LITHIC SOURCE USE AND PALEOARCHAIC FORAGING TERRITORIES IN THE GREAT BASIN

George T. Jones, Charlotte Beck, Eric E. Jones, and Richard E. Hughes

Paleoarchaic (11.5–8.0 ka) occupants of the Great Basin encountered numerous lithic sources as they moved across foraging territories. Source provenance and lithic technologic analyses applied to the tools manufactured from these source materials elucidate several aspects of mobility, including the geographic scale of material conveyance and extent and possible routes of population movement. This research indicates that central Great Basin groups traversed large subsistence territories, extending more than 400 km from north to south, with mobility tactics probably keyed to the distribution of resource-rich wetlands. Changes in source representation parallel warming and drying trends, suggesting that Paleoarchaic foraging ranges shifted as wetlands diminished after about 9.5–8.5 ka.

Los habitantes paleoarcaicos (11.500–8.000 a.p.) de la Gran Cuenca de los Estados Unidos encontraron numerosas fuentes línicas durante el recorrido de sus territorios de recolección. Los análisis tecnológicos y de proveniencia indican el uso de estas fuentes y además permiten elucidar algunos aspectos de movilidad, incluyendo la escala geográfica del transporte de material y el alcance de las posibles rutas de movimiento de población. Esta investigación indica que los grupos de la Gran Cuenca central explotaron vastos territorios, de más de 400 km, de norte a sur, con tácticas de movilidad enfocadas en la distribución de pantanos ricos en recursos. Cambios en el uso de ciertos materiales líticos coinciden con el desarrollo de un clima cálido y árido, sugiriendo que, a partir de 9.500–8.500 a.p., los habitantes paleoarcaicos modificaron sus territorios de recolección debido a la desecación de los pantanos.

There is widespread agreement among archaeologists that terminal Pleistocene-early Holocene human populations throughout North America were highly mobile, traversing large foraging territories to meet subsistence and other needs. In many places, changes in mobility appear to coincide with shifting climatic conditions and biotic reorganization during the early Holocene, reflecting adaptation to local subsistence opportunities and increasing population density. These changes are poorly understood in the intermountain region of western North America, but as we outline in this paper they certainly involved modifications of subsistence and mobility patterns.

In the broadest sense, mobility refers to the manner in which humans move across the landscape in relation to properties of the environment, particularly the distribution of subsistence resources (Binford 1980; Kelly 1983, 1992). Although a focus on mobility has been part of modern forager studies for many years (e.g., Kelly 1932; Lee and DeVore 1968; Lothrop 1928; Murdock 1967), archaeological applications gained critical methodological footing in Binford’s (1977, 1978, 1979, 1980) ethnoarchaeological research among the Nunamuit. Since that time, mobility patterns have become a central interest of archaeologists as well (e.g., Bettinger and Baumhoff 1982; Kelly 1988; Kelly and Todd 1988; Kuhn 1991, 1994; Shott 1986, 1989). Mobility involves several dimensions of group movement. These include the size of the territorial range, the frequency of residential and/or logistical moves, and who actually moves (individuals or the entire group) (Kelly 1992).

Research into Paleoindian mobility has emphasized the first of these dimensions; other aspects are more difficult to discern archaeologically.

Perhaps the most common approach to the problem has been to infer patterns of movement using the geologic source provenance of stone tools in archaeological assemblages (e.g., Beck and Jones 1990b;
Boldarian 1991; Hofman 1992; MacDonald 1968; Reher and Frison 1980). As Kelly (1992:55) notes, however, “such information provides a rough indication only of the range, rather than mobility, since the raw material could have been acquired through residential or logistical movement, or trade.” Others have dealt with the issue by focusing on the organization of tool technology (e.g., Binford 1977, 1978, 1979, 1980; Carr 1994; Kelly 1988; Kuhn 1991; Odell 1996b; Torrence 1989), emphasizing geographic patterns defined by variation in manufacture, transport, and tool discard tactics.

Archaeologists disagree, however, about the relationship between mobility and technology. Shott (1986, 1989), for example, suggests that there is a direct correlation between the frequency of residential moves and technological diversity and complexity (see also Kelly 1988). Conversely, Torrence (1989:62) doubts that mobility determines technological diversity, but acknowledges its constraining effect, while Tomka (2001) suggests functional requirements rather than portability are central considerations in tool design. Nonetheless, although archaeologists debate the nature of the relationship between mobility and technological organization, most agree that the relationship is important, regardless of how tactical details play out in particular situations (e.g., Bamforth 1986, 1991; Bettinger 1987; Kelly 1983, 1988; Kelly and Todd 1988; Kuhn 1991, 1994; Nelson 1991; Odell 1996a, 1996b; Parry and Kelly 1987; Torrence 1989).

Kelly (1992:46) suggests that “although many variables affect mobility, subsistence—and therefore foraging strategy—is certainly a primary one.” The geographic distribution of toolstone sources, however, also imposes significant constraints on patterns of movement (Bamforth 1986, 1991; Kuhn 1991). Since the locations of subsistence and toolstone resources may be disjunct (Goodyear 1989), both mobility (e.g., schedules and patterns of movement) and technological strategies (e.g., designs that meet functional and portability requirements) are selected to accommodate spatial incongruities (Andrefsky 1994; Kelly 1988). Thus, a reasonable beginning in the study of prehistoric mobility considers both source location and technological organization, rather than either exclusively (Kuhn 1991; Odell 1996a).

In this study, source attributions of obsidian and dacite tools are used to judge the geographic or territorial scale of terminal Pleistocene-early Holocene population mobility in the central Great Basin. The cultural systems of this period collectively are termed the “Paleoarchaic,” reflecting their broad-spectrum adaptations (Beck and Jones 1997; Willig 1989). We infer the geographic distribution of Paleoarchaic territories in this region through examination of the staging of lithic production events and illustrate the sequence in which geologic sources were exploited in an effort to understand how Paleoarchaic groups moved across this region. We also examine apparent changes in these variables during the early Holocene and explore the reasons for these observed shifts. Lastly, the inferred geographic patterns are evaluated in light of source provenance records from other parts of the Great Basin.

**Paleoarchaic Adaptation in the Great Basin**

When describing human adaptations during the terminal Pleistocene-early Holocene (TP-EH), Great Basin archaeologists have focused attention primarily on subsistence and settlement patterns, relating these to environmental structure and the distributions of critical food resources (e.g., Elston 1982). Beginning in the 1930s (e.g., Campbell et al. 1937), archaeologists identified a strong association between Paleoarchaic sites and pluvial landforms. Such evidence in the Fort Rock Valley, southern Oregon, led Bedwell (1973), for example, to argue that lacustrine or wetland environments were important foci of an adaptation he termed the “Western Pluvial Lakes Tradition.” Late-glacial pluvial lakes, in fact, had receded by about 13 ka (radiocarbon years B.P. x 103), prior to known human occupation of the Great Basin (see Beck and Jones 2001). Beginning just before 11 ka, however, shallow lakes and wetlands were reborn in many valleys during the moist Younger Dryas (Benson 1999; Huckleberry et al. 2001; Oviatt et al. 1992; Quade et al. 1998; Thompson 1992). Presumably because of their favorable position in relation to these wetlands, older pluvial landforms were preferentially selected for occupation, thereby giving rise to the environmental association identified by archaeologists. The distinctiveness of this settlement pattern is all the more evident when compared with later Archaic manifestations (Grayson 1993; Kelly 1997). Whereas Archaic sites are distributed across many environmental settings, and are especially prominent in woodland zones well above the valley floors,
Paleoarchaic sites and diagnostic isolates almost always occur on the floors and adjacent piedments of Great Basin valleys.

Although meager, the subsistence record indicates that wetlands were indeed foci of food procurement and settlement in many parts of the Great Basin after 11 ka (e.g., Bedwell 1973; Eiselt 1997; Greenspan 1994; Mehnringer and Cannon 1994). Paleoarchaic groups also apparently sought large terrestrial mammals (Fry 1970, 1976; Grayson 1979), but over time they made increasingly greater use of small mammals, waterfowl and other birds, and fish (e.g., Basgall 1993a, 1993b; Basgall and Hall 1993; Douglas 1990; Douglas et al. 1988; Oetting 1994). Intensive plant exploitation appears to have begun by 10 ka in a few places in the Great Basin (e.g., Danger Cave [Jennings 1957]) where less-costly alternative food resources were rare. Seed use, a hallmark of the Desert Culture (Jennings 1957), became widespread in the Great Basin during the next millennium (Cummings 1999; Napton 1997; for summary of Paleoarchaic subsistence research see Beck and Jones 1997).

