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Obsidian Use in Wyoming and the Concept of Curation

Craig S. Smith

ABSTRACT

The concept of curation has been extensively used in studies of the organization of flaked stone tool technology. This concept incorporates a wide range of strategies and behaviors that mobile hunter-gatherers would have employed under disparate conditions. The quality and availability of raw materials is one factor influencing how mobile hunter-gatherers manufactured, used, and transported flaked stone implements. Because obsidian can be sourced to at least general locales, the examination of obsidian use in locations at various distances from its source provides a means of understanding the role of distribution of raw materials. The results of x-ray fluorescence sourcing of 179 specimens from 18 excavated sites in Wyoming and northern Colorado indicate that the most important sources were Obsidian Cliff, Bear Gulch, and Malad in eastern Idaho and northwest Wyoming, located approximately 115 to 700 km from the excavated sites. It appears that mobile hunter-gatherers inhabiting the sites nearest the obsidian sources brought blanks from the source to the site for further reduction. By exchange with groups encountered during their annual movements, the occupants of sites farther from the sources obtained completed tools that they conserved and maintained as individuals' personal gear.

Keywords: obsidian; curation; technological organization; Wyoming; mobile hunter-gatherers

A major realm of archaeological inquiry is inferring prehistoric hunter-gatherer behavior from the study of flaked stone artifacts. Many studies have focused on understanding the organization of flaked stone tool technology, including factors influencing how hunter-gatherers designed, made, used, transported, and discarded their tools in relation to the entire cultural system (e.g., Andrefsky 1991, 1994; Bamforth 1986, 1990, 1991; Kelly 1988; Nelson 1991). Ever since its introduction by Binford (1973, 1977, 1979), researchers have extensively explored the concept of curation in discussions of tool use efficiency, planning, and tool utility, among other issues (Bamforth 1986; Kuhn 1992; Nelson 1991; Odell 1996; Shott 1996). Curation, as often defined, includes such behaviors as "production of implements in advance of use, design of implements for multiple uses, transport of implements from location to location, maintenance, and recycling" (Bamforth 1986:39). Such a wide-ranging definition of curation encompasses a variety of strategies and behaviors that mobile hunter-gatherers would have employed under disparate conditions. Even what is prepared or transported for anticipated future use represents different strategies adapted to varying conditions (Odell 1996). As Nelson (1991) points out, the transport of cores and blanks (potential sources of tools) versus finished tools are distinct endeavors exemplifying diverse strategies.

Two important factors in studies of curation are availability and quality of raw material and group mobility and land use patterns (Roth and Dibble 1998). In discussing these factors, Odell (1996) distinguishes between the two by referring to the aspects of curation associated with mobility organization as "curation" and those aspects related to the availability and quality of tool stone as "scarcity-induced economizing activity." He sees tool production, design, and transport as influenced by the group's mobility and settlement systems, while tool recycling and maintenance are part of tool conservation associated with the scarcity of materials. However, all aspects of curation are probably influ-

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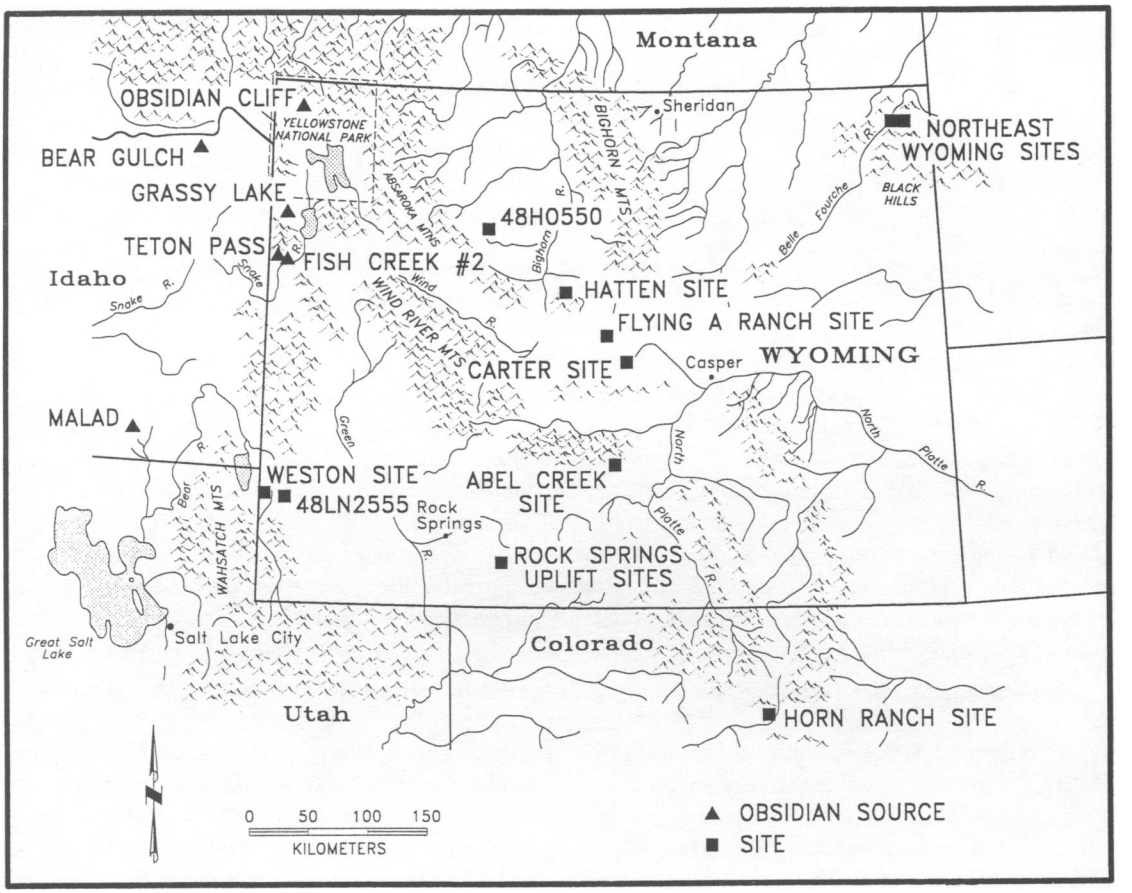

Figure 1. Location of discussed sites and obsidian sources.

enced to some degree by the availability and quality of tool stone (Andrefsky 1991, 1994; Bamforth 1991; Kuhn 1991). In addition to tool recycling and maintenance, distribution of raw materials also affects how mobile hunter-gatherers produced, designed, and transported stone tools.

