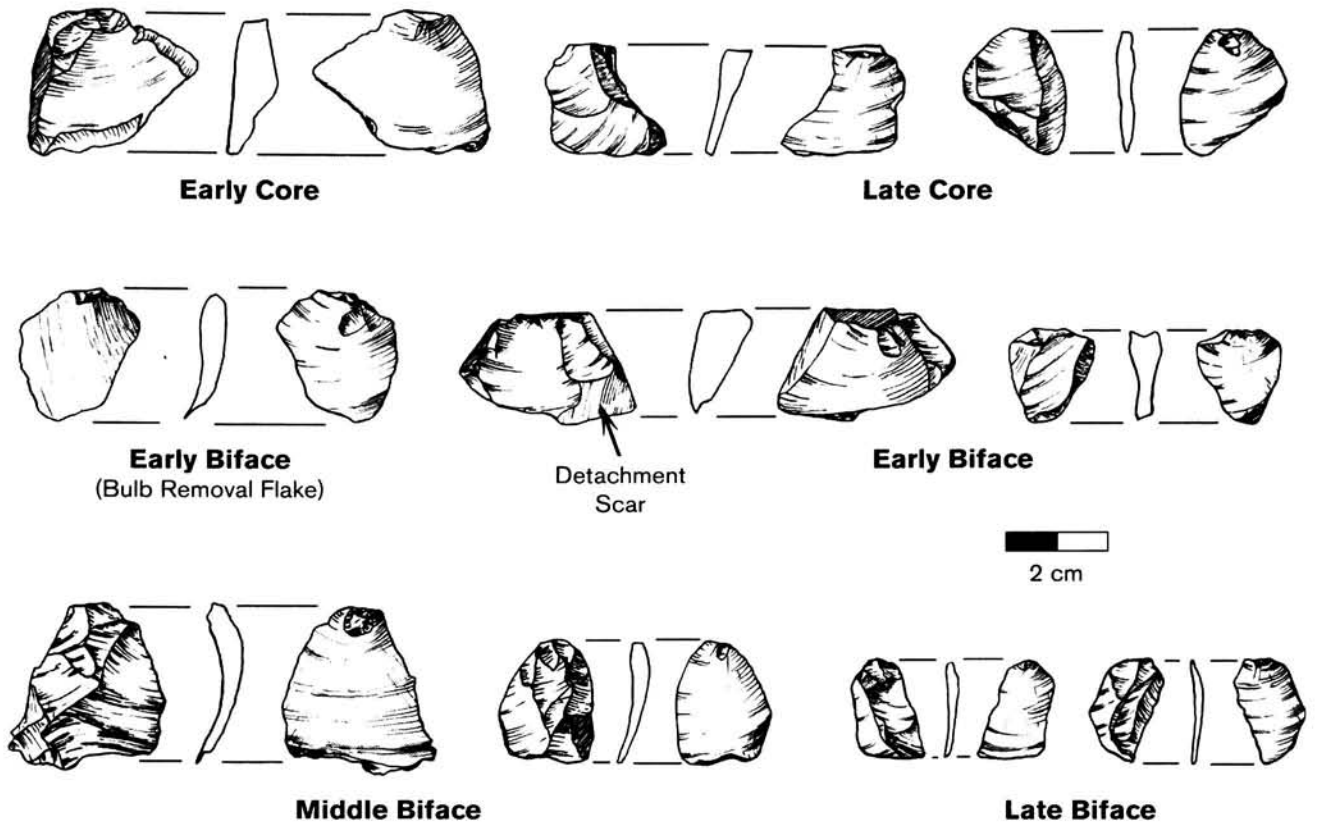


Figure 3. Hunchback debitage. (Illustration by Bradford Andrews)

altogether (Magne 1985). Instead, the stage approach is founded on reconstructing reduction behavior by looking at artifact populations or a randomly selected sample of a population. We assume that most flakes have been identified correctly, thus yielding a technological pattern. Such signatures reflect patterned cultural behavior. Using probabilistic approaches, the identification and interpretation of this patterned behavior is a primary goal of scientific archaeology (Ensor and Roemer 1989:177; Magne 2001:29).

There were two reasons for applying an attribute-based flake typology in the analysis of the Hunchback debitage assemblage. First, such an approach requires that each artifact be examined for its technological attributes. Second, individual flake analysis permits the classification of small diagnostic flakes. This is important, because small flakes are often lumped into late stage categories, despite experimental studies indicating that they are produced during every reduction stage (Andrefsky 2001:8; Magne 1989:16; Patterson 1982, 1990; Stahle and Dunn 1982).

The stage-based typology applied to the Hunchback debitage distinguished five diagnostic flake types: early core; late core; and early, middle, and late biface thinning flakes (Fig. 3). Debitage was placed in these technological categories on the basis of multiple attributes. Core reduction flakes were removed from flake cores to make expedient implements or blanks for formal tools. In general, early core flakes have less than three dorsal scars, flat unmodified striking platforms, relatively large sizes, high thickness to width ratios, and the presence of cortex (although that is not a requirement; see Fig. 3). In contrast, late core reduction flakes exhibit multiple dorsal scars, have lower thickness to width ratios, and lack dorsal cortex.

Debitage related to biface thinning is represented by a variety of flake types. Early biface thinning flakes represent percussion activities related to the initial edging of flake blanks or tablets of raw material. These flakes are generally associated with the reduction of Stage 2 bifaces (Callahan 1979). Typical, or "formal" early percussion biface thinning flakes have oval, expanding,

or rounded plan-views, curved or bent long-sections, lenticular cross-sections, lipped ventral platform edges, and few (0–3) dorsal scars running parallel to their long axes (Fig. 3). This stage also includes alternate or turning, bulb removal, edge preparation, and margin removal flakes (*sensu* Flenniken 1981; Yerkes and Kardulias 1993). As a stage, early biface thinning produces debitage exhibiting considerable morphological variation, making identification less straightforward than is the case with the relatively standard outputs of successive stages.

Middle biface thinning flakes typically represent the early thinning of Stage 3 bifaces (Callahan 1979). Like the formal early biface thinning flakes, these items have oval, expanding, or rounded plan-views, but they are slightly bent to nearly flat in long-section, and have dorsal flake scars (2–5) originating from more than one direction (sometimes reflecting the removal of previous flakes from the opposite margin) (Fig. 3). More so than their early counterparts, middle biface thinning flakes often have multifaceted platforms that are lipped on their ventral edges and ground on their dorsal edges. Platform grinding indicates careful platform preparation associated with systematic thinning activities.

Late biface thinning flakes represent secondary thinning activities usually associated with the reduction of Stage 4 and 5 bifaces (Callahan 1979). Often, they are flat in long-section, smaller and thinner in cross-section, and have thinner platform widths than their early and middle counterparts. Depending on their size, these flakes usually have multiple dorsal flake scars originating from more than one direction. They also exhibit grinding on their dorsal platform edges. In addition, some late biface thinning flakes appear to have been removed with pressure techniques. Pressure biface thinning flakes typically have ground dorsal platform edges, are relatively regular and linear in plan-view, and may have dorsal flake scars nearly parallel to their long axes, reflecting the removal of previous pressure flakes.

Debitage that could not be assigned to a technological stage was classified as angular debris or technologically indeterminate flakes. Angular debris is defined as any piece of flaked material lacking a discernable ventral surface (Sullivan and Rozen 1985). Technologically indeterminate flakes and flake fragments lack platform and bulb attributes; these items cannot be confidently assigned to a stage.