Admittedly this description draws on evidence from many parts of the Great Basin and from a considerable span of time and, as such, is probably overly generalized. Nevertheless, relative to later Great Basin Archaic subsistence adaptations, which are well known for their emphasis on seeds and other vegetal foods (Elston 1982; Grayson 1993; Kelly 1997), Paleoarchaic people focused on more highly ranked resources, which were especially abundant in wetland settings. Thus there can be little doubt that the quality and distribution of TP-EH lakes and marshes substantially influenced the subsistence scheduling and mobility tactics of Paleoarchaic foragers. As significant climatic warming proceeded in the early Holocene and mesic habitats diminished, the archaeological record indicates that shifts in diet breadth occurred. Almost certainly these were accompanied by changes in mobility patterns.

Unfortunately, the details of the environmental changes are not well known in the majority of Great Basin valleys. Nevertheless, evidence of lake transgressions, marsh expansion, and greater spring and stream flow is widespread throughout the Great Basin between 11.2 and 10.1 ka (Benson et al. 1997; Benson et al. 1990; Currey 1990; Quade et al. 1998; for a summary see Madsen 1999), indicating that effective moisture was greater during this period than in any subsequent interval. TP-EH faunal records, which exhibit significantly greater species diversity than younger assemblages, commonly contain mesic species that were extirpated by the middle Holocene (e.g., Grayson 1998, 2000). Vegetation records indicate that many montane tree and shrub species occupied lowland settings along with more expansive steppe communities during the TP-EH (Grayson 1993; Spaulding 1990; Thompson 1990). In many areas greater moisture persisted until ca. 8.5 ka, but substantial drying is recorded in some valleys following the Younger Dryas, shortly after 10 ka (e.g., Huckleberry et al. 2001). With drying, shrubby, low quality, xerophytic plant communities expanded at the expense of steppe and marsh communities (Wigand and Rhode 2002). Mesic settings did not disappear abruptly or synchronously across the Great Basin (Madsen 1999); rather, variation is recorded along latitudinal gradients (Benson 1999) and in response to particular local circumstances, e.g., area and elevation of watershed. The environmental changes that culminated by 8.5 ka were significant for human populations. The archaeological record after this time contains significant increases in the use of ground stone artifacts, suggesting increasing importance of seeds in the diet, while in some geographic areas the occupation record diminishes to almost nothing (Baumhoff and Heizer 1965; Beck and Jones 1997; Grayson 1993).

**Paleoarchaic “Travelers”**

High biotic productivity and concentrated low-cost food resources in wetlands and contiguous steppe patches would have supported comparatively narrow diet breadths and, as the settlement record suggests, use of a limited suite of microenvironments (subsistence patches). Analyzing a different archaeological context, Bettinger and Baumhoff (1982) predict such conditions would favor a “traveler” strategy, one emphasizing use of a narrow suite of high-quality resources. Bettinger (1991, 1994, 1999) posits that “travelers” operate in small groups under conditions of low population density (hence, little competition for resources) and, though traveling great distances, make only brief residential stays at settlements. In short, “travelers” invest effort in movement between resource-rich patches, and, because subsistence efforts focus on just a few resources that may be rapidly depleted, peoples practicing such a strategy rarely make long residential stays.
At the other end of this spectrum is a “processor” strategy. As the term implies, in this case investment is made in resource handling, or processing, rather than in travel. This difference is occasioned by wider diet breadth involving resources whose values can only be realized by costly processing. Increased population size and/or diminished concentrations of highly ranked resources favor expansion of diet breadth. As efforts in resource processing increase, the relative costs of seeking resources in nearby, poorer resource patches diminishes. Thus, “processors” will make longer stays at residential sites (Bettinger 1991) and perhaps organize procurement along the lines of a logistic strategy (sensu Binford 1979).

Extant subsistence and settlement records, combined with evidence about TP-EH environments, suggest that Paleoarchaic groups acted more like “travelers” than “processors” in that they appear to have exploited a small set of food resources, focused subsistence efforts on a few kinds of resource patches, and allocated relatively greater effort to travel than to the extraction and processing of resources than did later Great Basin groups.¹ These adaptations appear to have changed as climatic warming and drying diminished wetlands and stream systems during the early Holocene. Greater use of small mammal, fish, and vegetal foods, the latter especially after 9.5 ka, indicate that Paleoarchaic diet broadened in concert with climate change.

These conclusions rest, admittedly, on modest subsistence evidence. Despite the fact that Great Basin rockshelters often contain remarkably well-preserved assemblages of organic artifacts, TP-EH components with good preservation are rare. Consequently, to allow evaluation of these hypotheses, we need to recast expectations to make use of other sources of information. Here, we examine what implications these hypothesized adaptive changes have for Paleoarchaic mobility patterns. In particular, we focus on the geographic scale of mobility and address the extent to which shifts in the duration of site residence coincide with other changes in mobility. Given that reductions in the number and quality of favored resource patches occurred, we expect that Paleoarchaic groups would have shifted their subsistence ranges in attempts to seek productive wetland environments. An expanding diet breadth would have encouraged longer residential stays within patches and shifts to more logistical strategies, which permitted exploitation of a wider range of subsistence patches in an efficient manner. In short, under these conditions Paleoarchaic foragers increasingly would have behaved more like “processors” than “travelers.”

### Operationalizing Mobility

Mobility refers to various strategies of movement and settlement in relation to properties of the natural environment. Although often described as a characteristic of human adaptation, mobility is not a single variable. For example, to differentiate ethnographic practices, Kelly (1983, 1992, 1995) treats several dimensions of mobility, including the number of moves, distance of moves, and residence time. These dimensions are difficult to monitor using archaeological data.

One aspect of mobility that archaeologists have addressed successfully is the size of the territory or foraging range that a group or set of related groups habitually occupied. Lithic source provenance information often is central in these analyses (e.g., Anderson and Hanson 1988; Beck and Jones 1990b; Buck et al. 1996; Seeman 1994; Tankersley 1990). Providing that the locations of geologic sources are known, that the source provenance of artifacts can be identified unambiguously, and that exchange can be ruled out as a tactic of lithic material conveyance (a problematic exercise that we return to below), simply plotting source locations provides a rough measure of the geographic territory utilized. Given an adequate census of source locations, it is not difficult to determine which areas were traversed and which were not, in short providing a picture of the geographic extent of the foraging territory.

These requirements sometimes are difficult to satisfy completely. For instance, lithic material from different sources may be hard to differentiate. Even geochemical analyses may fail to discriminate between sources, particularly when there is considerable chemical variation within a single source, as often appears to be the case in some kinds of cryptocrystalline silicates (e.g., Leudtke 1992; but see Hess 1996; Lyons 2001). Great Basin archaeologists have focused attention, therefore, on geochemical analyses of obsidian sources, which exhibit considerable within-source chemical homogeneity. Distinguishing among sources of fine-grained volcanic rocks, e.g., rhyolite, dacite, and andesite, also is proving to be successful, although provenance studies of these toolstones are in their infancy (e.g., Jones et al. 1997; Latham et al. 1992).
Another difficulty arises in distinguishing between those exotic lithic materials that are products of procurement embedded in mobility and those that are products of exchange (LaTourneau 2000; Meltzer 1989). Both produce identical archaeological signatures—artifact assemblages containing non-local material. Basgall (1989:111) argues that, although the presence of extra-local material may reflect exchange or other complexities of social interaction, “among many hunter-gatherer populations lithic procurement is a fundamental component of subsistence settlement organization and occurs primarily or wholly within that context.” Most Paleolithic specialists appear to accept this argument, believing that exchange played a minor role in the acquisition of lithic material (see Barnforth 2002:84). Hughes (1994b), on the other hand, observes that an uncritical stance toward the material consequences of embeddedness in exchange-systems studies has led to the substitution of default postures (“mobility” vs. “exchange”) that rest more on assertion than on empirical contrasts in material cultural remains. Exclusive reliance on exchange to provision a critical resource like lithic material, however, entails great risk. Difficulties in coordinating exchanges between groups, especially under conditions of low population density as seen in the TP-EH, would increase the likelihood that the exchange would fail to convey the resources to the groups needing them (Beck and Jones 1990b). Thus, although we acknowledge that some of the lithic material discussed here very likely was obtained via local ad hoc exchange, in the present study we assume the majority of well-represented raw materials—particularly utilitarian items—were obtained via direct procurement. With precise and reliable chemical information on lithic tools and their sources, as well as the locations of those sources, a good estimate of territorial range can be made.