An important avenue to understanding the relationships between raw materials and how mobile hunter-gatherers procured, used, and transported tools is examination of the role of nonlocal materials in the overall system (Roth and Dibble 1998). Studying the various aspects of curation of a nonlocal material at varying distances from its known source should provide useful insights into factors influencing the distribution of materials. Among the informative aspects of curation are movement of materials between locations, including the type of implements transported (i.e., partly reduced blanks or finished tools), the production of tools for anticipated use, and the conservation of materials and implements through repair and maintenance. It is expected that prehistoric mobile hunter-gatherers handled various aspects of curation differently depending on distance from source.

To be of the most benefit in these studies, the nonlocal material needs to have a known source with a fairly limited geographic distribution (Morrow and Jefferies 1989). Obsidian meets this criterion. It can be sourced to at least general locales, allowing examination of its use at sites at various distances from a known source. The distribution of obsidian at sites in Wyoming and northern Colorado is ideal for this type of study because most of the sources are confined to eastern Idaho and northwest Wyoming (Figure 1). As one proceeds east across Wyoming, the distance to the obsidian sources increases. This provides an excellent opportunity to explore the effects of distance from source on the

ways mobile hunter-gatherers used the obsidian. It is also fitting that this study was conducted in Wyoming, one of the areas where neutron activation analysis of obsidian sources was pioneered in the 1960s (Frison et al. 1968).

The 179 obsidian specimens recovered from 18 excavated and dated sites were sourced to geochemical types by Ray Kunselman and Craig Skinner using x-ray fluorescence spectrometers (Kunselman 1998; Skinner et al. 1998). They analyzed the obsidian using the nondestructive method and compared the resulting trace element values of the specimens with those for known obsidian sources. Both analysts examined a few of the same specimens and provided similar source identifications, although the trace element readings were slightly different from the two spectrometers, probably due to the small size of some of the specimens. Despite these minor differences, their work is comparable.

This paper explores differences in how mobile hunter-gatherers manufactured, used, and transported obsidian tools at varying distances from the sources. It discusses the effects of raw material distribution on how mobile hunter-gatherers curated stone tools. It also examines patterns of the major identified obsidian sources used in Wyoming. This paper also considers methods of obsidian procurement in light of differences in obsidian use. The paper begins with a brief review of each excavated site included in the study.

THE SITES

The 18 sites discussed in this study are located across Wyoming and northern Colorado (Figure 1). The sites provide a southwest to northeast transect across Wyoming. The components containing obsidian date from approximately 7,500 to 100 years ago. Most sites appear to be fairly short-term residential camps of mobile hunter-gatherers. Table 1 summarizes information for these sites.

The Weston Site (48LN3117)

The Weston site is situated on a terrace on the eastern bank of the upper Bear River in an area midway between the upper Snake River drainage of southeastern Idaho to the northwest, the eastern Great Basin of northeastern Utah to the west, and the Wyoming Basin to the east (McNees et al. 1996). This site is the nearest of the discussed sites to the obsidian sources of southeastern Idaho. Excavations produced evidence of numerous extensive prehistoric occupations ranging from approximately 3,000 to 100 years ago. Throughout its history, the site served as a residential camp from which people exploited the rich resources of the Bear River riparian zone and the upland resources of the southern Overthrust Belt. General domestic activities evident for every occupation at the site include the opportunistic procurement, preparation, and consumption of a variety of animals. After about 1,300 years ago, the major economic activity at the site was collecting and processing roots or bulbs, probably camas, and possibly also seeds. The hunter-gatherers also exploited a broader range of small animals during this time. Evidence for intensive, multiple episodes of root processing comes from the presence of pit features interpreted as large earth ovens, extensive amounts of charcoal-stained sediment, and abundant heat-altered rocks. Also encountered was a housepit dated to 2,260 years ago. Overall, use of the site corresponded to the river- and stream-oriented subsistence patterns typical of the upper Snake River area of Idaho.

Test units, shovel tests, backhoe trenches, and four small blocks (Blocks A-D) totaling 116 m^2 were excavated. The remains from each of these blocks were divided into from one to four components, though mixing between components in the blocks is evident. All defined components contained flaking debris of obsidian, with obsidian making up 39.9% of the total analyzed debitage. The trend appears to have been a decrease in use of obsidian and an increase in use of chert through time, with components dated after about 1,300 years ago containing less obsidian than the earlier components. Obsidian artifacts and tools included 18 projectile points or final biface fragments, one preform fragment, one blank fragment, two indeterminable biface fragments, and two expedient flake tools. The two identifiable projectile point fragments were an Elko-eared and a Desert side-notched.

The forty-six obsidian artifacts (tools and debitage) selected for source analysis consisted of a grab sample of the larger specimens from most components, including specimens representing all visual differences evident in the obsidian assemblage. The majority (67%) were assigned to the Bear

Table 1. Summary information and identified obsidian sources for discussed sites.

Component	Uncorrected ^{14}C Age (yrs B.P.)	No. of Analyzed Flakes	No. of Obsidian Flakes (%)	Obsidian Sources
Weston Site (48LN3117)				
AI	--	826	562 (68.0)	3 Bear Gulch; 1 unknown
AII	2260 ± 70	1,350	792 (58.7)	8 Bear Gulch; 3 unknown
AIII	980 ± 60	1,011	488 (48.3)	5 Bear Gulch;1 unknown; 1 Malad
AIV	70 ± 50; 30 ± 60	344	141 (40.9)	5 Bear Gulch
BI	--	88	25 (28.4)	--
BII	--	207	47 (21.3)	--
BIII	1330 ± 60-1110 ± 70	617	70 (11.4)	4 Bear Gulch; 1 unknown
BIV	--	402	38 (9.5)	--
CI	2760 ± 60	2,539	1,082 (42.6)	4 Bear Gulch; 5 unknown
CII	--	666	1,557 (42.8)	--
DI	1310 ± 60	320	45 (14.0)	2 Bear Gulch; 2 unknown; 1 Malad
Site 48LN2555				
I	5260 ± 90	1,959	202 (10.3)	18 Malad
II	3420 ± 70-3070 ± 60	1,051	52 (4.9)	4 Malad
III	2360 ± 90; 1470 ±70	1,744	159 (9.1)	15 Malad
IV	--	1,418	136 (9.6)	10 Malad
Site 48SW211				
I	4670 ± 140; 5080 ±130	6,725	4 (0.06)	--
II	--	3,209	3 (0.1)	2 Mineral Mountain[2]
III	2660 ± 70-1760 ± 130	3,144	1 (0.03)	1 Unknown 4
IV	1530 ± 70	6,515	3 (0.05)	1 Teton Pass
Site 48SW212				
I	4830 ± 100-4280 ± 70	1,330	15 (1.1)	4 Bear Gulch; 1 Obsidian Cliff
Site 48SW270				
II	1460 ± 90-1210 ± 90	6,483	4 (0.1)	1 Malad
Site 48SW6324				
WI	3020 ± 80-2050 ± 90	487	5 (1.0)	1 Green River Pebble
WII	1010 ± 50	4,139	20 (0.5)	2 Teton Pass; 1 Green River Pebble 1 Unknown
WIII	950 ± 70; 900 ± 60	3,052	6 (0.2)	1 Bear Gulch
EII	--	10	2 (20.0)	1 Teton Pass[2]
EIII	--	26	6 (23.0)	3 Teton Pass
EIV	1270 ± 80	33	7 (21.2)	1 Teton Pass
EV	1190 ± 100	60	12 (20.0)	--
EVI	430 ± 50	275	46 (16.7)	5 Teton Pass