Flaked Stone Tools

The flaked stone tools were classified according to morphological or functional attributes that indicated how they were derived or hypothetically used (Fig. 4). General tool categories include bifaces, projectile points, drills, and scrapers. These artifacts are referred to as formal implements because they represent the shaping of flakes, spalls, or bifacial cores into specific tool types. Bifaces were typed according to Callahan's (1979:10–11) stage typology. He distinguishes five stages beginning with Stage 1, which is defined as a usable blank. Stage 2 results from the initial edging of a blank, which is then transformed into a Stage 3 implement by removing middle biface thinning flakes. The subsequent Stage 4 category is the result of secondary thinning activities involving the removal of late biface thinning flakes. Stages 1 through 4 are generally regarded as bifaces that were thinned with percussion flaking techniques. The final Stage 5 bifaces are refined, well-shaped implements, usually produced by removing late biface thinning flakes with percussion and pressure techniques.

In contrast to formal implements, retouched and utilized flakes are referred to as expedient tools. These artifacts were identified on the basis of edge characteristics and lack of a formal body plan. Site-wide, a total of 25 informal, expedient flake cores were recovered (Table 2, Fig. 5), most of which exhibit multidirectional flake scars ($N=23$). The mean maximum dimension of the site's cores is 5.2 cm. ($\sigma=1.3$). Eight cores with a mean maximum dimension of 5.8 cm. ($\sigma=0.7$) were recovered from the A-F Transition deposits; only three cores with a mean maximum dimension of 3.9 cm. ($\sigma=0.5$) were recovered from the Fremont deposits. Given the relatively small size of these items and the proximity of Hunchback to the WHC and SM sources, we think they were discarded because they could no longer be reduced to obtain usable flakes.

Table 2

EXPEDIENT FLAKE CORES AT HUNCHBACK SHELTER

Component	No. of Cores	Ave. Maximum Dimension	Standard Deviation
Site-wide	25	5.2	1.3
A-F Transition	8	5.8	0.7
Fremont	3	3.9	0.5

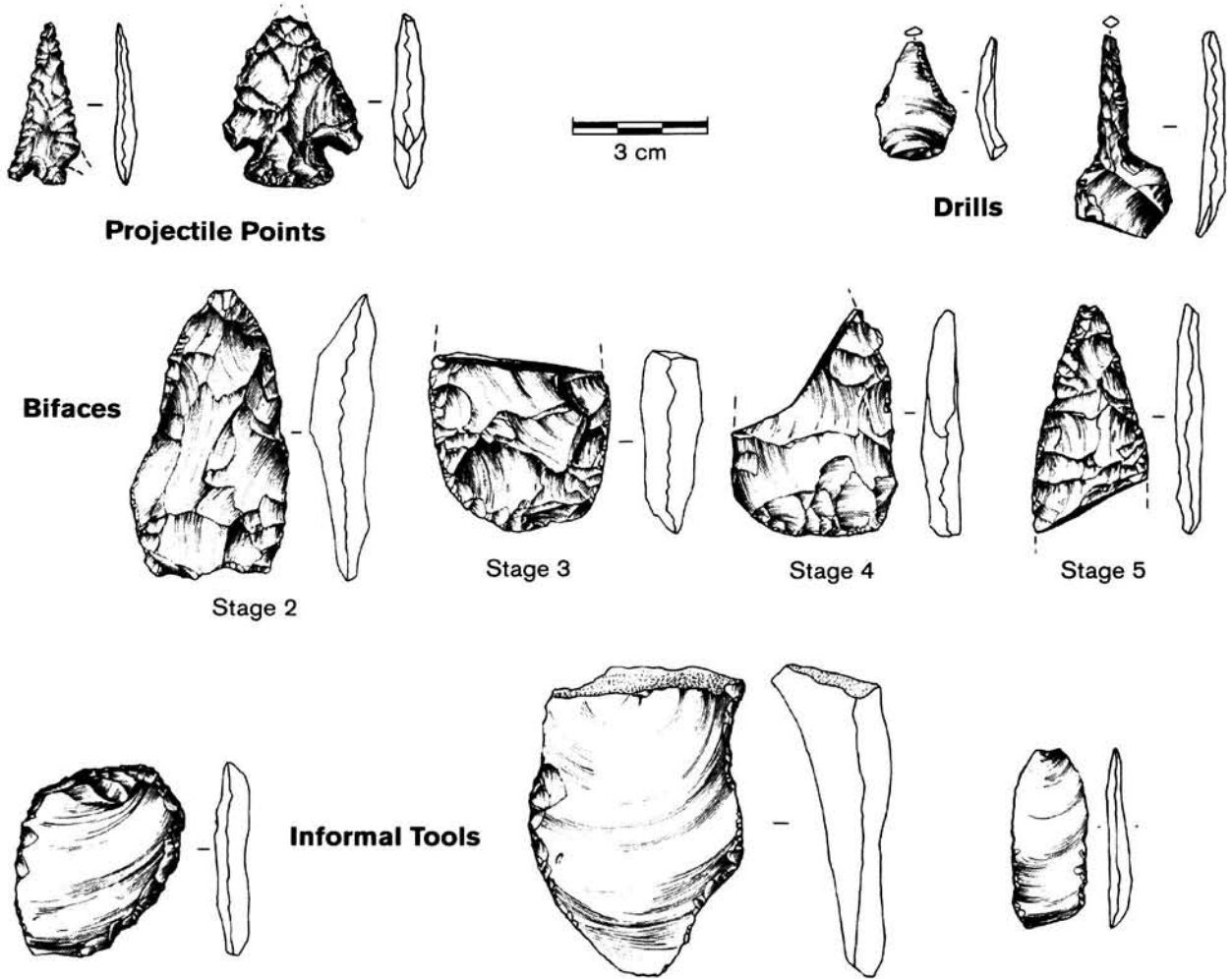


Figure 4. Hunchback formal and informal tools. (Illustration by Eric Carlson)

Some readers might question the validity of our interpretations, because data recovery using 1/4-inch mesh does not retain debitage from the small end of the spectrum. Experimental research has shown that some reduction strategies result in high percentages of very small debitage, such as the pressure flakes typically associated with late-stage bifacial reduction (Patterson 1982, 1990; Stahle and Dunn 1982). However, because reconstructions of human tool-producing behavior should attempt to establish a clear relationship between debitage and tools (Magne 2001), we have chosen in this analysis to focus on both data categories, rather than relying solely on debitage. Consequently, we are confident in our interpretations because the relative percentages of debitage attributed to particular reduction stages are consistent with the degree of processing reflected by the

tools. We do not feel, therefore, that the inclusion of small debitage recoverable with 1/8-inch mesh would have resulted in significantly different interpretations.

BEHAVIORAL PATTERNS EVIDENT IN THE A-F TRANSITION AND FREMONT FLAKED STONE ARTIFACTS

Hunchback flaked-stone artifacts dating to the A-F Transition and Fremont periods have been summarized in various ways for this discussion (Tables 1–9). Out of the 9,344 debitage artifacts that were analyzed, 4,328 were associated with the A-F Transition and Fremont components (Table 3). At a glance, the percentages of angular debris, core flakes, biface flakes, and technologically indeterminate categories in both components are similar