Under some circumstances, the patterns of movement within a territory also can be inferred. These inferences rely on provenance data and can be improved with attention to how tool manufacture and maintenance events were staged across space. Provided that we understand which lithic sources were utilized and how tools made from these sources were manufactured and refashioned, we are in a position to track how tools “moved” over space. In simple terms, assemblages of early production stages and related flake debris will occur near the geologic source of a particular tool material (Elston 1990; Kuhn 1994). Moving further from the source, as the number of tool-using events increases, so does the number of assemblages containing expended or broken tools and associated resharping debris ( Hofman 1992; Ingbar 1994). Such patterns among a set of contemporaneous assemblages form the material basis for inferences about the order in which geologic sources were exploited. Indeed, these patterns make it possible to disentangle directions of movement even when assemblages contain several equally well represented types of extralocal toolstone (e.g., Hofman 1992).

In sum, then, precise and reliable source provenance information and patterns of lithic tool manufacture, use, and discard offer complementary measures of various dimensions of mobility.

Great Basin Lithic Source Studies

Studies of raw material procurement, mobility, and exchange in the Great Basin have relied in large measure on the well-studied obsidian source record compiled over the last 25 years or so (e.g., Basgall 1989; Bouey and Basgall 1984; Ericson 1977, 1981, 1982; Gilreath and Hildebrandt 1997; Hughes 1982, 1983, 1985, 1986, 1988, 1989, 1994b, 2001a; Jack 1976; Jackson 1984, 1986, 1988; Jackson and Ericson 1994; Nelson 1984). Geochemical techniques, principally X-ray fluorescence spectrometry (XRF), have been used to differentiate numerous obsidian sources. These obsidians primarily lie around the edges of the province, where younger volcanic rocks dominate (Figure 1), and are especially common in the northern section and along the western edge of the Great Basin. In the central Great Basin, obsidian sources containing nodules of suitable size and quality for the manufacture of large tools appear to be uncommon.

In comparison, provenance studies of other lithic types are uncommon. Numerous chert sources are known in the Great Basin, but their complex chemical signatures and optical variability have complicated efforts to differentiate among them. Fine-grained volcanic rocks, on the other hand, are amenable to geochemical characterization, but researchers are only just beginning to conduct provenance studies of these lithic types. When they are better known and integrated with obsidian source information, these provenance data will provide unparalleled opportunity to evaluate settlement and mobility questions in the region.
Figure 1. Location of obsidian sources (small squares) in the Great Basin and archaeological localities (triangles) discussed in the text.

Paleoarchaic Technological Organization

The TP-EH chipped stone record of the Great Basin is referred to as the Western Stemmed Tradition (hereafter, WST [Willig and Aikens 1988]), reflecting the dominance of large, stemmed bifacial knives/projectile points in lithic assemblages of this age (Figure 2). A number of other tool types that are typical components of Paleoindian technologies in other regions are also common, including gravers, scrapers of several morphologies, and notched flakes. Bifacially flaked crescentic-shaped tools—crescents—are another common diagnostic of these assemblages (Tadlock 1966). Material selection patterns are quite pronounced. Fluted and unfluted lanceolate projectile points, gravers, scrapers, and crescents typically are made from chert and much less frequently from obsidian (Amick 1995, 1999; Beck and Jones 1990b). In contrast, stemmed projectile points most often are made from obsidian and fine-grained volcanic rock (Amick 1995; Basgall 2000; Beck and Jones 1990b, 1997; Elston 1994; Jones and Beck 1999).

By far the most common artifacts in the central Great Basin assemblages we have studied are stemmed projectile points and flakes derived from point manufacture (Beck and Jones 1988, 1990a, 1994a, 1994b; Beck et al. 2002). The long-stemmed varieties, such as the Cougar Mountain type (Figure 2), were probably inserted in socket hafts (Musil 1988). Their long, thick stems would have resisted twisting forces and so would have served well for knife-like functions. Use-wear patterns are consistent with such functions, but larger-scale damage at the tip of many specimens indicates these tools also may have served projectile or thrusting functions (Beck
Figure 2. Diagnostic artifacts of the Western Stemmed Tradition: (A) Cougar Mountain point, (B) reworked Cougar Mountain point, (C) Lake Mohave point, (D) Parman point, (E) crescent.

and Jones 1993, 1997; Jones and Beck 1999). These artifacts were highly curated and underwent several episodes of resharpening during their use-lives.

Most of what we know about stemmed point manufacture comes from studies of workshop sites associated with dacite quarries rather than obsidian sources (e.g., Beck and Jones 1994b; Beck et al. 2002; Graf 2001). Nevertheless, the morphologies of stemmed points made from both materials are so similar as to suggest that the same fairly simple reduction technique was applied to both obsidian and fine-grained volcanic rock (Figure 3). It is a reasonably simple matter to isolate those parts of an assemblage that are derived from this production-use sequence. Thus, it is possible to use the relative frequencies of production bifaces, completed forms, and flakes to roughly gauge how different assemblages relate to a hypothetical sequence of production and maintenance events. We expect, for instance, that assemblages produced at or near quarries will contain relatively more production bifaces and large flaking debris than assemblages created later in the

Figure 3. Manufacture trajectory (A-D) of long-stemmed projectile points.
Figure 4. Site locations in the eastern Nevada project area. Site designations are as follows: CCL = Combs Creek Localities; HPL = Hunter Point Localities; JP = John’s Point; WSWL = White Sage Well Locality.

manufacture-use sequence. Assemblages geographically more distant from quarries should contain late-stage bifaces broken in the final stages of manufacture, remnants of hafted bifaces broken in use or resharpening, and smaller flaking debris reflecting tool refurbishment (Beck et al. 2002; Elston 1990).

The Eastern Nevada Lithic Database
The materials used in this study were collected by the authors from surface lithic assemblages at 16 site localities and survey units in Butte, Long, and Jakes valleys in eastern Nevada (Figure 4). Hereafter, we refer to this area as the eastern Nevada project area and identify the assemblages collectively as the eastern Nevada sample. Each assemblage contains WST diagnostics, primarily stemmed projectile points. The assemblages range in size from a few hundred to nearly 7,000 chipped stone artifacts and contain a variety of raw material types (Table 1). Artifacts manufactured from fine-grained volcanic rock and chert are most common, while obsidian artifacts typically make up less than 30 percent of most assemblages. Additional artifacts have been examined from a collection made at the Sunshine Well Locality, Long Valley (Hutchinson 1988; Jones et al. 1996), the largest Paleoarchaic site yet to be reported in eastern Nevada.

Age of Assemblages
Despite the fact that these assemblages come from
surface contexts, many of them exhibit little mixture
with later Archaic components (Table 2) and several
assemblages contain only WST projectile points.
Among the others, several contain Pinto-style pro-
njective points and small square-base points. The lat-
ter are morphologically similar to Windust forms,
particularly categories 1-2 and 1-3 of Rice (1972; 
Leonhardy and Rice 1970), which date ca.
10,500–7500 B.P. (Rice 1972). The co-occurrence
of Windust and Pinto points in the eastern Nevada
sample assemblages suggests these two types are
coeval in the eastern Nevada project area.

Pinto points overlap with, and postdate, WST
-types in the Mohave region (Basgall 1993a, 1993b;
Basgall and Hall 1993, 2000; Jenkins and Warren
1984; Warren and Crabtree 1986; but see Schroth
1994), but they are poorly dated in the central Great
Basin. In the eastern Nevada sample they are most
often associated with Western Stemmed forms and
less commonly with Archaic points. Taken together,
these data suggest Pinto points probably date to the
latter part of the early Holocene, perhaps between
9.5 and 8 ka. Four site assemblages also contain siz-
able numbers of Archaic points (Table 2). The major-
ity of these are probably of mid-Holocene age (ca.
8.0–4.0 ka) based on cross-dating (Beck 1998) and
obsidian hydration results (see below), but a small
number of late Holocene points also occur.

Radiocarbon dating suggests that many WST
point types were used over a long span, ca. 11 to 8
ka (Beck and Jones 1997). Because these types do
not follow a clear sequence of replacement, as
Archaic point types do (e.g., Thomas 1981), they are
of limited use in deriving serial orders. Thus to
enhance chronological control, we have applied
obsidian hydration dating to the eastern Nevada sam-
ple (Beck and Jones 1994a; Jones and Beck 1990).
A hypothetical chronological order was achieved by
arranging assemblages according to the mean hydra-
ation values of seven obsidian types.4 This order,
shown in Figure 5 using the four most common
obsidians (Brown’s Bench, Butte Mountain, Source

<table>
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<tr>
<th>Unit</th>
<th>Fine-Grained Volcanics</th>
<th>Raw Chert</th>
<th>Obsidian</th>
<th>Other</th>
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<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
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<tr>
<td>Butte Valley Sites</td>
<td></td>
<td></td>
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<td>10,314</td>
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*Site names are based on USGS quads: CC = Combs Creek Quad and CCL1 = Locality 1 on Combs Creek Quad; HP = Hunter Point Quad; LP = Limestone Peak Quad.
Table 2. Projectile Point Type Groups\(a\) represented in Eastern Nevada Assemblages.