Table 1, continued

Site 48SW7991				
I	3030 ± 90	95	1 (1.1)	--
II	1740 ± 80-1220 ± 60	3,424	11 (0.2)	2 Fish Creek Var. 2[2]; 4 Green River Pebbles
Abel Creek Site (48SW998				
III	--	185	5 (2.7)	3 Malad[2]
Site 48HO550				
III	3360 ± 80	110	1 (0.9)	1 Obsidian Cliff
IV	--	62	1 (1.6)	--
Hatten Site (48HO656)				
I	5750 ± 60; 3740 ± 70	3,025	1 (0.03)	1 Obsidian Cliff
II	1560 ± 40	6,394	8 (0.1)	6 Obsidian Cliff; 1 Bear Gulch
III	--	7,172	25 (0.4)	9 Obsidian Cliff
Flying A Ranch Site (48NA1431)				
II	4360 ± 80-4060 ± 50	17,685	1 (0.0)	--
III	1220 ± 50; 1080 ± 80	4,249	5 (0.1)	3 Obsidian Cliff
Carter Site (48NA1425)				
--	580 ± 60	5,265	2 (0.03)	2 Obsidian Cliff
Site 48CK1387				
I	7430 ± 80	441	1 (0.2)	1 Obsidian Cliff
Red Canyon Rockshelter (48CK1395)				
IIIA	2470 ± 50-1530 ± 60	508	1 (0.3)	1 Obsidian Cliff
Site 48CK1403				
--	2570 ± 60; 1480 ± 60	4,729	12 (0.3)	1 Obsidian Cliff; 1 Malad
Site 48CK1416				
--	--[1]	8,342	6 (0.07)	5 Obsidian Cliff; 1 unknown
Site 48CK1417				
West	1830 ± 80	1,899	12 (0.6)	4 Obsidian Cliff
East	1970 ± 40	376	2 (0.5)	2 Grassy Lake?
Horn Ranch Site (5GA869)				
II-N	800 ± 50; 770 ± 80	2563	3 (0.1)	3 Malad
I-S	6910 ± 60; 6500 ± 50	5,832	1 (0.02)	1 Malad
II-S	920 ± 50-340 ± 60	13,673	8 (0.06)	5 Malad; 1 Polvadera Peak; 2 Bear Gulch

[1]Probably dates to similar age as 48CK1417, west block, based on obsidian hydration rim measurements.

[2]Included very small samples that required correcting the lowered measured x-ray concentration (Kunselman 1998).

Gulch source area approximately 300 km north of the site (Skinner et al. 1996). Surprisingly, only two artifacts were sourced to Malad, an important source only 115 km northwest of the site. Both artifacts belonged to components dated to after 1310 years ago, suggesting that the Malad source was not used until after that date.

Site 48LN2555

The next closest site to the southeastern Idaho obsidian sources is 48LN2555 (Reust et al. 1994) in the Twin Creek valley about 20 km east of the Weston site. This valley provides the major natural corridor through the Overthrust Belt between the Bear River valley and the Green River Basin of southwest Wyoming. The remains recovered from the 162 m^2 excavation block were divided into four components with radiocarbon dates ranging from 5,260 to 1,470 years ago. The remains from each component represent multiple short-term occupations superimposed on relatively stable land surfaces. The site probably served as a residential camp where a wide range of general domestic activities took place, including the procurement and immediate consumption of a wide range of plant and animal resources. A total of 8.9% of the flaked stone artifacts and debitage recovered from the site was of obsidian. In addition to debitage, obsidian artifacts included four small projectile point fragments, two small projectile point fragments that refitted, three small final biface tip fragments, and four expedient flake tools. The projectile point fragments included large side-notched and small corner-notched types.

Forty-seven obsidian artifacts (tools and debitage) consisting of a grab sample incorporating specimens from each component were sourced to Malad, located approximately 135 km northwest of the site in southeastern Idaho (Kunselman 1994a). This is the closest major source to the site. The exclusive use of Malad obsidian at 48LN2555 contrasts with observations at the Weston site where Bear Gulch obsidian was dominant.

Rock Springs Uplift Sites of Southwest Wyoming

Five additional sites (48SW211, 48SW212, 48SW270, 48SW6324, and 48SW7991) in southwest Wyoming along the eastern slope of the Rock Springs Uplift, the divide between the Green River and Great Divide Basins, contained sourced obsidian. The major drainage in the area is Bitter Creek which cuts east to west through the Rock Springs Uplift providing an excellent travel corridor between the basins in southwest Wyoming. These sites are approximately 170 and 190 km from Site 48LN2555 and the Weston site, respectively.

Site 48SW211 is located along a tributary of Bitter Creek (McNees et al. 1992). The 60m^2 block was excavated to over 3m deep, and the remains were divided into four components dating over the past 5,000 years. High artifact densities represent repeated multiple occupations during which general domestic activities took place. The four obsidian artifacts of sufficient size for analysis were submitted for sourcing. One was from an unknown source, one was from Teton Pass, and two were identified to Mineral Mountain, Utah (Skinner 1998; Kunselman 1998). Teton Pass is one of the identified sources closest to the site area, at a distance of about 290 km. The Mineral Mountains are about 480 km southwest of the site.