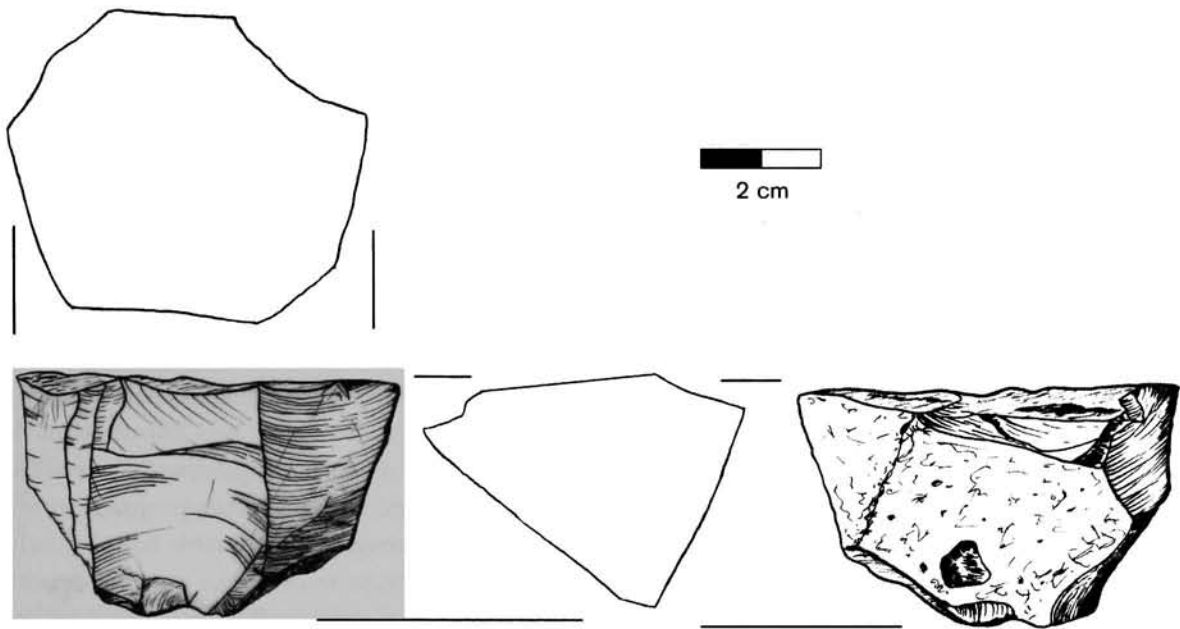


Figure 5. Hunchback expedient flake core. (Illustration by Bradford Andrews)

(Table 4). In general, biface thinning flakes outnumber core flakes two-to-one. In addition, both components have low percentages of angular debris and high percentages of technologically indeterminate flakes. Further classification of the core and biface debitage into stage-specific categories does demonstrate subtle inter-component variation (Table 5). In general, however, it appears that there was an emphasis on the later stages of biface reduction during both time periods.

The extremely low percentages of angular debris are interesting; such percentages are experimentally associated with late-stage biface thinning activities (Ahler 1986; Flenniken 1981:32–48; Tomka 1989:140). Hence, the angular debris data are consistent with a focus on late biface reduction at the rockshelter. This interpretation notwithstanding, such low percentages also may relate to screening materials through 1/4-inch mesh. As a result, many small pieces of angular debris produced during any stage of reduction were probably missed. However, relatively large-sized angular debris typically associated with the initial reduction of large cores would not have been missed. Therefore, the evidence for core reduction, discussed in greater detail below, indicates that large cores were not reduced at the shelter.

The relatively low proportion of early biface thinning flakes in both components is also noteworthy

Table 3

**COUNTS OF DEBITAGE PER COMPONENT
SUBJECTED TO TECHNOLOGICAL ANALYSIS**

Component	Sample Size
A-F Transition	1,854
Fremont	1,622
Total	4,328

Table 4

**COUNTS OF DEBITAGE PER COMPONENT
SUBJECTED TO TECHNOLOGICAL ANALYSIS**

Component	Angular Debris	Core Reduction	Bifacial Reduction	Indeter.	Totals
A-F Transition	10 (1%)	189 (10%)	366 (20%)	1,289 (69%)	1,854
Fremont	9 (1%)	180 (11%)	316 (19%)	1,117 (69%)	1,622

Table 5

**PERCENTAGES OF TECHNOLOGICALLY
DIAGNOSTIC FLAKES AT HUNCHBACK SHELTER**

Component	Early Core	Late Core	Early Biface	Middle Biface	Late Biface	Totals
A-F Transition	55 (10%)	133 (25%)	61 (11%)	205 (38%)	87 (16%)	541
Fremont	61 (13%)	106 (22%)	47 (10%)	153 (32%)	107 (23%)	474

(Table 5). This flake category constitutes 11% and 10%, respectively, of the stage-diagnostic material in the A-F Transition and Fremont components. These data could be construed as evidence that most of the biface blanks entered the site as Stage 2 bifaces. Although this is possible, it also may reflect the constraints associated with identifying flakes diagnostic of early biface reduction. Experimental research has shown that blank edging and initial thinning activities result in a high percentage of morphologically variable debitage that is difficult to identify (Reed et al. 1996).

The high frequency of technologically indeterminate debitage is not unusual. The senior author has analyzed sizable collections with diagnostically identifiable flakes comprising only 1/3 to 1/2 of the total (Andrews 2002; Andrews et al. 2004). Moreover, the occupation of Hunchback Shelter over several millennia probably rendered many artifacts undiagnostic because they were broken by the trampling associated with successive reoccupations of the site.

Although the A-F Transition and Fremont period debitage data indicate similar reduction activities, subtle variation indicates the rockshelter was used somewhat differently during each component. Consistent with the study expectations modeled above, the A-F Transition data appear most consistent with longer-term, residential occupations; in contrast, the Fremont data reflect relatively short, logistical occupations. Five lines of evidence support these inferences: (1) the nature of flake core reduction; (2) the ratio of expedient to formal tools; (3) the percentages of biface thinning flakes and staged bifaces; (4) the ratio of staged bifaces to formal tools; and (5) the relative densities of flaked stone artifacts per unit excavated volume.

Core Reduction

Evidence for core reduction at the site reflects the shaping and processing of expedient flake cores (Fig. 5). The fact that only 11 cores were recovered from the A-T Transition and Fremont components (Table 2) indicates that either most of them were carried off-site to be reduced elsewhere, or lie in deposits in front of the shelter that were not excavated.³ However, the moderate amount of core flakes at the site are undeniable evidence that—to a degree—cores were reduced on-site.

Many decortication flakes are usually removed during the initial core shaping. This activity is especially

notable when raw material is obtained as nodules with a preponderance of weathered surface, like the material available at the WHC and SM sources. The principal attribute used to identify early core flakes in Hunchback Shelter debitage was the presence of cortex (although, once again, this attribute was not a requirement). As such, the limited number of cortical flakes in both components suggests that flake cores at Hunchback Shelter were initially shaped closer to the quarry.

This interpretation is supported by debitage at 42BE52 and 42BE88, two lithic scatters on alluvial fans west of the primary WHC and SM obsidian deposits (Fig. 1). While we are not suggesting that these sites were the ones visited by Hunchback knappers (6 to 10 km. away), they provide an acceptable basis for behavioral inference because most of the material processed at the rockshelter was acquired from the WHC and SM vicinity. Sites 42BE52 and 42BE88 represent a source of cobbles in secondary context. Many of these cobbles were procured and processed at these sites, prior to being carried away as cores (Dames and Moore 1994:21–67). Conservative estimates indicate that cortical flakes comprised between 40% and 50% of the debitage assemblages from 42BE52 and 42BE88.

At the Hunchback Shelter, the percentage of early core flakes in the A-F Transition component is lower than that attributed to the Fremont component (Table 5), although the significance of this difference as determined with a chi-square test is borderline ($\chi^2 P = .07$, $df = 4$). Moreover, relative to late core flakes, the proportion of early core flakes is lower in the A-F Transition data than it is in the Fremont component. These observations support the inference that the late-stage reduction of prepared cores for making more refined products received greater emphasis during the A-F Transition period.

The higher percentage of late core flakes in the A-F Transition deposits is also consistent with the higher percentage of A-F Transition informal expedient flake tools (Table 6). Depending on hafting and functional considerations, it is reasonable to assume that late core flakes made for more favorable expedient flake tools than early core flakes. Late core flakes are usually devoid of cortex, and because they are made later in the reduction sequence from more refined cores, the knapper can more easily produce desirable flake blanks for expedient activities.