<table>
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\(a\)Site and survey units as in Table 1. WST = Western Stemmed Tradition diagnostics; Early Holocene = Pinto and Windust types; Archaic = Elko, Gatecliff, Large Side-Notched, Rosegate, and Desert Series types; Indeterm = type is indeterminate.

Figure 5. Hypothesized chronological order of eastern Nevada assemblages based on obsidian hydration dating. Site names are the same as in Figure 4 and Table 1.
B, and Panaca Summit), represents the fewest number of reversals among the obsidian types. Confidence in this order is reinforced by the fact that those assemblages that are dominated by WST diagnostics lie together at the base of the order (Table 2). Assemblages containing Pinto or Archaic specimens consistently exhibit narrower hydration means. We note, however, that there is a good deal of overlap in the ranges of hydration readings between adjacent assemblages. This could reflect one or more factors, including the insensitivity of the technique to small chronological differences, the fact that some of the sites may have complex occupation histories, and that a considerable amount of artifact rejuvenation may have taken place over this relatively long temporal span.

**Obsidian Provenance Analysis**

A total of 840 specimens was selected for geochemical analysis from a collection of more than 3,000 obsidian artifacts in the eastern Nevada sample; 76 artifacts from the Sunshine Well Locality were also analyzed. Energy-dispersive XRF analysis (performed by Hughes) was employed to establish the trace element profile of each artifact. These results were compared with the chemical profiles of known sources from throughout the intermountain region. Of the 40 chemical types identified in the eastern Nevada sample, 21 represent known sources (Table 3; Figure 6); many of these sources are represented by very small numbers of artifacts. Indeed, four chemical types, Butte Mountain, Brown’s Bench, Panaca Summit, and source B, were used to manufacture nearly 75 percent of the artifacts in this sample.

With one exception, unknown chemical types are treated as distinct obsidian sources, although future research may show that some of these can be subsumed within the same geochemical type. Source provenance studies carried out in the last decade have shown that a number of Great Basin sources are quite complex and contain more than one geochemical type (e.g., Hughes 1988, 1989, 1994a; Hughes and Smith 1993). Brown’s Bench, for example, is a complex volcanic center containing many ash-flow tuff units, some of which contain welded glasses that have not been studied in detail (Hughes and Smith 1993). Three of the chemical types identified in this study—Brown’s Bench, Coal Bank Creek, and Brown’s Bench Area—are known to come from this source area. A fourth geochemical type, unknown source A, shares a close “family resemblance” with the Brown’s Bench group. Although these four types have different chemical profiles, they come from the same general geographic region and thus for purposes of this study carry the same information; for subsequent analyses they were combined to create the Brown’s Bench source group and are presented as such in Table 3.

The considerable richness of chemical types in the eastern Nevada sample was an unanticipated surprise because few geologic sources of obsidian are known in the central Great Basin. Although volcanic centers are numerous in the Great Basin, those containing obsidian are generally younger than 15 mya and ring the Great Basin (Figure 1). In contrast, volcanism in the central region is much older, exceeding 30 mya (Stewart 1980). Obsidian is rarely well preserved in such old deposits. If present at all, it will usually occur only as small nodules or pebbles (i.e., Apache tears). Our own searches seem to bear this out; we have not identified any sources of large obsidian nodules in this region, although localized pebble sources occur south of the eastern Nevada project area. One of the most common is Butte Mountain, a pebble source available from alluvial fan surfaces along the western margin of Butte Valley. As we have learned from reconnaissance of this source, pebble sources occasionally yield nodules large enough to be flaked bifacially, but do not now contain nodules of sufficient size to have been used for the manufacture of large stemmed points.

Unknown sources are common in the eastern Nevada sample, but their numerical contribution is relatively small. Just seven of the 40 geochemical types occur in frequencies greater than 2 percent. Besides Butte Mountain, none of the principal obsidian types comes from an identified source closer than 150 km to the eastern Nevada project area (Figure 6). The most common extralocal obsidian is the Brown’s Bench group (28.9 percent), distributed over a large area of northeastern Nevada and southern Idaho about 250 km north of the project area. The locations of source B and Panaca Summit obsidian lie some 220 km from the eastern Nevada project area, respectively to the south and to the southeast. Several western Utah obsidians are represented as well, among which Topaz Mountain (2.4 percent) and Wildhorse Canyon (2.3 percent) are the most common.
Table 3. Obsidian Sources\(^6\) Represented in the Eastern Nevada Assemblages.

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<th>Sunshine n=</th>
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Obsidian Source\(^6\)

- CCL1
- CCL2
- CCL3
- CCL4
- CCL5
- CCL6
- CCL7
- CCL8
- CCL9
- HPL1
- HPL2
- HPL3
- HPL4
- HPL5
- John's Pt.
- WSWL1
- LPL1
- Survey
- Sunshine

Unit: %

Brown's Butte Mtn.: 16.7
Panaca Summit: 7.0
Topaz Mtn.: 28.0
Wildhorse Canyon: 2.0
Paradise Valley: 64.0
Var 13: 50.0
Var 2: 50.0
Malad: 20.0
Black Rock: 7.0
Kane Springs: 70.0
Var 1: 20.0
Mt. Hicks: 70.0
Var 4: 20.0
Queen: 70.0
Var 5: 70.0
Pancake Range: 70.0

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CCL2: n=2, %50.0
CCL3: n=2, %20.0
CCL4: n=2, %66.7
CCL5: n=47, %64.0
CCL6: n=2, %28.0
CCL7: n=1, %20.0
CCL8: n=1, %20.0
CCL9: n=1, %20.0
HPL1: n=5, %41.7
HPL2: n=29, %27.1
HPL3: n=34, %28.6
HPL4: n=45, %34.1
HPL5: n=45, %34.1
John's Pt.: n=6, %31.5
WSWL1: n=16, %59.3
LPL1: n=51, %35.9
Survey: n=10, %17.9
Sunshine: n=19, %25.0
Well: %25.0
Total: 265
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*Sources of unknown location are designated D-F, H-K, Varieties 1-14, and Unknown.

Brown's Bench is represented by four chemical types: Brown's Bench, Coal Bank Creek, Unknown Source A and Unknown Source C. Source B is Tempiute Mountain. Wildhorse Canyon also contains Pumice Hole.

Obsidian Butte also contains Airfield Canyon.

Site names are the same as those in Figure 4 and Table 1.
Figure 6. Obsidian sources that occur in eastern Nevada assemblages (exclusive of the Sunshine Well Locality). Arrow size indicates frequency: (large) > 15 percent; (intermediate) 5–15 percent; (intermediate) 2–5 percent; (small) < 2 percent.

The location of source E is unknown. We note, however, that its pattern of representation parallels that of Brown’s Bench but is different from source B, Panaca Summit and the Utah sources, suggesting its location lies north of the eastern Nevada project area. Other unknown geochemical types occur in such low frequencies that it is difficult to guess their locations. Unfortunately, we know comparatively little about the lithic terrane of southern Nevada—especially of extensive federal military reservations—but current field and laboratory research promises to redress this (Hughes 2001b).

Fine-grained Volcanic Rock Provenance Analysis
In addition to the obsidian sample, 177 artifacts of either dacite or andesite have been characterized by wavelength-dispersive XRF and matched with sources in the eastern Nevada project area (Jones et al. 1997). Because of the semi-destructive nature of specimen preparation, only flake artifacts were analyzed. Based on their associations with temporally sensitive projectile points and production bifaces, however, these artifacts clearly belong to the WST assemblage in the eastern Nevada sample.

Although we have identified nearly 20 sources of artifact-quality dacite and andesite within a 100-km radius of the eastern Nevada project area (Figure 7), only seven of these are of major importance in the eastern Nevada artifact sample (Table 4). Not surprisingly, the best-represented sources in the archae-
ological assemblages, like Jakes Wash and Little Smoky Quarry, have dacite compositions (ca. 62–65 percent SiO₂). These rocks are relatively more glassy and brittle than the tougher andesites and, as a result, are more easily flaked. Nevertheless, andesite artifacts do appear in many of the assemblages, in large part, we think, because of the proximity of their sources to sites in the project area.

Fine-grained volcanic rocks, along with minor obsidian types, are used in the analysis that follows to supplement and enhance patterns of toolstone conveyance identified on the basis of the provenance of the major obsidian types. Aspects of mobility are evaluated in greater detail based on patterns of source representation among tool types and source diversity.