Site 48SW212 is on the edge of a low sand-covered bench that slopes into a shallow drainage just upstream from 48SW211 (McNees et al. 1992). Six charcoal-stained layers were encountered within the 60m^2 excavation block associated with two slab-lined basins. Charcoal dumped down the face of the slope during different periods of occupation formed the six layers. The occupations represented by these layers occurred between 4,830 and 4,280 years ago. The slab-lined basins were probably ovens for baking some type of root such as biscuitroot (Smith and McNees 1999). Of the five obsidian artifacts of sufficient size for analysis, four were from Bear Gulch and one was from Obsidian Cliff (Skinner 1998; Kunselman 1998). Obsidian Cliff is about 410 km and Bear Gulch approximately 430 km from the site.

The 88m^2 excavation block at 48SW270 was in a small interdunal basin on an undulating dip slope west of Bitter Creek (McNees et al. 1992; Smith et al. 1995). Two distinct localities of prehistoric activity were evident within the excavation block. One was a household area that contained a structure (stone circle) and adjacent, generalized, central, domestic work areas. The other activity area consisted of concentrations of bone, heat-altered rock, and debitage where multiple intensive processing

and manufacturing took place, including butchering and bone grease processing. The approximately 9,000 bone specimens included at least two, and probably three, bison and at least two pronghorn, as well as a wide variety of small mammals. The only specimen of sufficient size was sourced to Malad (Skinner 1998). This source is about 310 km from the site, one of the closest sources.

Site 48SW6324 consists of a series of extant and collapsed overhangs below the crest of a ridge east of Bitter Creek (McNees et al. 1992). Two blocks were excavated adjacent to and under two of these overhangs. The west block was 134m^2 and the east block 21m^2. Three components were defined in the west block and six in the east block. These components represent a series of repeated occupations over at least the last 3,000 years, focused predominantly on individual hunting of medium and large mammals. Eight of the components contained some obsidian debitage, with obsidian forming approximately 18% of the small amount of debitage from the east block. Sixteen of the larger pieces of obsidian were sourced to three origins: Teton Pass (12 specimens), one of the closest sources to the site; Bear Gulch (one specimen) about 430 km from the site; Green River pebbles (two specimens), a local source; and an unknown source (one specimen) (Skinner 1998; Kunselman 1998).

Site 48SW7991 is located on a small drainage west of Bitter Creek (McNees et al. 1992). The 144m^2 excavation block yielded evidence of two components. Component II (1,740 to 1,220 years ago), contained obsidian among overlapping remains from multiple occupations consisting of many densely spaced basin features and a dense scatter of debris from the manufacture of projectile points and other tools. Of the six obsidian specimens of sufficient size for analysis, two were from the Fish Creek Variety 2 source near Jackson about 290 km from the site, and four are Green River pebble obsidian, a local source (Kunselman 1998).

Abel Creek Site (48SW998)

The Abel Creek site is located near the northern edge of the Great Divide Basin just below Green Mountain on a tributary to the perennial Lost Soldier Creek (Reust et al. 1993). Three components were defined from two excavation blocks totaling 70m^2. Component III, representing a Late Prehistoric period short-term camp with limited remains, yielded five small obsidian flakes. The three flakes of sufficient size for analysis derived from Malad, about 280 km from the site (Kunselman 1998).

Site 48HO550

The site closest to Obsidian Cliff is Site 48HO550 on a tributary of Gooseberry Creek in the southwestern portion of the Big Horn Basin in northern Wyoming (McNees et al. 1995). The excavation of a 60m^2 block revealed four charcoal-stained layers or components containing limited remains. The obsidian flake of sufficient size for analysis from Component III originated from Obsidian Cliff, about 200 km from the site (Skinner 1998).

The Hatten Site (48HO656)

The Hatten site is in the Bridger Mountains, which form the divide between the Big Horn and Wind River basins, and is the next site closest to Obsidian Cliff (Martin et al. 1999a). The site is on a terrace above an unnamed perennial tributary of Kirby Creek. The remains from the heavily mixed deposits of the 100m^2 excavation block were divided into three components representing a discontinuous series of occupations of a residential camp over the past 8,000 years. Thirty-four pieces of obsidian debitage and a small indeterminate biface fragment were recovered from the three components. Of the representative grab sample of the larger obsidian artifacts submitted for sourcing, 16 derived from Obsidian Cliff and one flake from Component II came from Bear Gulch (Skinner et al. 1998). Obsidian Cliff is about 290 km and Bear Gulch 340 km from the site.

The Flying A Ranch Site (48NA1431)

The Flying A Ranch site occurs in aeolian deposits along the western edge of the Casper Arch, the divide between the Wind River and Powder River basins in central Wyoming (Martin et al. 1999b). The 95m^2 excavation block contained remains divided into three components dating from 6,650 to 1,080 years ago. The site functioned as a residential base and a center of a variety of domestic activities. Two well-preserved housepits were among the pit features and high density and diversity of artifacts excavated from Component II.

Obsidian artifacts included one small flake from Component II and five flakes from Component III. The three obsidian flakes from Component III of sufficient size for analysis originated from Obsidian Cliff about 330 km northwest of the site (Skinner et al. 1998).

The Carter Site (48NA1425)

The Carter site lies along the terrace of a tributary of the South Fork of the Powder River in central Wyoming (Martin 1999). The 94m^2 excavation unit contained the remains of a feature surrounded by over 5,000 flaked stone artifacts, over 500 ceramic sherds, and about 2,500 bone specimens representing at least one bison and two pronghorn. The site appears to have been a campsite where the prehistoric inhabitants processed bone for marrow and grease. Two small obsidian flakes were sourced to Obsidian Cliff, about 350 km from the site (Skinner et al. 1998).

Northeast Wyoming Black Hills Sites

Five excavated sites (48CK1387, 48CK1395, 48CK1403, 48CK1416, and 48CK1417) in the Bear Lodge Mountains of the northwestern Black Hills contained small amounts of obsidian sourced to areas in northwestern Wyoming and southeastern Idaho. These sites are about 500 to 700 km from the sources.

The 33m^2 excavation block at Locality 1 of 48CK1387 yielded three bifaces, 10 flake tools, 441 pieces of debitage, and three bone fragments associated with an area of charcoal-stained sediment (Schneider et al. 1997; Schneider and Smith 1997). Analysis of the remains indicates a short-term occupation consisting of several hearth-centered activities, including manufacturing bifaces from primarily local materials and use of expedient scraping tools. A single bifacial thinning flake fragment of obsidian from the excavation was sourced to Obsidian Cliff (Kunselman 1996).