Table 6**HUNCHBACK SHELTER FLAKED STONE TOOL COUNTS**

Tool Type	A-F Transition (n)	Fremont (n)
Formal		
Projectile Point	133	93
Knife	13	2
Formal Scraper	11	7
Drill	6	3
Other Biface	326	326
Subtotal	489 (68%)	431 (76%)
Informal		
Retouched Flake	159	100
Utilized Flake	68	39
Utilized piece	1	0
Subtotal	228 (32%)	139 (24%)
Total	717 (100%)	570 (100%)

Ratios of Expedient to Formal Flaked Stone Tools

The ratio of formal tools, such as bifaces, to expedient tools also indicates the on-site use of more expedient implements during the A-F Transition period. For the A-F Transition component this ratio is 2.6:1, whereas for the Fremont component it is 3.1:1 (Table 7). It appears, therefore, that during the A-F Transition period, fewer formal implements relative to expedient flake tools were produced. Again, a higher demand for expedient flake tools during this period may have been met by reducing small flake cores. This demand is consistent with longer-term residential use of the site by family groups, which would tend to be associated with a greater intensity of domestic activities requiring a larger range of tools. Many domestic activities associated with food preparation and tool maintenance can be performed with informal implements such as retouched and utilized flakes.

Table 7**RATIOS OF FORMAL TO EXPEDIENT TOOLS AT HUNCHBACK**

Component	Formal	Informal	Ratio
A-F Transition	489	228	2.1:1
Fremont	431	139	3.1:1

Fewer expedient flake tools in the Fremont deposits are consistent with the inference that occupations during this period were shorter than the A-F Transition occupations. If the Fremont visits were primarily short logistical forays, expedient tools for on-site domestic

activities would be of limited importance. Again, core reduction during the Fremont period appears to have primarily focused on shaping flake cores for reduction elsewhere rather than the on-site production of expedient implements.

Percentages of Biface Thinning Flakes and Staged Bifaces

An interesting pattern of component-specific contrast can be seen in the distributions of early, middle, and late biface thinning flakes (Table 5). The A-F Transition percentages of early (11%) and middle (38%) biface thinning flakes are higher than those for the Fremont component (10% and 32%, respectively). In contrast, the A-F Transition percentage of late biface thinning flakes (16%) is lower than that for the Fremont component (23%). Again, we suggest that, in general, early biface reduction flakes were removed during the edging and initial reduction of Stage 2 bifaces, middle biface thinning flakes were removed during the reduction of Stage 3 bifaces, and late biface thinning flakes were removed from Stage 4 and 5 bifaces. Accordingly, these data indicate that the A-F Transition knappers were primarily focused on the production of Stage 3 and 4 bifaces. What is particularly important is that the percentage differences between components are statistically significant for the middle ($\chi^2 P = .04$, $df = 4$) and late ($\chi^2 P < .01$, $df = 4$) biface thinning flakes. These data indicate that the reduction of Stage 3, 4, and 5 bifaces differed according to component.

Turning for a moment to the staged biface data, these tools mirror the component-specific differences in the percentages of biface thinning flakes. The majority of typable A-F Transition bifaces were either the Stage 3 (29%) or 4 (41%) varieties (Table 8); in contrast, the percentages of these types of bifaces are lower in the Fremont deposits (26% and 39%, respectively). The opposite pattern characterizes the Stage 5 biface distributions: the A-F Transition percentage (19%) is lower than the Fremont percentage (22%).

Table 8**UNFINISHED BIFACES BY STAGE**

Component	Stage 2	Stage 3	Stage 4	Stage 5	Totals
A-F Transition	29 (11%)	75 (29%)	104 (41%)	48 (19%)	256
Fremont	38 (14%)	72 (26%)	110 (39%)	61 (22%)	281

In concert, the distributions of biface thinning flakes and the staged bifaces imply an emphasis on the production of Stage 3 and 4 bifaces during the A-F Transition period; these items may have been primarily destined for transport away from the site. The A-F Transition knappers, however, also appear to have produced numerous formal implements out of Stage 5 bifaces (Table 6). We suggest, therefore, that these tool-making activities are consistent with greater residential mobility. The transport of Stage 3 and 4 bifaces would have been efficient because they are more robust, durable items whose reduction and refinement would have provided formal tools and a “roving” supply of larger biface thinning flakes for expedient uses at other seasonal residences (Elston 1992a, 1992b; Johnson 1989; Kelly 1988; Nelson 1991). The A-F Transition occupants also, however, made formal biface tools for use during residence at Hunchback Shelter.

In contrast, the Fremont knappers appear to have placed more emphasis on late stage biface reduction than their A-F Transition counterparts. They appear to have been more concerned with transporting finished or nearly finished Stage 4 and 5 bifaces away from the site. This behavior is consistent with forays primarily focused on obtaining obsidian products for transport back to home settlements. Compared to the Stage 3 and 4 bifaces carried away from Hunchback by the A-F Transition occupants, a larger batch of Stage 4 and 5 bifaces could be exported from the site because each individual item was lighter, less bulky, and more refined. Transporting larger batches of more refined bifaces would be efficient (Henry 1989:153), especially if most of these knappers were supplying the needs of large aggregated villages.

Ratios of Staged Bifaces to Finished Bifacial Tools

The aforementioned inferences are further supported by a difference in the ratios of staged bifaces to finished bifacial tools (Table 9). This ratio is 2.0:1 for the A-F Transition, as opposed to 3.1:1 for the Fremont. The A-F Transition ratio is consistent with longer residential occupations associated with proportionally more finished formal tools for on-site use. In contrast, the higher Fremont ratio of 3.1:1 is more consistent with shorter occupations requiring fewer formal tools for on-site activities, but with a greater emphasis on biface production.

Table 9

RATIOS OF FORMAL TO EXPEDIENT TOOLS AT HUNCHBACK

Component	Staged Bifaces	Finished Formal Tools	Ratio
A-F Transition	326	163	2.0:1
Fremont	326	105	3.1:1

Densities of Flaked Stone Artifacts per Unit Volume Excavated

The final line of evidence considered in our argument is the density of flaked stone artifacts per unit-excavated volume. A total of 10.6 m.³ of A-F Transition deposits were excavated, containing a total of 16,228 flaked stone artifacts (Table 1). Consequently, the A-F Transition component had a density of 1,530.9 flaked stone artifacts per m.³. In contrast, a total of 9.16 m.³ of Fremont deposits were excavated, containing a total of 13,496 flaked stone artifacts. The Fremont component, therefore, had a lower density of 1,473.3 flaked stone artifacts per m.³ (Table 1).

Admittedly, the density differences between the components are not drastic. However, assuming that density reflects intensity or length of occupation, these figures are consistent with our inferences on site use. A-F Transition residential occupations would be expected to exhibit higher densities of flaked stone artifacts if they were of longer duration. In contrast, somewhat shorter Fremont logistical occupations would be expected to exhibit lower densities.

DISCUSSION

Rockshelters often represent a confusing palimpsest of information resulting from cultural mixing and bioturbation over several millennia (Madsen and Berry 1975; Schroedl and Coulam 1994). The patterns reflecting diachronic change in rockshelter deposits, therefore, are frequently weak and difficult to clearly define. That is precisely why multiple lines of evidence, however subtle they might be, must be marshaled in support of one's inferences.

As we have indicated, our interest has been to discern whether Hunchback Shelter was occupied for different reasons during the A-F Transition and Fremont periods. Notable variation is likely to be the result of different settlement systems during each period. Compared to the Fremont period, A-F Transition occupations appear

to have been relatively lengthy—perhaps as long as several weeks in duration (Greubel 2005:535). Besides the flaked stone artifacts, additional evidence supporting this inference includes A-F Transition deposits reflecting the cleaning and maintenance of interior space, the excavation of several pits to intentionally expand the interior space, limited but present FCR and charcoal-laden soils reflecting trampled and churned thermal features, and a larger groundstone assemblage than the Fremont component. Relatively lengthy occupations associated with domestic artifacts and refuse indicating the presence of males and females is consistent with a use of the shelter by family units (Greubel 2005:381). Together, these data collectively indicate that the average length of occupations was longer during the A-F Transition period than it was during the Fremont period.