**Paleoarchaic Foraging Territories in the Central Great Basin**

Occurrences of extralocal obsidian are the basis for describing lithic conveyance zones (e.g., Seeman 1994), which we suggest delimit geographically the foraging territories of Paleoarchaic populations in the central Great Basin. These data (Table 3) show that obsidian was conveyed from sources within a zone measuring over 450 km in a north-south direction and 150 km in a west-east direction. The corresponding foraging territory may have been larger, but it appears to have extended at least from the Nevada-Idaho border well into southern Nevada and eastward from the central Great Basin to the eastern edges of
the Bonneville Basin in Utah. Although this geographic range may be modified once locations of unknown sources are discovered, our confidence in this reconstruction is based on the considerable similarity among the assemblages of the eastern Nevada sample in regards to source representation. This similarity is especially noteworthy in light of differences in sample sizes among the assemblages (Table 3).

Unfortunately, there are very few data sets from other central Great Basin locations that we can compare to these results. Occurrences of Brown’s Bench obsidian in Paleoarchaic assemblages in Railroad Valley, over 100 km southwest of the project area, and in the Yucca Mountain area of southern Nevada (Buck et al. 1996) add further support to our reconstruction, as does the presence of source B in assemblages from the Goshute Valley, about 70 km northeast of the eastern Nevada project area (Ted Goebel, personal communication, 2001).

Another noteworthy feature of the eastern Nevada record is the nearly complete absence of artifacts made from western and northern Great Basin obsidian sources. Excluding the Sunshine Well Locality sample, only two (.2 percent) artifacts were manufactured from a western source—in this instance the Paradise Valley source. These results indeed are surprising because some of the sources, like Paradise Valley and Double H Mountains (Figure 1), are no further from the eastern Nevada project area than the sources that dominate the sample. The Sunshine Well Locality provenance sample, in contrast, contains 14 artifacts (ca. 18 percent), six of which have certain WST affiliations, that represent western (Mt. Hicks and Queen) or northwestern (Paradise Valley and Bordwell Spring) obsidian sources (Table 3). Evaluation of these data is difficult, however, because the Sunshine Well Locality sample is small and consists mostly of rare artifact types.

We suggest that the source-use configuration in the eastern Nevada sample documents a special case of a more widespread pattern of movement that encompassed the central and eastern Great Basin during this time. The paucity of western or northwestern sources indicates a pronounced barrier to obsidian conveyance in central Nevada. We consider this pattern in light of the Sunshine Well Locality sample more fully below.

Chronological differences in source use are also evident in these data. To demonstrate these differences, we have divided the obsidian sample into four age-related groups, summarized in Table 5. The first group consists of projectile points, point fragments, and a single crescent, all with clear-cut WST affiliation. The second group contains examples of Pinto and Windust points, later Early Holocene diagnostics. The third group consists of Archaic projectile point types, most of which probably postdate 8 ka (see Beck 1998; Thomas 1981). The fourth group contains temporally nondiagnostic obsidian flakes and other tools.

Beginning with the WST diagnostics (group 1), Brown’s Bench is the most common source (Table 5), about three times more common than either Panaca Summit or source B. This sample group con-
tains a number of other sources as well, but each of these is represented by just one or two specimens. Three western Utah sources (e.g., Black Rock, Topaz Mountain, and Wildhorse Canyon) are represented by only three specimens (2.2 percent). Among later Early Holocene diagnostics (group 2), source B becomes more common at the expense of both Brown’s Bench and Panaca Summit. The frequencies of western Utah sources also increase, suggesting an eastward expansion of Paleoarchaic foraging territories during the latter part of the early Holocene. Chi-square analysis demonstrates the difference in source representation between groups 1 and 2 is statistically significant ($X^2 = 21.13, df = 4, p << .01$). The difference between groups 2 and 3 is less pronounced, suggesting that the trend first identified in the latter part of the early Holocene continued into, but did not change substantially during, the middle Holocene.

Source representation among group 4 artifacts is similar to WST projectile points, especially in the small percentage of Utah sources represented. On the other hand, nearly one-half (45.9 percent) of these artifacts represent “other” sources, rather than those sources that dominate the other three groups. The large variety of sources is, to a certain extent, a consequence of the larger size of group 4. Yet it is interesting that nearly all of the “other” obsidians contained in groups 1 and 4 are unknown sources, while among the Archaic projectile points nearly all come from known obsidian sources. These data suggest to us that Paleoarchaic foragers encountered many obsidian sources, but that only a few of them contained large nodules. Rare obsidian types perhaps represent pebble sources that were exploited opportunistically and contributed relatively few tools to the curated component of the WST lithic technology. This certainly appears to be true of Butte Mountain obsidian, which is represented only rarely in assemblages outside Butte Valley. That rare obsidian types occur at all suggests to us that toolstone supplies remained adequate and were not depleted, a consequence of both brief residential stays and great distances between residential sites.

**Movement within Paleoarchaic Territories**

Patterns of source representation provide us with a means to construct a general map of the parts of the central Great Basin traversed by Paleoarchaic foragers, but additional data are required if we are to attempt to describe the routes followed by those groups. For this analysis we consider both the relative contribution of different sources to assemblages and how these sources are distributed among tool categories. During the course of conducting these provenance studies we have learned that many assemblages share the same obsidian types in roughly coequal frequencies, and that these obsidians are not distributed equally among tool categories in each assemblage. The same obsidian type may, for example, comprise mainly flakes in one assemblage and mainly projectile points in another assemblage. Considered in light of the use-life of these artifacts and the staging of tool manufacture, these patterns of source representation provide clues as to the order in which sources were visited. Thus, under the best of circumstances, we may be able to use this information to backtrack along a route connecting obsidian sources used by groups that visited, and lived in, the eastern Nevada project area.

To illustrate, we consider two assemblages of similar age that exhibit contrasting source represen-
translucency and color, Brown’s Bench obsidian can be reliably identified visually. Within the entire Combs Creek Locality 5 obsidian sample, the identical proportions of specimens—67 percent—exhibit Brown’s Bench visual characteristics. Among the other common extralocal obsidians, only source E is well represented at Combs Creek Locality 5. Panaca Summit and source B are represented by just one and two specimens, respectively.

Judging from relative frequencies, Brown’s Bench was probably the last obsidian source visited before the occupation of Combs Creek Locality 5 took place. All of the projectile points in the provenance sample from Combs Creek Locality 5 are from the Brown’s Bench source group. Nevertheless, they represent slightly more than 25 percent of all specimens attributed to the Brown’s Bench source; flakes are nearly three times as common. These values, however, exaggerate the importance of projectile points in the Brown’s Bench group (since these were preferentially selected for source analysis because of their temporal sensitivity). We can derive a better estimate of the importance of Brown’s Bench obsidian projectile points by comparing their frequency in the overall Combs Creek Locality 5 obsidian assemblage (n = 14) to that of Brown’s Bench flakes (n = 209). Flakes clearly are far more common than projectile points. This pattern is precisely what we
would expect if most of the Brown’s Bench material had been transported to the site as late-stage bifaces ready for further reduction. We may also surmise that the relative paucity of artifacts representing southern sources is attributable to the fact that larger nodules available from these sources had been largely depleted when material provisioning took place at the Brown’s Bench source, or during subsequent retooling events, before reaching Combs Creek Locality 5.

In contrast to Combs Creek Locality 5, the pattern of source representation at Limestone Peak Locality 1 is consistent with movement into Jakes Valley from the south. At this site we see, for example, that Panaca Summit and source B are well represented; moreover, flakes attributed to these sources are far more common than projectile points, implying the presence of large bifaces still suitable for reduction. This mirrors the pattern exhibited by Brown’s Bench specimens at Combs Creek Locality 5. Still, Brown’s Bench obsidian is common in the provenance sample at Limestone Peak Locality 1 (n = 49), representing about 35 percent of all extralocal specimens. Yet among these specimens, projectile points—not flakes—dominate. As before, however, it is necessary to examine the entire obsidian sample to determine whether or not these patterns in Brown’s Bench obsidian hold true. When we do so, we find that Brown’s Bench accounts for about 41 percent of the complete obsidian sample, and that flakes (n = 250) are nearly six times more common than projectile points (n = 42). Still, the ratio between flake and projectile points is far lower in the Limestone Peak Locality 1 assemblage than in the Combs Creek Locality 5 assemblage.

Based on these source analyses of obsidian samples from Combs Creek Locality 5 and Limestone Peak Locality 1, Paleoarchaic mobility in the central Great Basin appears to have emphasized a territory whose principal axis ran north to south and covered more than 450 km. The dominant obsidians represented in these assemblages suggest this territory might more nearly resemble a triangle with its narrow base in south central Nevada. The complementary patterns of source representation and technology of Limestone Peak Locality 1 and Combs Creek Locality 5 suggest a more complicated pattern of movement, however, perhaps involving a sequence of settlement moves from Brown’s Bench (then to source E), to Panaca Summit, to source B, and returning to Brown’s Bench, passing through the eastern Nevada project area on both the northerly and southerly traverses (Figure 8).