The Red Canyon Rockshelter (48CK1395) contained seven stratified components dating over the past 6,000 years in deposits extending over 5m in depth (Schneider et al. 1997; Schneider and Smith 1997). Throughout much of its occupation history, the rockshelter served as a short-term residential camp that was repeatedly reused and reoccupied, resulting in the mixing of cultural remains and blurring of the occupations. The component containing the single obsidian flake included eight hearths and seven postholes just below the dripline of the shelter. The small obsidian flake fragment was sourced to Obsidian Cliff (Kunselman 1996).

Site 48CK1403 is a large site situated on an upland divide where repeated occupations occurred on a fairly stable land surface over several thousand years (Schneider et al. 1997; Schneider and Smith 1997). Two features encountered on virtually the same surface within the 34m^2 excavation block yielded radiocarbon dates of 2,570 ± 60 and 1,480 ± 60 years B.P. The flaked stone artifact assemblage represents a reduction strategy focusing on later stage thinning, final tool production, and maintenance activities. The 12 pieces of obsidian consisted of small bifacial thinning and pressure flakes and fragments. The two specimens of sufficient size for analysis were sourced to Malad in southeast Idaho and to Obsidian Cliff (Kunselman 1996).

The 52m^2 excavation block at 48CK1416 contained the remains of a series of short-term occupations along the terrace of Little Beaver Creek, a tributary of the Belle Fourche River (Schneider et al. 1998). Though bone collagen samples yielded radiocarbon dates ranging from modern to 200 years ago, obsidian hydration rim measurements of the samples from Site 48CK1416 are nearly identical to two measurements of Obsidian Cliff specimens from 48CK1417, a nearby site in a similar depositional environment with a radiocarbon age of 1,830 + 80 years B.P. The limited number of activities performed at the site included various kinds of flaked stone tool production, depending on material type, and secondary animal butchering. Obsidian artifacts are one small (1.1 cm in length) projectile point fragment, one small (1.5 cm in length) biface fragment, and six pieces of debitage. Two of the specimens are fairly large (one is over 3.0 cm in length and 0.5 cm thick) flake fragments. Of the six obsidian specimens submitted for source analysis, all except the projectile point fragment came from Obsidian Cliff. The projectile point was from an unknown source (Skinner et al. 1997).

Site 48CK1417 is located adjacent to and on the same terrace as 48CK1416 (Schneider et al. 1998). The two small blocks totaling 54m^2 yielded remains from multiple tasks typical of a series of short-term occupations at a residential camp simi-

lar to those at 48CK1416. The west block contained 12 pieces of obsidian. One of the specimens is a large (over 2.5 cm in length), thick (0.5 cm) flake fragment with some bifacial flaking; the other specimens are small flake fragments or pressure flakes. The four specimens of sufficient size for analysis from the west block were from Obsidian Cliff (Skinner et al. 1997). The two from the east block are chunky flake fragments with primary cortex that appear to be from the same piece of obsidian. Both specimens possibly originated from Grassy Lake (Skinner et al. 1997).

Horn Ranch Site (5GA869)

The Horn Ranch site is located on a south-sloping bench immediately above the floodplain of the Colorado River near its confluence with the Frazer River in eastern Middle Park, north-central Colorado (Reust and Johnston 1998). Excavation of 43m^2 and 114m^2 blocks yielded the remains of hearths, stone circles, rock alignments, and heat-altered rock. These remains were divided into two components for each block. The site appears to have been a residential camp with temporary structures such as windbreaks or wickiups. Twelve pieces of obsidian debitage were recovered from three of the components. Nine were from Malad, approximately 570 km from the site; two were from the Bear Gulch source about 650 km from the site; and one was from Polvadera Peak, New Mexico, about 430 km from the site (Skinner and Davis 1998; Kunselman 1998).

OBSIDIAN SOURCES

The 179 obsidian artifacts were identified to eight different geochemical sources. Obsidian Cliff, Bear Gulch, and Malad obsidians were extensively used at the discussed sites. Obsidian from two of the Jackson sources (Teton Pass and Fish Creek Variety 2) was limited to only three of the Rock Springs Uplift sites. Possible Grassy Lake obsidian occurred only at 48CK1417. The Horn Ranch site in northern Colorado contained the only obsidian from Polvadera Peak, New Mexico. Mineral Mountain, Utah, obsidian was present at only 48SW211, on the Rock Springs Uplift. Green River pebble obsidian, a secondary source in the Green River Basin, was identified from only two sites on the Rock Springs Uplift. The sources are discussed below.

Obsidian Cliff

Obsidian Cliff in Yellowstone National Park is a well known obsidian source studied for over a century (Davis et al. 1995). It was one of the first obsidian sources recognized by early neutron activation studies (Frison et al. 1968; Frison 1974; Griffin et al. 1969). Obsidian from Obsidian Cliff has been identified as far as the Hopewell sites in Illinois and Ohio (Hatch et al. 1990; Hughes 1992), in the Kansas City area (Hughes 1995), in Iowa (Anderson et al. 1986), and in North Dakota and Oklahoma (Baugh and Nelson 1988), among other places. Though the use of the obsidian was far-reaching, the prehistoric inhabitants in areas nearer the source focused on obsidian from other locations to a greater extent, especially if they were closer. An analysis of obsidian projectile points found in the Jackson Hole area of Wyoming showed that the Teton Pass and Fish Creek sources located near Jackson were more heavily used during most periods than was Obsidian Cliff (Connor and Kunselman 1995). A study of obsidian from surface sites in southwest Montana equidistant from Bear Gulch and Obsidian Cliff indicated that 64% of the obsidian was from Bear Gulch, while only 36% derived from Obsidian Cliff (Baumler 1997).

Except for one flake from Site 48SW212 on the Rock Springs Uplift, only the sites located in the northern half of Wyoming contained Obsidian Cliff obsidian (Figure 2). The earliest occurrence of Obsidian Cliff obsidian from these sites dates to 7,430 years ago at 48CK1387 in the Black Hills of northeast Wyoming. The other sites containing Obsidian Cliff obsidian date from 5,750 to 580 years ago. The lack of Obsidian Cliff obsidian in southwest Wyoming is consistent with Thompson et al.'s (1997) analysis of the source of obsidian found on sites in the Green River Basin. The results of their analysis of 38 specimens from nine excavated sites indicated that the obsidian was from Malad, Green River pebbles, Engineer's Quarry, Mineral Mountains, and Bear Gulch, with none from Obsidian Cliff. However, Frison's (1974) analysis of obsidian from sites such as Wardell and Eden-Farson in the Green River Basin did indicate some use of Obsidian Cliff obsidian.