We view the use of the site during the A-F Transition period as one in which obsidian tool procurement was embedded in the seasonal rounds of relatively small-scale, mobile foragers/farmers that were both residentially and logistically organized. We argue that like that of residentially mobile groups, the occupation of Hunchback by logistically mobile foragers during the A-F Transition period entailed the seasonal residential use of the site for more than simply acquiring toolstone (summer residences *sensu* Binford 1980).

In contrast, during the Fremont period, occupations appear to reflect shorter visits of perhaps several days to two weeks duration. Besides the flaked stone artifacts, other data supporting this interpretation include less evidence for the cleaning and maintenance of interior spaces and a more modest groundstone assemblage than the A-F Transition component (Greubel 2005:536). Less groundstone may indicate that overall, floral processing was less intensive during the Fremont period occupations. Taken together, these data indicate that most occupations may have been primarily focused on provisioning larger, aggregated Fremont settlements with non-local obsidian tools.

Diachronically, our interpretations revolve around the issue of hypothetical provisioning intents. A more specialized and intensive logistical system for acquiring relatively large batches of late-stage bifaces and flake cores would have been an efficient way to supply the high volume needs of aggregated communities. This type of organization would not have been necessary for

provisioning smaller A-F Transition groups with obsidian implements.

Single site inferences of logistical field camp behavior are often difficult to test because they can rarely be supported by comparative data from primary residential loci (Black and Metcalf 1997). Recent data from Five Finger Ridge (42SV1686; Fig. 1), however, are consistent with our model of a more specialized logistical use of Hunchback, during the Fremont period (Talbot et al. 2000). This relatively large Fremont settlement, located atop a knoll on the south side of Clear Creek in Central Utah, had a peak population of at least 75 people (Talbot 2000:Table 11.1). Obsidian was the second most prevalent toolstone represented, and provenance studies indicate that 62% of it came from the WHC and SM sources located 40 to 50 km. away (Talbot et al. 2000:396). Interestingly, the debitage reflects the reduction of flake cores made of this obsidian and of relatively inferior, local materials such as breccias and cherts. Like the items initially shaped at Hunchback, the Five Finger Ridge core technology indicates the reduction of non-bifacial flake cores with little cortex. Moreover, the high frequency of flake tools (N=1089) (Talbot et al. 2000:366) at Five Finger Ridge indicates that these flake cores were reduced largely for expedient purposes.

Talbot and his associates (Talbot et al. 2000:340-341) have suggested that work parties from Five Finger Ridge traveled to source areas to acquire obsidian for the community in the form of bifaces and “blank cores.” Numerous bifaces (n=401), 38% (n=152) of which are Stage 3 to 5 obsidian implements, and a high frequency of expedient flake cores (n=537) were recovered at Five Finger Ridge. Only 38 of the 537 flake cores recovered at the site were made of obsidian. The low number of obsidian cores, coupled with the considerable amount of obsidian debitage reflecting flake core reduction, suggests that obsidian cores were intensively processed at the site. It is highly unlikely that the acquisition of obsidian by the Five Finger Ridge inhabitants entailed transporting core debitage to the site.

What is particularly noteworthy about these data is that the types of products that we suggest were made for transport away from Hunchback Shelter during the Fremont period are similar to the types of items reduced and used at Five Finger Ridge. We do not contend that the logistical groups who visited Hunchback Shelter

came from Five Finger Ridge. In fact, the principal periods during which both sites were occupied may not have been contemporaneous (Greubel 2005; Talbot 2000; Talbot et al. 2000). What we are suggesting, however, is that the obsidian used at many Fremont villages like Five Finger Ridge was acquired by specialized logistical task groups. The question is whether these task groups were specialized for the community in this capacity, or whether various groups of community members went on these forays independently. We suggest that the data from Hunchback Shelter are consistent with the hypothesis that these forays were carried out by groups of craftsmen specialized in acquiring and producing flaked stone tools for their respective communities (see Greubel and Andrews, this issue).

Ethnographic information from the small-scale, agriculturally-based village of Langda in Indonesian Irian Jaya reflects a comparable flaked stone tool economy. Langda has about 300 residents, seven of which are knapping specialists who supply the village with flaked stone adzes (Stout 2002). Adze raw material is found along the banks of the Ey River, nearly a half day's journey from the village. The specialists periodically visit the river as a group to quarry stone, flake the material into blanks, and then further refine the blanks into preforms. Quarrying and preforming forays often last several days, requiring that the knappers spend the night in small huts next to the river. They exchange adzes to cement social bonds, as part of their bride price obligations, for meat (pigs), or for various prestige products including bird feathers and marine shell (Toth et al. 1992).

The Langda organization is a good analog for the proposed Fremont logistical use of Hunchback for at least two reasons. First, the population of Langda is similar in magnitude to the population estimates for many Fremont villages (<500 people) in the southeastern Great Basin. (Talbot 2000: Table 11.1). Such a similarity is important because it demonstrates that villages this size can and do support small groups of craftsmen specialized in the production of stone tools for community needs. Second, the Ey River quarrying locations are sufficiently difficult to access, thereby requiring short-term occupation campsites along the river; the primary activity at these sites is toolstone procurement and processing. Hence, the Langda knappers engage in short-term logistical forays with an objective comparable to what we suggest was the

case for many of the Fremont occupants of Hunchback Shelter.

Core versus Biface Technology during the Fremont Period

The Five Finger Ridge data also underscore a very important point about the relationship between mobility and expedient core versus biface technologies. Taking issue with the generalization that expedient reduction strategies become more prevalent as sedentism increases (Parry and Kelly 1987), the data discussed here clearly indicate that both flake core and biface technologies were economically important during the Fremont period. Data from Hunchback Shelter indicate a principal focus on the production of finished bifaces and viable flake cores. The predominance of bifacial debitage at Hunchback Shelter is a consequence of the emphasis on the manufacture of nearly finished bifaces. During the Fremont period expedient flake cores were mostly refined to a ready state for reduction elsewhere.

In contrast, data from Five Finger Ridge indicate a predominance of debitage reflecting expedient flake core reduction along with comparable quantities of flake cores (N=537) and bifacial tools (N=600), which include staged bifaces (N=401) and projectile points (N=199) (Talbot et al. 2000:364–366 and Table 6.24). Consequently, the emphasis that we see as archaeologists on core technology reflected in the debitage at Five Finger Ridge may have been overly enhanced by the specialized logistical acquisition of expedient flake cores and nearly finished bifaces. If flake cores and nearly finished bifaces were the principal obsidian imports, then relative to biface thinning flakes, core flakes should dominate the debitage assemblage because they were primarily removed at Five Finger Ridge. In contrast, the vast majority of bifacial reduction may have taken place off-site at distant locations like Hunchback Shelter, perhaps to maximize the amount of bifaces that could be transported back to the village. The point is that raw material location and the reduction strategies employed by logistical task groups may have had a direct bearing on what we see in the archaeological record at village communities and at sites like Hunchback Shelter. What is perceptible technology-wise, especially based on debitage, may be more a function of procurement behavior than a group's level or quality of residential mobility. We do not deny that bifacial technologies were well suited for

meeting the needs of highly mobile foragers. The very presence of these items at Fremont villages, however, indicates that they were also quite important for Great Basin farming groups. We suggest a need to quantify the differential economic importance of expedient core versus bifacial technologies for these groups. Future research on village sites should evaluate the respective frequencies of core reduction flakes in relationship to the amount of bifacial implements, and the stage affiliation of bifacial thinning flakes, to see if our inference is consistent with archaeological data from other Fremont period villages.

