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

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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
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). 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 Bevill 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 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

<table>
<thead>
<tr>
<th>Component</th>
<th>No. of Flaked Stone Artifacts(^a)</th>
<th>Volume Excavated (m(^3))</th>
<th>Estimated Density (m(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-F Transition(^b)</td>
<td>16,228</td>
<td>10.60</td>
<td>1,530.9</td>
</tr>
<tr>
<td>Fremont</td>
<td>13,496</td>
<td>9.16</td>
<td>1,473.3</td>
</tr>
</tbody>
</table>

\(^a\) Includes Debitage, Flaked Stone Tools, and Flake Cores  
\(^b\) Archaic-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 entire debitage assemblage (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. This sample was selected from every collection provenience. As such, it is of adequate size for defining the broad patterns evident in the debitage 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 stone debitage 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 Hunchback debitage 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.
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,
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. (σ=1.3). Eight cores with a mean maximum dimension of 5.8 cm. (σ=0.7) were recovered from the A-F Transition deposits; only three cores with a mean maximum dimension of 3.9 cm. (σ=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>
<thead>
<tr>
<th>EXPEDITED FLAKE CORES AT HUNCHBACK SHELTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
</tr>
<tr>
<td>Site-wide</td>
</tr>
<tr>
<td>A-F Transition</td>
</tr>
<tr>
<td>Fremont</td>
</tr>
</tbody>
</table>
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.
(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.
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. However, the moderate amount of core flakes at the site is 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 ($\chi^2 = 1.07$, 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.
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### Table 6

<table>
<thead>
<tr>
<th>Tool Type</th>
<th>A-F Transition (n)</th>
<th>Fremont (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projectile Point</td>
<td>133</td>
<td>93</td>
</tr>
<tr>
<td>Knife</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Formal Scraper</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Drill</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Other Biface</td>
<td>326</td>
<td>326</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>489 (68%)</td>
<td>431 (76%)</td>
</tr>
<tr>
<td>Informal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retouched Flake</td>
<td>159</td>
<td>100</td>
</tr>
<tr>
<td>Utilized Flake</td>
<td>80</td>
<td>38</td>
</tr>
<tr>
<td>Utilized Piece</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>228 (32%)</td>
<td>139 (24%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>717 (100%)</td>
<td>570 (100%)</td>
</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Component</th>
<th>Formal</th>
<th>Informal</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-F Transition</td>
<td>489</td>
<td>228</td>
<td>2:1:1</td>
</tr>
<tr>
<td>Fremont</td>
<td>431</td>
<td>139</td>
<td>3:1:1</td>
</tr>
</tbody>
</table>

### Table 8

<table>
<thead>
<tr>
<th>Component</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-F Transition</td>
<td>29 (11%)</td>
<td>75 (23%)</td>
<td>104 (38%)</td>
<td>48 (19%)</td>
<td>256 (100%)</td>
</tr>
<tr>
<td>Fremont</td>
<td>38 (14%)</td>
<td>72 (26%)</td>
<td>110 (39%)</td>
<td>61 (22%)</td>
<td>281 (100%)</td>
</tr>
</tbody>
</table>

### 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%).
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**

<table>
<thead>
<tr>
<th>Component</th>
<th>Staged Bifaces</th>
<th>Finished Formal Tools</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-F Transition</td>
<td>326</td>
<td>163</td>
<td>2.0:1</td>
</tr>
<tr>
<td>Fremont</td>
<td>326</td>
<td>105</td>
<td>3.1:1</td>
</tr>
</tbody>
</table>

**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

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

2 Artifacts 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 thedebitage 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 analyt 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 ±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 3,344 artifacts, approximately 12.4% of the assemblage total.

3 The 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.

4 The 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).

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