The results of several studies in the northern portion of Wyoming demonstrate an emphasis on

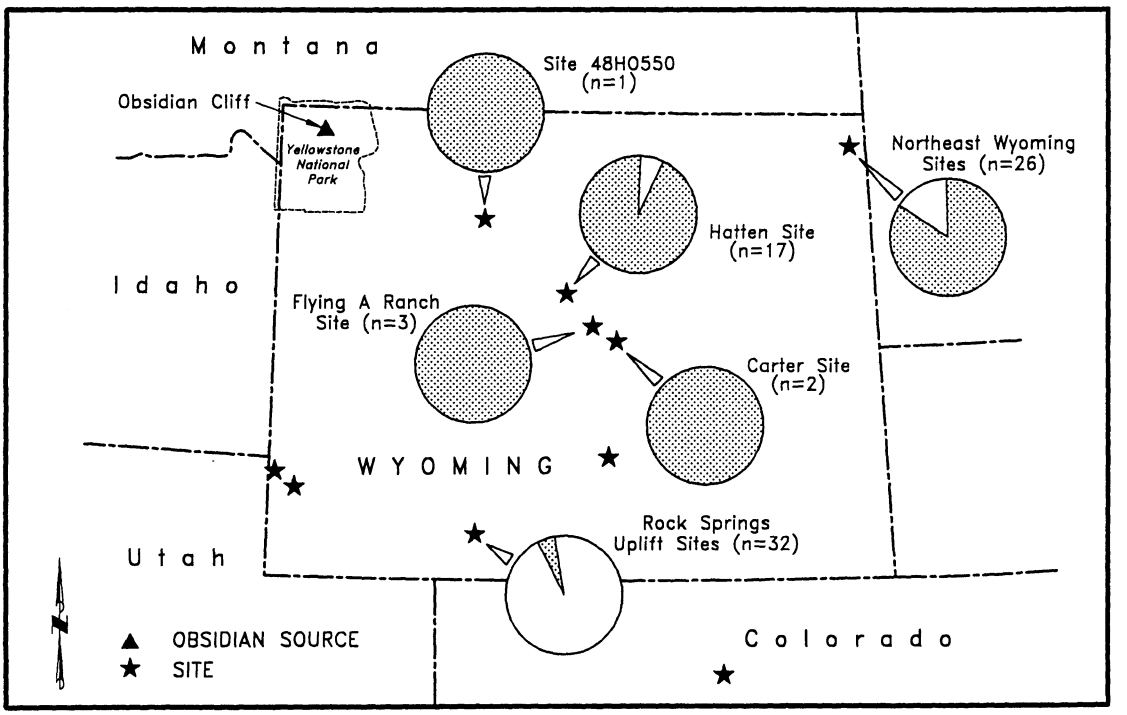

Figure 2. Obsidian Cliff obsidian, percent of total sourced obsidian per site.

Obsidian Cliff obsidian in agreement with the current observed patterns. Frison et al.'s (1968) early analysis of obsidian from sites on the west and east side of the Big Horn Mountains showed that most of the obsidian was from Obsidian Cliff. Likewise, 79% of the obsidian collected from the Beartooth Mountains of Montana and Wyoming derived from Obsidian Cliff (Kunselman and Husted 1996). At the Laddie Creek site, also located on the western slope of the Big Horn Mountains, two of three analyzed flakes from the Early Archaic levels were sourced to Obsidian Cliff with the third from Bear Gulch (Larson 1990). In contrast to these studies, Bear Gulch obsidian dominated (56%) the collection from the Lookingbill site in the Absaroka Mountains of northwest Wyoming, though 26% of the obsidian was from Obsidian Cliff (Kunselman 1994b).

Bear Gulch

Bear Gulch, also referred to as Camas-Dry Creek and Big Table Mountain, is another important obsidian found as far from its source as Ohio and Illinois (Willingham 1995). It was one of the first obsidian types described during the early neutron activation studies as Field Museum Yellowstone 90 Group, though the actual source area was unknown (Griffin et al. 1969). In the late 1980s, the source was determined to be in the Centennial Mountains of eastern Idaho (Hughes and Nelson 1987; Wright and Chaya 1985; Wright et al. 1990). It is often identified with Obsidian Cliff obsidian throughout its known range. At some locations, including southwest Montana (Baumler 1997) and the Lookingbill site in northwest Wyoming (Kunselman 1994b), it dominates the obsidian assemblage. It was used throughout most of the prehistory of the region. Hell Gap and Alberta projectile points made of this obsidian occur in the greater Yellowstone area (Cannon 1993).

At the Weston site over 67% of the sourced obsidian from all components was from Bear Gulch, even though it was not the closest source to the site (Figure 3). Small amounts were also identified from the 920- to 340-year-old component at the Horn Ranch site in northern Colorado and from the 4,200- to 4,800-year-old component at 48SW212 and the 900-year-old component at 48SW6324 on the Rock