CONCLUSIONS

Rockshelter deposits rarely provide clear-cut reflections of diachronic changes in cultural behavior because they are stratigraphically complex. Such deposits can, however, reflect broad behavioral trends over time. Accordingly, this study demonstrates how the organization of obsidian procurement varied in relationship to changes in settlement and subsistence from the A-F Transition (A.D. 100 to 650) to Fremont (A.D. 650 to 1250) periods in the southeastern Great Basin. We think the procurement visits during the A-F Transition period were relatively long-term residential occupations most compatible with small-scale forager or forager/farmer groups. By Fremont times, the data indicate a shift towards primarily single-intent, logistical visits focused on obsidian acquisition for transport back to village locations. This diachronic shift in procurement behavior is consistent with a change from primarily small, relatively mobile groups during the A-F Transition period, to larger, village-based agricultural groups during the Fremont period.

Numerous researchers have argued that raw material availability is an important variable structuring the organization of lithic technology (Andrefsky 1994a, 1994b; Kelly 1988, 1992; Magne 1985, 1989). Availability is clearly influenced by distance to sources of stone. Distance is an important behavioral constraint because it conditions the energetic cost of transporting heavy resources (Hirth and Andrews 2002; Metcalfe and Barlow 1992). Hence, during the A-F Transition and Fremont periods, the patchy distribution of obsidian resources relative to distant residential locations favored a fairly high degree of toolstone processing close to the source. This pattern is not surprising.

What we wish to stress is that raw material availability was not the only factor structuring the organization of procurement in parts of the southeastern Great Basin. The settlement system also played an important role. An overall decrease in residential mobility during the Fremont period was accompanied by an increase in the size, and therefore the social complexity, of some residential communities. We suggest that the appearance of larger villages brought with it an increase in the complexity of economic provisioning, at least for non-locally available obsidian.

A greater emphasis at Hunchback Shelter on the production of flake cores and nearly finished bifacial tools for export during the Fremont period, and evidence that the Hunchback knappers during this period were more highly skilled than their A-F Transition counterparts (see Greubel and Andrews, this issue), support the suggestion that logistically-organized craft specialists may have supplied the flaked stone tool needs of Fremont villagers. This system may have been similar to the part-time craft specialists who supply the inhabitants of the village of Langda in Indonesia with flaked stone adzes (Stout 2002).

Admittedly, like many studies of technological organization, our stance is evolutionary (Bettinger 1991; Carr 1994b:2). We have examined the variability in tool production to better understand changes in social behavior over time (Binford 1982). Although cross-cultural research indicates that “there is no single relationship between specialization, exchange and social complexity” (Brumfiel and Earle 1987:4), population increase, especially when it is coupled with social aggregation, is often associated with the emergence of interdependent economic relationships (Durkheim 1933; Fried 1967; Service 1971; Steward 1955; White 1949, 1959). It is reasonable, therefore, to expect the appearance of more complex systems of economic provisioning in the southeastern Great Basin during the Fremont period given the appearance of relatively large villages. Institutionalized economic interdependence (e.g., specialized craft production) would have been an efficient means of provisioning larger, more sedentary communities with certain non-local, strategic resources. Further comparative research aimed at defining diachronic changes in the nature and prevalence of such economic institutions is imperative if we wish to understand the dynamic character of prehistoric social evolution throughout the Great Basin.

NOTES

¹The Hunchback Shelter was excavated as part of the Kern River 2003 Expansion Project funded by the Kern River Gas Transmission Company (KRG T).

²Artifacts were selected from every collection provenience (which includes all of the components identified) with the exception of those with less than eight pieces, because a count of this size will not yield a 12.5% sample. The overall analytic sample was extracted using a sediment splitter, which consists of an apparatus with a hopper into which the debitage from each collection provenience was dumped. Attached to the hopper is a chute with a ridge that divides a collection into two equal halves. To mitigate analyst bias, the right half was always selected and run through the hopper again to produce two proportions equating to 25% of the collection total. Once again, the right half was run through the hopper to derive two proportions of 12.5% of the collection total. This method had a $\pm 3\%$ margin of error because it was impossible to guarantee an equal split each time the proportions were run through the hopper. This process resulted in a final sample of 9,344 artifacts, approximately 12.4% of the assemblage total.

³The possibility that a significant number of flake cores were missed because they were located primarily in deposits in front of the shelter is unlikely. Like excavations in the interior, few flake cores were found in the respectable sample of deposits in front of the shelter that were excavated as part of the north-south trench.

⁴The second most prevalent type of obsidian (36%) at Five Finger Ridge was from the Black Rock source (Janetski 2000:122; Talbot et al. 2000:396).

ACKNOWLEDGMENTS

We express our thanks to the Kern River Gas Transmission Company, which funded the Kern River 2003 Expansion Project, and whose support made possible the recovery of the data discussed in this article. Also, we thank Lucille Harris for her analysis of the Hunchback debitage. We appreciate the support of numerous individuals at Alpine Archaeological Consultants, Inc., including Claudia Berry, Susan Chandler, Diana Gansemer, Jon Horn, Burr Neely, Diane Perry, Kim Redman, Alan Reed, Sage Wall, and the entire Hunchback field crew. Also, we thank the SWCA personnel involved in the Kern River 2003 Expansion Project, particularly Matthew Seddon. In addition, we appreciate the feedback of Martin Magne on an earlier version of this manuscript. Moreover, we greatly appreciate the efforts of two anonymous reviewers whose insightful comments and suggestions made our discussion much stronger. Finally, we would like to extend thanks to the Bureau of Land Management, especially Gardiner Dalley of the Cedar City Field Office. He discovered the Hunchback Shelter, perceived its research potential, and advocated work at the site during the Kern River 2003 Expansion Project.

REFERENCES

- Ahler, Stanley A.
1986 *The Knife River Flint Quarries: Excavations at Site 32DU508*. Bismarck: State Historical Society of North Dakota.
- 1989 Mass Analysis of Flaking Debris: Studying the Forest Rather Than the Tree. In *Alternative Approaches to Lithic Analysis*, D. O. Henry and G. H. Odell, ed., pp. 85–118. *Archaeological Papers of the American Anthropological Association* 1. Washington D.C.: American Anthropological Association.
- Andrefsky, William, Jr.
1994a The Geological Occurrence of Lithic Material and Stone Tool Production Strategies. *Geoarchaeology: An International Journal* 9:375–391.
- 1994b Raw Material Availability and the Organization of Technology. *American Antiquity* 59:21–34.
- 1998 *Lithics*. Cambridge: Cambridge University Press.
- 2001 *Lithic Debitage: Context, Form, Meaning*. Salt Lake City: University of Utah Press.
- Andrews, Bradford W.
2002 Stone Tool Production at Teotihuacan: What More Can We Learn from Surface Collections. In *Pathways to Prismatic Blades: A Study in Mesoamerican Obsidian Core-Blade Technology*, K. G. Hirth and B. W. Andrews, eds., pp. 47–60. Los Angeles: The Cotsen Institute of Archaeology, University of California.
- Andrews, Bradford W., Timothy M. Murtha, Jr., and Barry Scheetz
2004 Approaching the Hatch Quarry from a Technological Perspective: A Study of Prehistoric Stone Tool Production in Central Pennsylvania. *Midcontinental Journal of Archaeology* 29(1):57–101.
- Bettinger, Robert L.
1991 *Hunter-Gatherers: Archaeological and Evolutionary Theory*. New York: Plenum Press.
- Binford, Lewis R.
1980 Willow Smoke and Dogs Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4–20.
- 1982 The Archaeology of Place. *Journal of Anthropological Archaeology* 1:5–31.
- Black, Kevin D., and Michael D. Metcalf
1997 Archaic Period Logistical Organization in the Colorado Rockies. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains*, M. L. Larson and J. E. Francis, eds., pp. 168–209. Vermillion, South Dakota: The University of South Dakota Press.
- Broecker, W. S.
2001 Was the Medieval Warm Period Global? *Science* 291:1497–1499.