This conclusion accords well with the representation of minor obsidian sources and dacite sources. For example, Limestone Peak Locality 1 contains specimens from the Kane Springs obsidian source, located southwest of Panaca Summit, and from an obsidian source in the Pancake Range (Figure 6). Among dacite sources, Duckwater and Little Smoky Quarry (Figure 7), both of which are adjacent to the Pancake Range, are represented (the dominant dacite is the Jakes Wash source, which lies a few kilometers east of the site). Unfortunately, we do not know the locations of secondary obsidians that are present in the Combs Creek Locality 5 assemblage, but it is noteworthy that southern dacite sources are poorly represented at this site. This assemblage contains much higher frequencies of proximate source materials, particularly from the Buck Mountain source, located along the western border of the eastern Nevada project area in Long Valley, and the Murry Canyon source located further to the north (Figure 7).

Many assemblages in the eastern Nevada sample, especially the oldest ones, are quite small and contain few obsidian artifacts (Table 1), hindering comparably detailed analyses of technological patterns. Still, the patterns of source dominance are consistent with those just outlined. For example, some assemblages like White Sage Well Locality 1 are dominated by Brown’s Bench obsidian, but they also contain a few artifacts from southern sources, which we suggest are products of curation and long tool life. Other assemblages exhibit a contrasting pattern. For instance, at Combs Creek Locality 9, which lies less than 1 km from Combs Creek Locality 5, only source B and Butte Mountain are represented, suggesting a pattern of extralocal obsidian source representation most like Limestone Peak Locality 1. Further support is added by the fact that of the 139 obsidian artifacts represented at the site, none exhibits Brown’s Bench visual characteristics. Moreover, the fine-grained volcanic rock provenance sample reveals the presence only of Little Smoky Quarry dacite. Many assemblages also contain sources that are both numerically rare and occur in just a few assemblages, but we do not yet know the locations of these sources. Once found, however, they will provide an effective test of the patterns of movement we have hypothesized.
The other assemblages of comparable size to Limestone Peak Locality 1 and Combs Creek Locality 5 have more complex patterns of source representation. For instance, each of these assemblages—Hunter Point localities 2, 3, and 5—contain significant numbers of artifacts from two western Utah sources, Topaz Mountain and Wildhorse Canyon. Together with the patterns of representation of other sources, these data do not yield a solution consistent with a single route of movement between sources. These results are not surprising, however, in light of the complex occupation histories of these sites, indicated by occurrences of both WST and later diagnostic artifacts (Table 2). We suggest these complexities are, in fact, products of changes in the geographic extent of foraging territories in the central Great Basin, which may have occurred in response to shifts in the locations of viable resource patches during the early Holocene. We address this issue below.

Changes in Mobility Patterns

As warming and drying proceeded in the early Holocene, there were commensurate reorganizations of biota and the loss of mesic habitats in many Great Basin valleys. One apparent consequence of these changes was a decline in resource abundance within favored subsistence patches like wetlands. Our review of the subsistence record (Beck and Jones 1997) suggests that Paleoarchaic foragers responded to these conditions by incorporating seeds, using a wider range of animal prey, and generally increas-

Figure 8. Hypothesized mobility route of Paleoarchaic foragers in the central Great Basin.
ing diet breadth. As we have shown above, obsidian source use shifted as well, indicating that there were parallel changes in foraging territories of central Great Basin Paleoarchaic peoples during the early Holocene.

We anticipate that changes in subsistence and mobility tactics would have led to other responses by Paleoarchaic peoples. In particular, with expanded use of lower-ranked foraging patches, groups would have increased the length of stays at sites. Although the length of residence time is difficult to measure archaeologically, even in the presence of architectural evidence, generally speaking, it should be positively correlated with assemblage size and more environmental modification at occupation sites. As residence time increases, there should be a corresponding increase in the numbers of tool items discarded at a site simply because people deplete more of their tool and raw material inventories during longer average stays. As a result, artifacts would be less likely to “travel” as far from source areas than if occupations were briefer. This suggests, then, that extralocal source diversity may serve as a proxy for residence time; as residence time increases, we expect a corresponding decrease in source diversity.

Because source diversity is influenced by assemblage size, we must be certain that changes in the latter are a result of residence time and not site reoccupation.

Our capacity to discern which of these factors (or both) contributes to variation in assemblage size is limited because of the insensitivity of our dating tools. Still, most of the eastern Nevada assemblages exhibit unimodal obsidian hydration profiles, from which we infer they are (largely) products of single occupational events (Beck and Jones 1994a). Several of the largest assemblages (e.g., Hunter Point localities 2 and 5), however, display multimodal profiles. Along with Hunter Point Locality 3, these assemblages also contain WST and later time-sensitive artifacts. Together, this evidence indicates that reoccupation accounts for their larger sizes.

Figure 9 presents the relationship between obsidian source diversity (number of sources/assemblage size) and site age (based on the order shown in Figure 5). The strong correlation between these variables (Spearman’s rho = -.73) is consistent with our expectation that source diversity drops with decreasing assemblage age. Yet before we can draw any firm conclusions from this trend, we first must evaluate the relationship between assemblage size and site age to remove any doubt that source diversity is a product of sample size. When we conduct this evaluation, we find that assemblage size, in fact, also changes with site age (Spearman’s rho = .65), suggesting that changes in richness cannot be explained apart from a trend in sample size.

As discussed above, some of the trend in assemblage size apparently is related to site reoccupation. After eliminating those assemblages in which reoccupation may be a factor, we computed correlations between source diversity and site age, and between site age and assemblage size. The resulting coefficients are somewhat lower (respectively, Spearman’s rho = -.65 and .56) than in the first test, but we continue to see that assemblage size is positively correlated with site age.

While we cannot be certain of temporal trends in source diversity or the implications of changes in assemblage size, we have demonstrated that there were changes in the relative contributions of different sources through time. For example, use of the Brown’s Bench and Panaca Summit obsidians declined through the early Holocene, while use of source B and Utah obsidians increased (Table 5). These patterns appear to indicate that there was a geographic shift in foraging territories to incorporate an eastern segment, and perhaps a simultaneous retraction from more distant areas to the north and south.
These changes may reflect efforts by Paleoarchaic groups to find and exploit still-productive wetlands, while at the same time they may have increased the length of time spent at residential locations to accommodate the requirements of processing lower-ranked resources exploited over a wider range of patches. In attempting to cope with conflicting subsistence and scheduling issues brought about by changing biophysical conditions, peoples living in adjacent valleys would very likely have come into more frequent contact with one another, increasing the probability that material exchanges (in addition to subsistence-related information gathering) would have taken place.

**Comparisons with Other Lithic Provenance Records**

The eastern Nevada project area provides a small window from which to view Paleoarchaic mobility in the central Great Basin. To assess the degree of fit between our expectations and the archaeological record elsewhere in the region, we review two records in close proximity to the eastern Nevada project area, then turn to examine cases from more distant areas.

Provenance information from the Sunshine Well Locality has been presented with the eastern Nevada sample in several tabular summaries in this paper, but we have not considered this record in detail. Represented among the 76 artifacts in the Sunshine Well Locality sample are 16 obsidian types (Table 3), making this sample as diverse as eastern Nevada samples nearly twice its size. The Sunshine Well Locality sample also contains several sources that appear in no eastern Nevada assemblage (Table 3), among which are sources from northwestern Nevada (e.g., Bordwell Springs) and eastern California (e.g., Queen and Mt. Hicks). Yet despite representing considerable source richness, the Sunshine Well Locality sample contains none of the unattributed sources found in the eastern Nevada sample, with the exception of source E. We think this last feature relates to the fact that the sample is almost entirely comprised of complete bifacial tools; flake tools, particularly those made from pebble sources, are not represented in this sample.

The Sunshine Well Locality (Huckleberry et al. 2001; Hutchinson 1988; Jones et al. 1996; York 1995) is an enormous site, consisting of dense lithic scatters that parallel Sunshine Wash for roughly 3 km. This deeply incised paleochannel gives evidence of substantial stream flow prior to 9.8 ka. The paleochannel contained rich wetland habitats (Huckleberry et al. 2001) and it seems likely that a large marsh was present where the channel debouched onto the valley floor. The hydrologic conditions at the Sunshine Well Locality appear to have held fairly constant during the TP-EH and as a result we suspect this location was attractive to Paleoarchaic foragers in good times and bad.