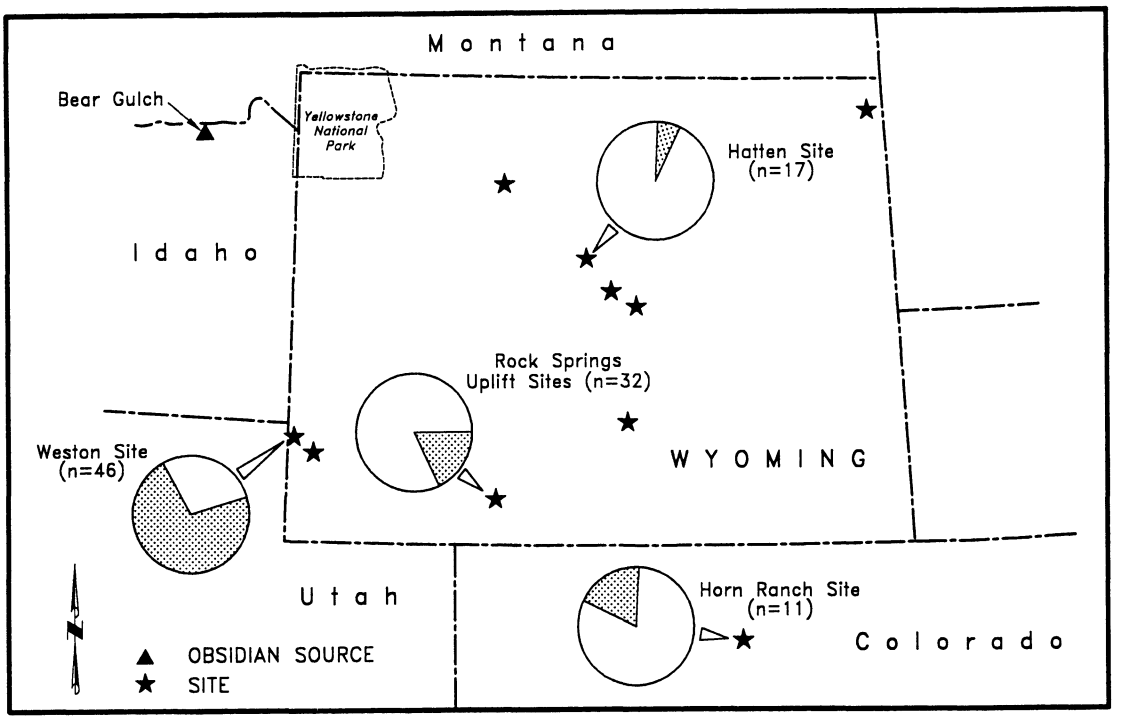

Figure 3. Bear Gulch obsidian, percent of total sourced obsidian per site.

Springs Uplift. Only one of the studied sites, the Hatten site, in the northern portion of Wyoming contained Bear Gulch obsidian. This contrasts with the results of other studies from this portion of Wyoming where Bear Gulch obsidian is present or dominant in most obsidian collections (Frison et al. 1968; Kunselman 1994b; Kunselman and Husted 1996). The results from the southern portion of the study area indicate a greater use of Bear Gulch obsidian then previously noted (Thompson et al. 1997; Weathermon 1996). Bear Gulch was important throughout the region and competed with Obsidian Cliff as the preferred source.

Malad

The Malad source, also known as Wright Creek, was the most intensively used of the southeastern Idaho sources during prehistoric times (Holmer 1997). Limited amounts have been found in such far-reaching areas as North Dakota, Nebraska, Oklahoma, and southern Texas (Baugh and Nelson 1988). The obsidian assemblages from sites in the southern portion of the study area contained or were dominated by Malad obsidian (Figure 4). All sourced obsidian from 48LN2555 dating over the past 5,000 years was from Malad, the nearest major source. Malad obsidian also dominated the collection from the Horn Ranch site in northern Colorado. Limited amounts were also identified from a 1,200- to 1,400-year component at 48SW270 on the Rock Springs Uplift and from 980- to 1,300-year-old components at the Weston site on the Bear River. The only occurrence in the northern portion of the study area was a single flake at 48CK1403 in northeastern Wyoming.

This distribution conforms to the results of previous research. Thompson et al. (1997) noted Malad obsidian on the six excavated sites examined during their study of obsidian use in southwest Wyoming. Five sourced projectile points from the Eden-Farson site in southwest Wyoming, dating to 230 years ago, were made from Malad obsidian (Weathermon 1996). It was also used in southeast Wyoming (Kunselman 1994b). The Lookingbill site in northwest Wyoming lacked obsidian from this source. Only 3% of the sourced obsidian artifacts from the Beartooth Mountains of Montana and Wyoming belonged to the Malad

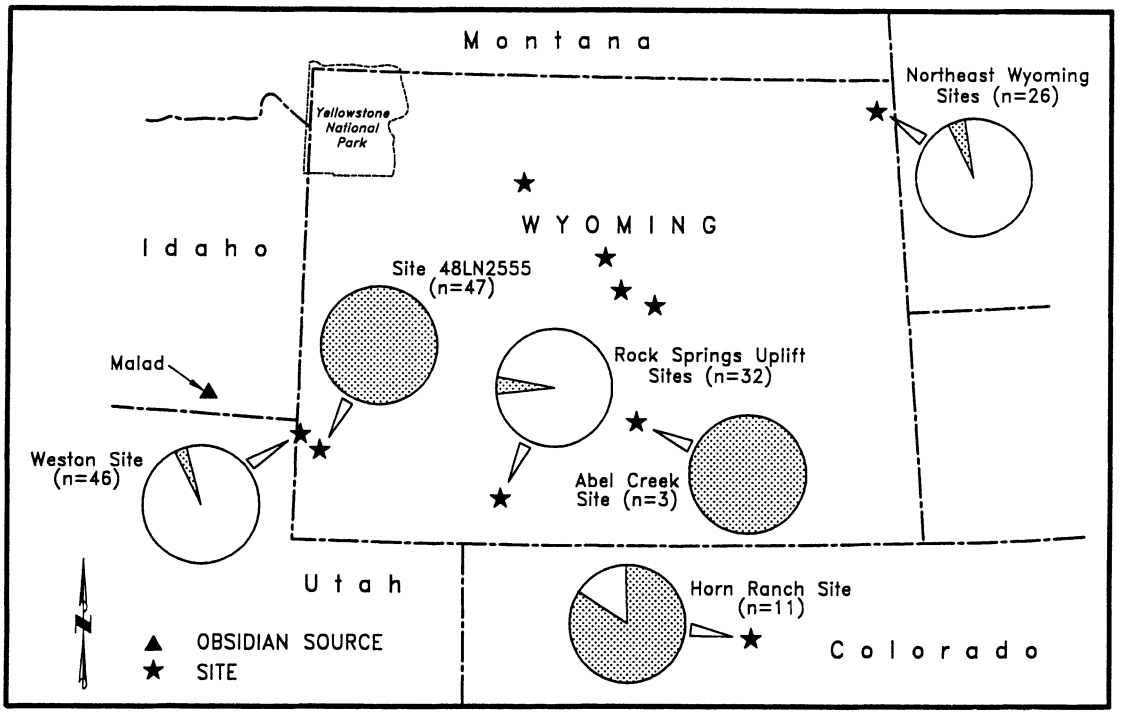

Figure 4. Malad obsidian, percent of total sourced obsidian per site.

source (Kunselman1994b; Kunselman and Husted 1996). Though limited quantities of Malad obsidian occur at sites in northern areas such as North Dakota (Baugh and Nelson 1988), most use appears to have been east and southeast of the source.