- Brumfiel, Elizabeth M., and Timothy K. Earle
1987 Specialization, Exchange, and Complex Societies: an Introduction. In *Specialization, Exchange, and Complex Societies*, E. Brumfiel and T. Earle, eds., pp. 1–9. Cambridge: Cambridge University Press.
- Callahan, Errett
1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flintknappers and Lithic Analysts. *Archaeology of Eastern North America* 7:1–180.
- Carr, Philip J. (ed.)
1994a The Organization of North American Prehistoric Chipped Stone Tool Technologies. *Archaeological Series* 7. Ann Arbor: International Monographs in Prehistory.
1994b The Organization of Technology: Impact and Potential. In *The Organization of North American Prehistoric Chipped Stone Tool Technologies*, P. J. Carr, ed., pp. 1–8. *Archaeological Series* 7. Ann Arbor: International Monographs in Prehistory.
- Coltrain, Joan B., and Steven W. Leavitt
2002 Climate and Diet in Fremont Prehistory: Economic Variability and Abandonment of Maize Agriculture in the Great Salt Lake Basin. *American Antiquity* 67:453–485.
- Cross, John R.
1993 Craft Specialization in Nonstratified Societies. In *Research in Economic Anthropology, Vol 14*, B. Isaac, ed., pp. 61–84. Greenwich, Connecticut: JAI Press Inc.
- Dames and Moore, Inc.
1994 *Kern River Pipeline Cultural Resources Data Recovery Report: Utah*. MS on file at the Bureau of Land Management, Utah State Office.
- Drennan, Robert D.
1996 *Statistics for Archaeologists: A Commonsense Approach*. New York: Plenum Press.
- Durkheim, Emile
1933 *The Division of Labor in Society*. New York: Free Press.
- Eckerle, William, Marissa Taddie, and Sasha Taddie
2005 Geoarchaeological Assessment of the Utah Segment of the Kern River Pipeline Expansion. In *Kern River 2003 Expansion Project, Utah—Volume III: Pt 7, Appendix K.*, pp. 2665–2871. MS on file at Alpine Archaeological Consultants, Inc., Montrose, Colorado.
- Elston, Robert G.
1992a Economics and Strategies of Lithic Production at Tosawih. In *Archaeological Investigations at Tosawih, A Great Basin Quarry, Part 1: The Periphery*, R. G. Elston and C. Raven, eds., pp. 775–801. Silver City, Nevada: Intermountain Research.
1992b Modeling the Economics and Organization of Lithic Procurement. In *Archaeological Investigations at Tosawih, a Great Basin Quarry, Part 1: The Periphery*, R. G. Elston and C. Raven, eds., pp. 31–47. Silver City, Nevada: Intermountain Research.
- Ensor, H. Blaine, and E. Roemer, Jr.
1989 Comments on Sullivan and Rosens's Debitage Analysis and Archaeological Interpretation. *American Antiquity* 54:175–178.
- Euler, Robert C., George J. Gumerman, Thor N. V. Karlstrom, Jeffrey S. Dean, and Richard H. Hevly
1979 The Colorado Plateaus: Cultural Dynamics and Paleoenvironment. *Science* 205:1089–1101.
- Fish, Paul R.
1981 Beyond Tools: Middle Paleolithic Debitage Analysis and Cultural Inference. *Journal of Anthropological Research* 37:374–386.
- Flenniken, Jeffrey J.
1981 *Replicative Systems Analysis: A Model Applied to the Vein Quartz Artifacts from the Hoko River Site*. Pullman, Washington: Washington State University Laboratory of Anthropology.
1984 Past, Present, and Future of Flintknapping: An Anthropological Perspective. *Annual Review of Anthropology* 13:187–203.
- Fried, Morton H.
1967 *The Evolution of Political Society*. New York: Random House.
- Greubel, Rand A.
2005 Investigations at Hunchback Shelter (42BE751). In *Kern River 2003 Expansion Project, Utah—Volume III: Prehistoric Excavated Sites and Discoveries*. MS on file at Alpine Archaeological Consultants, Inc., Montrose, Colorado.
- Henry, Donald O.
1989 Correlations between Reduction Strategies and Settlement Patterns. In *Alternative Approaches to Lithic Analysis*, D. O. Henry and G. H. Odell, eds., pp. 139–155. *Archaeological Papers* 1. Washington, D.C.: American Anthropological Association.
- Hirth, Kenneth G., and Bradford W. Andrews
2002 Introduction. In *Pathways to Prismatic Blades: A Study in Mesoamerican Obsidian Core-Blade Technology*, K. G. Hirth and B. W. Andrews, eds., pp. 1–14. Los Angeles: The Cotsen Institute of Archaeology, University of California.
- Hull, Kathleen L., and R. W. Bevill
1994 Obsidian Studies. In *Kern River Pipeline Cultural Resources Data Recovery Report: Utah*. MS on file at the Bureau of Land Management, Utah State Office.
- Janetski, Joel C.
1998 *Archaeology of Clear Creek Canyon*. Provo, Utah: Museum of Peoples and Cultures, Brigham Young University.
2000 Obsidian. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by J. C. Janetski, R. K. Talbot, D. E. Newman, L. D. Richens, J. D. Wilde, S. B. Baker and S. E. Billat, pp. 121–124. *Museum of Peoples and Cultures Occasional Papers* 7. Provo, Utah: Brigham Young University.

- Jeske, R. J.
1992 Energetic Efficiency and Lithic Technology: An Upper Mississippian Example. *American Antiquity* 57:467–481.
- Johnson, Jay K.
1989 The Utility of Production Trajectory Modeling as a Framework for Regional Analysis. In *Alternative Approaches to Lithic Analysis*, D. O. Henry and G. H. Odell, eds., pp. 119–138. *Archaeological Papers of the American Anthropological Association* 1. Washington D.C.: American Anthropological Association.
- Jones, George T., Charlotte Beck, Eric E. Jones, and Richard E. Hughes
2003 Lithic Source Use and Paleoarchaic Foraging Territories in the Great Basin. *American Antiquity* 68:5–38.
- Jones, Terry L., Gary M. Brown, L. Mark Raab, Janet L. McVickar, W. Geoffrey Spaulding, Douglas J. Kennett, Andrew York, and Phillip L. Walker
1999 Environmental Imperatives Reconsidered. *Current Anthropology* 40:137–170.
- Kardulias, Nick P., and Richard W. Yerkes (editors)
2003 *Written in Stone*. Lanham, Maryland: Lexington Books.
- Kelly, Robert L.
1988 The Three Sides of a Biface. *American Antiquity* 53:717–734.
1992 Mobility/Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Review of Anthropology* 21:43–66.
- Kuhn, Steven L.
1991 “Unpacking” Reduction: Lithic Raw Material Economy in the Mousterian of West-Central Italy. *Journal of Anthropological Archaeology* 10:76–106.
1994 A Formal Approach to the Design and Assembly of Mobile Toolkits. *American Antiquity* 59:426–442.
- Larson, Mary Lou
1994 Toward a Holistic Analysis of Chipped Stone Assemblages. In *The Organization of North American Prehistoric Chipped Stone Tool Technologies*, P. J. Carr, ed., pp. 57–69. *Archaeological Series* 7. Ann Arbor, Michigan: International Monographs in Prehistory.
- Lipman, P. W., P. D. Rowley, H. H. Mehnert, S. H. Evans, Jr., W. P. Nash, and F. H. Brown
1978 Pleistocene Rhyolite of the Mineral Mountains, Utah—Geothermal and Archaeological Significance. *U.S. Geological Survey Journal of Research* 6(1):133–147.
- Madsen, David B.
1982 Get It Where the Getting’s Good: A Variable Model of Great Basin Subsistence and Settlement Based on Data from the Eastern Great Basin. In *Man and Environment in the Great Basin*, D. B. Madsen and J. F. O’Connell, eds., pp. 207–226. *SAA Papers* 2. Washington D. C.: Society for American Archaeology.
1989 Exploring the Fremont. *University of Utah Occasional Publications* 8. Salt Lake City: Utah Museum of Natural History.
- Madsen, David B. and Michael S. Berry
1975 A Reassessment of Northeastern Great Basin Prehistory. *American Antiquity* 40:391–405.
- Madsen, David B., and Steven R. Simms
1998 The Fremont Complex: A Behavioral Perspective. *Journal of World Prehistory* 12:255–336.
- Magne, Martin P.
1985 Lithics and Livelihood: Stone Tool Technologies of Central and Southern Interior British Columbia. *Archaeological Survey of Canada Paper Mercury Series* 133. Ottawa, Canada: National Museum of Man.
1989 Lithic Reduction Stages and Assemblage Formation Processes. In *Experiments in Lithic Technology*, D. S. Amick and R. P. Mauldin, eds., pp. 15–31. [*BAR International Series* 528, *British Archaeological Reports*.] Oxford: Archaeopress.
2001 Debitage Analysis as a Scientific Tool for Archaeological Knowledge. In *Lithic Debitage: Context, Form, Meaning*, W. Andrefsky, Jr., ed., pp. 21–30. Salt Lake City: The University of Utah Press.
- Manheim, Jarol B., and Richard G. Rich
1981 *Empirical Political Analysis: Research Methods in Political Science*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.
- Marwitt, J. P.
1980 A Fremont Perspective. In *Fremont Perspectives*, D. B. Madsen, ed., pp. 9–12. [*Antiquities Section Selected Papers* VII(6).] Salt Lake City: Utah State Historic Society.
- Metcalfe, Duncan, and K. Renee Barlow
1992 A Model for Exploring the Optimal Trade-Off between Field Processing and Transport. *American Anthropologist* 94:340–356.
- Nelson, Fred W., Jr.
1984 X-ray Fluorescence Analysis of Some Western North American Obsidians. In *Obsidian Studies in the Great Basin*, R. E. Hughes, ed., pp. 27–62. *Contributions of the University of California Archaeological Research Facility* 45. Berkeley: University of California.
- Nelson, Fred W., Jr., and Richard D. Holmes
1979 Trace Element Analysis of Obsidian Sources and Artifacts from Western Utah. *Utah State Historical Society, Antiquities Section Selected Papers* 6(15):65–80.
- Nelson, Margaret C.
1991 The Study of Technological Organization. In *Archaeological Method and Theory*, M. B. Schiffer, ed., pp. 57–100, Vol. 3. Tucson: University of Arizona Press.
- Odell, George H.
1989 Experiments in Lithic Reduction. In *Experiments in Lithic Technology*, D. S. Amick and R. P. Mauldin, eds., pp. 163–198. [*BAR International Series* 528, *British Archaeological Reports*.] Oxford: Archaeopress.