We cannot entirely dismiss the contribution of sampling vagaries in accounting for the unusual provenance patterns in the Sunshine Well Locality assemblage. Nevertheless, the size and density of its artifact record and the great functional variety of tool forms suggests that the Sunshine Well Locality was a regular residential location for Paleoarchaic foragers from ca. 10.5 ka to perhaps as late as 8.5 ka (Huckleberry et al. 2001). We consider it likely as well that groups whose usual patterns of movement lay further west made occasional visits to the Sunshine Well Locality.

Stoner et al. (2000) describe provenance studies of 62 obsidian artifacts from two sites in Giroux Wash. Although neither site has associated radiocarbon dates or obsidian hydration chronology, they contain Pinto and Windust projectile points and thus most nearly resemble Hunter Point Locality 5 in the eastern Nevada sample. The similarity with Hunter Point Locality 5 extends to the obsidian source data as well; among the sources represented by the 12 obsidian projectile points are Panaca Summit, Wildhorse Canyon, Brown’s Bench, sources B and E, and Topaz Mountain, the last being most common (Figure 10). Among flake artifacts, Topaz Mountain dominates (76 percent), with smaller numbers of artifacts made from Panaca Summit and Giroux Wash, a local pebble source. In view of the proximity of Giroux Wash to the eastern Nevada project area, the similarities between these provenance samples are not surprising. The Giroux Wash site samples do, nevertheless, lend support to our previous claim that Utah obsidian sources became increasingly important during the early Holocene.

Arkush and Piblado (2000) report on the source provenance of 22 obsidian projectile points from 13 sites located in the Wildcat Mountain area, just north of the Old River delta in the Great Salt Lake Desert in western Utah. This TP-EH landform developed at the terminus of the Old River, which discharged water from the Sevier Desert into the Great Salt Lake
during the Gilbert transgression. The authors argue this area would have supported “fairly lush marshlands” (Arkush and Pitblado 2000:18) that would have been attractive to foraging groups. Two obsidians, Topaz Mountain and Brown’s Bench (Figure 10), dominate the source provenance sample, while specimens of Malad and Black Rock obsidian also are present. Although these results are generally similar to the eastern Nevada sample, absences of Panaca Summit and sources B and E are noteworthy. But we caution that this is a small sample and one consisting only of projectile points. The eastern Nevada assemblages indicate that extralocal sources are sometimes represented exclusively by flake artifacts, so fuller provenance analysis of other artifact categories might reveal the presence of additional sources in the Wildcat Mountain site assemblages. Arkush and Pitblado (2000) also report that a considerable number of the projectile points were made expeditiously on small flake blanks. They note that such reduction trajectories are rare in other WST records and suggest it is evidence that Paleoarchaic residents were attempting to conserve lithic material. These efforts, they believe, were required because lithic supplies were severely taxed during extended residential stays. This conclusion fits well with the argument developed here that, during the latter part of the early Holocene, populations remained longer in resource patches and made greater use of local lithic sources. Among the sample of projectile points are
Table 7. Obsidian Sources Represented in the Knudtsen Site Assemblage from Grass Valley, Central Nevada.

<table>
<thead>
<tr>
<th>Source</th>
<th>Flake N</th>
<th>Flake %</th>
<th>Biface N</th>
<th>Biface %</th>
<th>Projectile Point N</th>
<th>Projectile Point %</th>
<th>Other N</th>
<th>Other %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt. Hicks</td>
<td>65</td>
<td>94.2</td>
<td>3</td>
<td>4.3</td>
<td>1</td>
<td>1.4</td>
<td></td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>Paradise Valley</td>
<td>7</td>
<td>77.8</td>
<td>1</td>
<td>11.1</td>
<td>1</td>
<td>11.1</td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Queen</td>
<td>4</td>
<td>100</td>
<td></td>
<td></td>
<td>1</td>
<td>100</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Double H Mountains</td>
<td>4</td>
<td>100</td>
<td></td>
<td></td>
<td>1</td>
<td>100</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Bodie Hills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Massacre Lake</td>
<td>1</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Crow Springs</td>
<td></td>
<td></td>
<td>1</td>
<td>100</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
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<tr>
<td>Brown’s Bench</td>
<td></td>
<td></td>
<td>1</td>
<td>100</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>14</td>
<td>87.5</td>
<td>1</td>
<td>6.3</td>
<td>1</td>
<td>6.3</td>
<td>1</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>94</td>
<td>7</td>
<td>3</td>
<td></td>
<td>2</td>
<td>69</td>
<td>106</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

numerous examples of Pinto and Windust forms (Arkush and Pitblado 2000:Figures 3–10)—types typical of the youngest of the eastern Nevada assemblages studied here. The presence of greater numbers of obsidian artifacts from western Utah sources seems to link these eastern Nevada assemblages with the Wildcat Mountain record.

Other Great Basin Records

Thus far, we have based our conclusions about Paleoarchaic mobility on obsidian conveyance patterns in the central and eastern Great Basin. We conclude with an examination of source provenance records from other sections of the Great Basin, beginning with a record from the Knudtsen site in Grass Valley, Nevada.

Central Nevada. The Knudtsen site is an extensive WST lithic scatter resting atop a terminal Pleistocene-age spit (Beck et al. 2002). Although dominated by dacite artifacts, the assemblage contains a small obsidian component that includes both fluted and stemmed projectile points. Eight known obsidian sources and one unknown source have been identified among the 106 artifacts that have been geochemically characterized (Table 7). By far the most common source is Mt. Hicks, located about 250 km southwest of the Knudtsen site (Figure 11). Paradise Valley and Double H Mountains sources, respectively about 200 and 225 km to the northwest, and Queen, about 260 km to the southwest, are the next most common sources. It is notable that the Knudtsen and eastern Nevada provenance records are very dissimilar.

Dugas et al. (1994) report on source provenance results from Mule Canyon some 70 km north of the Knudtsen site. The obsidian sample comes from a number of sites, most of which have multiple chronological components. Although it is difficult to distinguish which artifacts have WST affiliations, five of the assemblages are dominated by TP-EH diagnostics. Because these assemblages also contain later Archaic projectile points, we have used obsidian hydration results to identify about 50 artifacts with likely WST affiliation. Among these specimens are six known sources and seven unknown sources. Of the former, Paradise Valley and Majuba Mountain (170 km the west of the project area), are well represented (Figure 11). In contrast to the Knudtsen record, Mt. Hicks is poorly represented at Mule Canyon; Brown’s Bench, though still rare, is slightly more common (n = 3, 6 percent).

As different as the Knudtsen and Mule Canyon records appear to be, they are not so dissimilar when viewed from a wider geographic vantage point. Based on the representation of known sources, these records trace conveyance patterns with strong north-southwest orientation (Figure 11). The southwestern segment is anchored by the Mt. Hicks and Queen sources, which lie near the California–Nevada border, while the northern segment is represented by Paradise Valley and lesser frequencies of Double H Mountains and Brown’s Bench glass. The absence of northwestern or eastern Great Basin sources makes these samples appear quite different from WST provenance records in either the Lahontan Basin (see below) or the eastern Nevada sample. Because of these contrasts, it is tempting to suggest that these data delimit a distinct conveyance zone.

The Western Great Basin. Graf (2001) reports on obsidian provenance results from the Sadmat and Coleman sites, two WST locales in western Nevada
Figure 11. Contributions of obsidian sources to the Knudtsen Site, Mule Canyon (Dugas et al. 1994), Sadmat Site (Graf 2001), Coleman Locality (Graf 2001), and Fort Irwin (Basgall 1993a) assemblages. Arrow size denotes obsidian frequency (see Figure 6).

(Figure 11). The provenance sample from the Sadmat site \( (n=24) \) contains 12 obsidian sources. Eleven artifacts are from sources lying to the south, among which the Bodie Hills source is most common. Sources in northwestern Nevada, including Massacre Lake/Guano Valley, are also present. The Coleman assemblage \( (n=10) \) shares several of these sources, including Bodie Hills, and two northern sources, South Warners and Coyote Springs. Taken together, these data exhibit a north-south pattern of material conveyance from sources as much as 400 km from one another.

Tuohy (1984) finds complementary patterns to those of Graf (2001). Source assignments of fluted \( (n=7) \) and stemmed \( (n=18) \) obsidian projectile points from various western Nevada localities indicates clear preferences for western Great Basin sources, including Bodie Hills and such northwestern Nevada sources as Massacre Lake/Guano Valley.

The Northern Great Basin. Connolly (1999) presents information on Paleoarchaic source use at Newberry Crater, which lies along the northern edge of the Great Basin. Fifty-eight obsidian specimens were recorded from excavated deposits older than 8.5 ka. Among these artifacts are 14 geochemical types, 12 of which can be attributed to known central and south-central Oregon sources (Figure 12).

Oetting (1993) reports similar results from provenance studies at Buffalo Flat, located on the east side
of the Fort Rock Basin about 90 km southeast of Newberry Crater. Seventeen sources are represented in a sample of 31 WST projectile points. While the Buffalo Flat sample shows that a large number of sources located northeast and east of the Fort Rock Basin were used, it also documents use of several other obsidian sources (e.g., Silver Lake/Sycan Marsh and Spodue Mountain) that are well-represented in the Newberry Crater sample (Figure 12). Distant obsidian sources (> 100 km) are poorly represented in both samples.

At the Dietz site, located less than 50 km southwest of Buffalo Flat, a substantial share of the provenance sample (n = 34, 47.2 percent) is represented by Buck Mountain glass, the source of which lies about 120 km to the south in northeastern California (Fagan 1996). This source is particularly prominent among fluted points and related diagnostic artifacts. Each of the other four known sources is located less than 100 km from the site. The patterns of source representation in these three provenance samples suggest use of a foraging range lying north of the Lahontan drainage, extending from just south of the Oregon-California border into south-central Oregon.

The Mojave Desert. Obsidian source provenance studies carried out at Fort Irwin (Basgall 1993a, 1993b; Basgall and Hall 1993) identified far fewer obsidian sources than in the cases reviewed above (Figure 11), quite likely because there are fewer obsidian sources in the Mojave section of the Great Basin. Basgall (1993b:80) writes that "geochemical studies in the north-central Mojave Desert routinely indicate that . . . source profiles tend to be relatively simple and virtually all obsidian artifacts in these

Figure 12. Contributions of obsidian sources to the Newberry Crater (Connolly 1999) and Buffalo Flat (Oetting 1993) assemblages. Arrow size denotes obsidian frequency (see Figure 6).
deposits can be traced to the Coso volcanic field.” Despite the low diversity of obsidian sources, the Lake Mohave-Silver Lake (WST) record at Fort Irwin contains a wide range of other toolstone materials. Noting similarities with early assemblages elsewhere in the region, Basgall suggests the foraging territory of Lake Mojave populations may have included adjacent sections of southeastern California and southern Nevada, covering “an area 200–300 km or more on a side” (Basgall 1993b:386).

**Summary:** Although not exhaustive, this survey illustrates several significant points. First, no single assemblage provides a full census of the lithic sources exploited by groups within their foraging territory. When several samples from an area can be compared, however, they begin to yield a consistent picture of which sources were used and of the shape of foraging territories. Second, from a Great Basin-wide perspective we have seen distinct geographic patterns of obsidian source representation in the Paleoarchaic record. Based on these results we posit the existence of several lithic conveyance zones during the TP-EH (Figure 13). These data indicate remarkably little movement of source materials between zones, from which we infer that interaction between peoples living within these zones also was limited.

**Discussion and Conclusion**

The eastern Nevada study area, Knudtsen site and Mule Canyon sites lie closer to each other than they do to any of the major obsidian sources represented among artifacts contained in their assemblages. Despite this proximity, the eastern Nevada source provenance record bears almost no resemblance to the central Nevada record; instead it more closely resembles the record from the Bonneville Basin. Pattern identified among samples from central and western Nevada, and the northern and Mojave sec-
tions of the Great Basin, are equally dissimilar. It is conceivable that samples from intervening areas would exhibit intermediate patterns of source use, but we think this is unlikely. Studies of the eastern Nevada assemblages convince us that obsidians certainly “traveled” great distances, but they did so within clear-cut geographic areas. Every eastern Nevada assemblage of any size contains the same suite of sources—Brown’s Bench, Panaca Summit, and source B. From this we conclude that, with rare exception (e.g., Sunshine Well), Paleoarchaic foragers did not transport stone tools made from these sources to other sections of the Great Basin. Were it otherwise, artifact samples like the Knudtson assemblage would contain specimens from at least one of these sources. Similarly, none of the obsidians that dominate in the other areas studied occur in the eastern Nevada record.

These results permit us to construct a set of lithic conveyance zones that we interpret as coterminal with the foraging territories of Paleoarchaic populations during the TP-EH. The patterns of source representation suggest that the principle axes of movement were north-south, paralleling the orientation of mountain ranges and valleys throughout the Great Basin. We have tentatively concluded that three north-south territories once existed across the middle of the Great Basin, with separate territories conforming to the northern Great Basin and Mojave Desert (Figure 13). These source provenance results also seem to indicate that little, if any, obsidian moved between these territories. To the extent that material conveyance measures group interactions, we conclude that substantial communication did not occur across boundaries of these territories, although this by no means rules out casual exchange or trading of items within the zones. If, as we suspect, there was a marked boundary to the movement of obsidian and that there was indeed virtually no contact between Paleoarchaic groups in the western and eastern Great Basin, this may have been a consequence of generally low population density during this period and the fact that the movement patterns of these foraging groups conformed to the distribution of significant wetlands. We await better knowledge about TP-EH environments and more comprehensive source provenance data from sites in intervening areas to fully evaluate these ideas.

Source provenance studies are capable of elucidating the patterns of movement of the earliest occupants of the Great Basin. The research reported here indicates that geographically circumscribed territories were established early in the occupational sequence. Results of obsidian source provenance analysis indicate that Paleoarchaic groups in the central Great Basin traversed nearly the entire length of eastern Nevada and incorporated portions of western Utah in their travels. The actual geographic extent of these territories appears to have changed as drying conditions during the early Holocene altered the distribution and quality of resource zones, and particularly as wetlands containing rich concentrations of animal and plant foods disappeared from many valleys. Interestingly, Paleoarchaic groups of the central Great Basin never appear to have made significant traversals of more western areas, nor did they apparently interact with peoples living in the northern or southern parts of the province. Although we have based our inferences on a large number of obsidian provenance samples, we recognize that better geographic coverage of Paleoarchaic assemblages, tighter chronologies, and a more complete census of obsidian sources and other types of lithic materials will assist future efforts to clarify and refine the patterns identified here.

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**Notes**

1. While recognizing the heuristic value of drawing distinctions between “traveling” and “processing” strategies, we are hesitant to push their conceptual utility too far. Paleoarchaic groups appear most often to have practiced a traveler strategy, but they most probably switched from one adaptive pose to the other, or practiced both, depending on local environmental and social factors.

2. Basgall’s (1989) important observations about embeddedness notwithstanding, we certainly do not rule out informal exchange as an element in any settlement-subsistence regime. Even in cases where the majority of lithic material was obtained through an embedded strategy, some special artifacts may have entered the same system as a result of person-to-person exchange, or gift giving, at social events or even as a consequence of interaction between highly mobile neighboring social groups who encountered each other during otherwise-intentioned subsistence activity. Although procured differently, these items all become incorporated into the ongoing system and are themselves subject to later transformations. Identifying the circumstances under which appeal to embedded procurement via mobility is the most parsimonious account for the observed distribution of material remains does not, perforce, exclude or nul-
lify the potential importance of informal exchange, or ad-hoc trade, in the system under study, because all of these factors (mobility, embedded procurement, and exchange) are elements of human social life that may intersect to varying degrees under different physical and social conditions.

3. We use the term “source” here as shorthand for geochemical type, with the understanding that the actual geographic extent of the geologic parent material may be variable depending on formation processes (i.e., ash-flow and dome and flow origin) and posteruptive secondary redistribution. See Hughes (1998) for more extended discussion.

4. This arrangement is based on Beck and Jones (1994a). Slight revisions are based on additional obsidian hydration results and data from two additional site assemblages (Combs Creek Locality 9 and Limestone Peak Locality 1).

5. Robert Hafey recently has identified the location of source B in Sand Spring Valley, Lincoln County, Nevada. Hafey discovered naturally occurring pebbles and cobbles while recording sites in the area. He sent specimens to Craig E. Skinner (personal communication 2002), who, based on XRF analysis, identified them as source B. In a subsequent site visit, G. Jones and Beck found pebbles and small cobbles eroding from an alluvial fan; as yet a bedrock outcrop containing this obsidian has not been discovered. The source has been named Tempiute Mountain. We continue to refer to it here as source B to avoid confusion with previously published results.

6. In many cases, obsidians from different sources have similar colors and other visual properties. Consequently, such features are of limited value in distinguishing between glasses from different sources. Some sources, however, can be identified reliably on the basis of optical properties, e.g., color, translucency, iridescence (e.g., Bettinger et al. 1984). As part of our analysis we recorded each specimen’s texture and reflected and candled colors. In comparing the observed visual attributes with geochemical source assignments, we found > 95 percent correspondence between artifacts identified as Brown’s Bench on the basis of optical and geochemical properties. Comparably accurate source attributions cannot be made for any other optical class of obsidian in the eastern Nevada sample.

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