- Parry, William J., and Robert L. Kelly
1987 Expedient Core Technology and Sedentism. In *The Organization of Core Technology*, J. K. Johnson and C. A. Morrow, eds., pp. 285–304. Boulder, Colorado: Westview Press.
- Patterson, Leland W.
1982 Replication and Classification of Large Size Lithic Debitage. *Lithic Technology* 11(3):50–58.
1990 Characteristics of Bifacial Reduction Flake-Size Distribution. *American Antiquity* 55:550–558.
- Pecora, Albert M.
2001 Chipped Stone Tool Production Strategies and Lithic Debitage Patterns. In *Lithic Debitage: Context, Form and Meaning*, W. J. Andrefsky, ed., pp. 173–190. Salt Lake City: University of Utah Press.
- Rasic, Jeffrey, and William Andrefsky, Jr.
2001 Alaskan Blade Cores as Specialized Components of Mobile Toolkits: Assessing Design Parameters and Toolkit Organization. In *Lithic Debitage: Context, Form, and Meaning*, W. Andrefsky, Jr., ed., pp. 61–79. Salt Lake City: University of Utah Press.
- Reed, Alan D., Susan M. Chandler, and Rand A. Greubel
1996 Appendix J: Lithic Replication Experiments. In *Archaeological Investigations of 11 Sites Along Interstate 70: Castle Valley to Rattlesnake Bench*. MS on file at Alpine Archaeological Consultants, Inc., Montrose, Colorado.
- Schroedl, Alan R., and Nancy J. Coulam
1994 Cowboy Cave Revisited. *Utah Archaeology* 7:1–34.
- Service, Elman R.
1971 *Primitive Social Organization: An Evolutionary Perspective*. New York: Random House.
- Sheets, Payson D.
1975 Behavioral Analysis and the Structure of a Prehistoric Industry. *Current Anthropology* 16:369–391.
- Shott, Michael J.
1989 Technological Organization in Great Lakes Paleoindian Assemblages. In *Eastern Paleoindian Lithic Resource Use*, C. J. Ellis and J. C. Lothrop, eds., pp. 221–238. Boulder, Colorado, Westview Press.
1994 Size and Form in the Analysis of Flaked Stone Debris: Review and Recent Approaches. *Journal of Archaeological Method and Theory* 1:69–110.
- Simms, Steven R.
1986 New Evidence for Fremont Adaptive Diversity. *Journal of California and Great Basin Anthropology* 8(2):204–216.
- Stahle, David W., and James E. Dunn
1982 Analysis and Application of the Size Distribution of Waste Flakes from the Manufacture of Bifacial Stone Tools. *World Archeology* 14(1):84–97.
- Steward, Julian H.
1955 *Theory of Culture Change*. Urbana: University of Illinois Press.
- Stokes, William L.
1986 Geology of Utah. *Utah Museum of Natural History Occasional Papers* 6. Salt Lake City.
- Stout, Dietrich
2002 Skill and Cognition in Stone Tool Production. *Current Anthropology* 43:693–722.
- Sullivan, Alan P., III, and Kenneth C. Rozen
1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50:755–779.
- Talbot, Richard K.
1995 Clear Creek Canyon Archaeological Project, Volume 4, Part Three: Five Finger Ridge. *Museum of Peoples and Cultures Technical Series* 95–8. Provo, Utah: Brigham Young University.
2000 Fremont Settlement Patterns and Demography. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by J. C. Janetski, R. K. Talbot, D. E. Newman, L. D. Richens, J. D. Wilde, S. B. Baker and S. E. Billat, pp. 201–230. *Museum of Peoples and Cultures Occasional Papers* 7. Provo, Utah: Brigham Young University.
- Talbot, Richard K., Lane D. Richens, James D. Wilde, Joel C. Janetski and Deborah E. Newman
2000 Excavations at Five Finger Ridge, Clear Creek Canyon, Central Utah. *Museum of Peoples and Cultures Occasional Papers* 5. Provo, Utah: Brigham Young University.
- Tomka, S. A.
1989 Differentiating Lithic Reduction Techniques: An Experimental Approach. In *Experiments in Lithic Technology*, D. S. Amick and R. P. Mauldin, eds., pp. 137–162. [BAR International Series 528, *British Archaeological Reports*.] Oxford: Archaeopress.
- Toth, Nicholas, Desmond Clark, and Giancarlo Ligabue
1992 The Last Stone Adze Makers. *Scientific American* 267:88–93.
- Torrence, Robin (ed.)
1989 *Time, Energy, and Stone Tools*. Cambridge: Cambridge University Press.
- Wenzel, Kristin E., and Philip H. Shelley
2001 What Put the Small in the Arctic Small Tool Tradition: Raw Material Constraints on Lithic Technology at the Mosquito Lake Site, Alaska. In *Lithic Debitage: Context, Form, and Meaning*, W. J. Andrefsky, ed., pp. 106–123. Salt Lake City: University of Utah Press.
- White, Leslie A.
1949 *The Science of Culture*. New York: Grove Press.
1959 *The Evolution of Culture*. New York: McGraw-Hill.
- Whitlock, C., and P. J. Bartlein
1993 Spatial Variation of Holocene Climate Change in the Yellowstone Region. *Quaternary Research* 39:231–238.
- Yerkes, Richard W., and Nick P. Kardulias
1993 Recent Developments in the Analysis of Lithic Artifacts. *Journal of Archaeological Research* 1(2):89–119.