Jackson Sources

Several obsidian geochemical types including Teton Pass, Fish Creek Variety 2, Engineers Quarry, and West Gros Ventre Butte have been defined for the Jackson area (Schoen 1997). Teton Pass is the most commonly used of these types, with Fish Creek Variety 2 the second most common. Obsidian from these sources appears to have been used prehistorically within only a limited distance from the Jackson area, and most sites contain only small quantities. During the present study, the Teton Pass obsidian was found only in components dating between 1,000 and 430 years ago at 48SW6324 and a component dated 1,500 years ago at 48SW211, both on the Rock Springs Uplift (Figure 5). Fish Creek Variety 2 was identified only at Site 48SW7991 also on the Rock Springs Uplift. Only one of the six excavated sites examined by Thompson et al. (1997) yielded obsidian from a Jackson source, a single flake from Engineers Quarry at the Taliaferro site. One projectile point from the Eden-Farson site was sourced to Teton Pass and one to Fish Creek Variety 2 (Weathermon 1996). The Lookingbill site, about 200 km from the sources, had only 18% of the obsidian identified either to Teton Pass or Fish Creek Variety 2 (Kunselman 1994b). The more distant Beartooth Mountains had only 1% obsidian from the Jackson sources (Kunselman and Husted 1996).

Green River Pebble Obsidian

Obsidian in the form of small pebbles occurs on the terraces of the Green River (Love 1977). Green River pebble obsidian has been found only in sites in the Wyoming Basin, including the Taliaferro and Mayfly sites, located near the Green River in the vicinity of the source (Thompson et al. 1997). As expected, the only sites examined during the present study with Green River pebble obsidian are on the Rock Springs Uplift (Figure 5). Components dating between 3,000 and 1,000 years ago at 48SW6324 and the component dated 1,700-1,200 years ago at

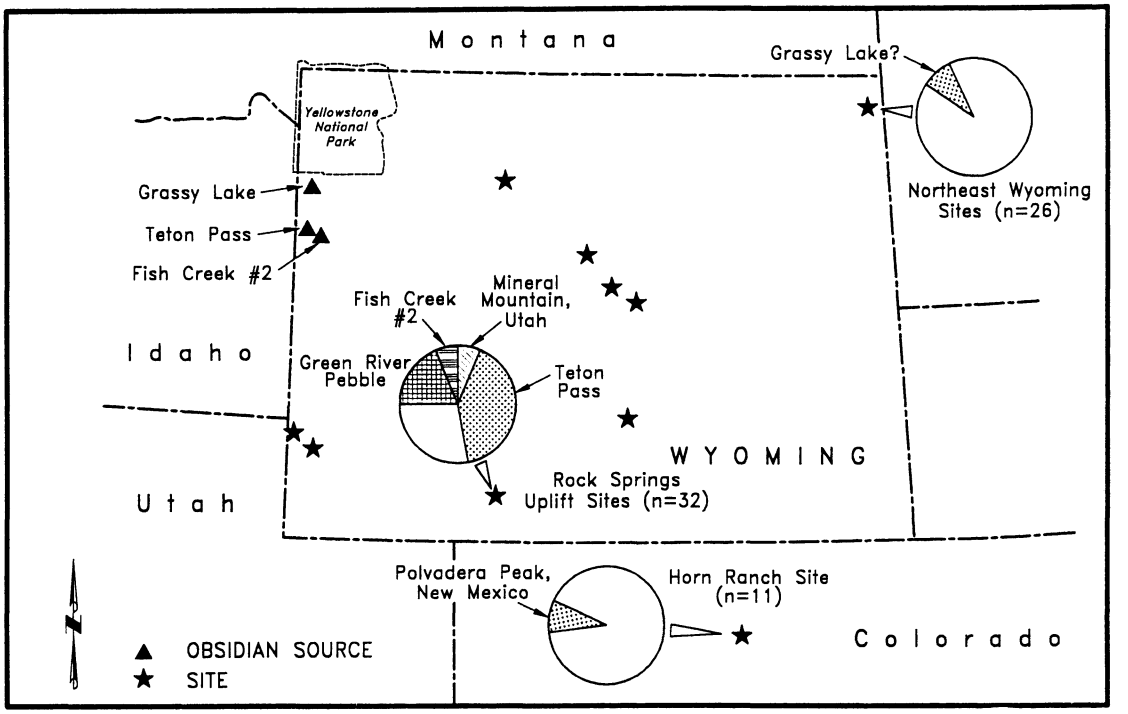

Figure 5. Other obsidian, percent of total sourced obsidian per site.

48SW7991 contained Green River pebble obsidian. These six samples matched the trace element values of pebble obsidian collected from the surface along Highway 320 west of Green River and from near the Blacks Fork River (Kunselman 1998). Five of the six specimens also had cortex similar to pebble obsidian. This secondary source is geochemically similar to the primary source West Gros Ventre Butte from the Jackson area.

Other Sources

The Wyoming and northern Colorado sites contained obsidian debitage in limited quantities from three additional sources (Figure 5). Two flake fragments from the east block at 48CK1417 most likely originated from Grassy Lake, a source characterized by Nelson (1984). The source occurs just south of the Yellowstone National Park boundary about 530 km from the site. One Early Plains Archaic projectile point from the Jackson-Grand Teton area is of Grassy Lake obsidian (Connor and Kunselman 1995), but obsidian from this source is rarely found in archaeological sites. One piece of debitage from Component II-S at the Horn Ranch site in northern Colorado came from Polvadera Peak in the Jemez Mountains of New Mexico. Obsidian from this source is found in sites in at least New Mexico (Baugh and Nelson 1987) and eastern Colorado (Lyons and Johnson 1994). Two pieces of debitage from Component II at 48SW211 were sourced to Mineral Mountain, Utah, a source chemically defined by Nelson and Holmes (1979). One site in southwest Wyoming, the Harrower site, also contained a specimen of this obsidian (Thompson et al. 1997).

OBSIDIAN TOOL MANUFACTURE, USE, AND TRANSPORT

As discussed, prehistoric inhabitants throughout Wyoming used obsidian in varying amounts from a variety of sources. All the discussed sites had obsidian artifacts, often obtained at great distances, even though good-quality raw materials were present in abundant quantities locally. Under most situations, it would be expected that prehistoric hunter-gatherers would manufacture most types of their stone implements from locally available materials (Andrefsky 1994). Local materials

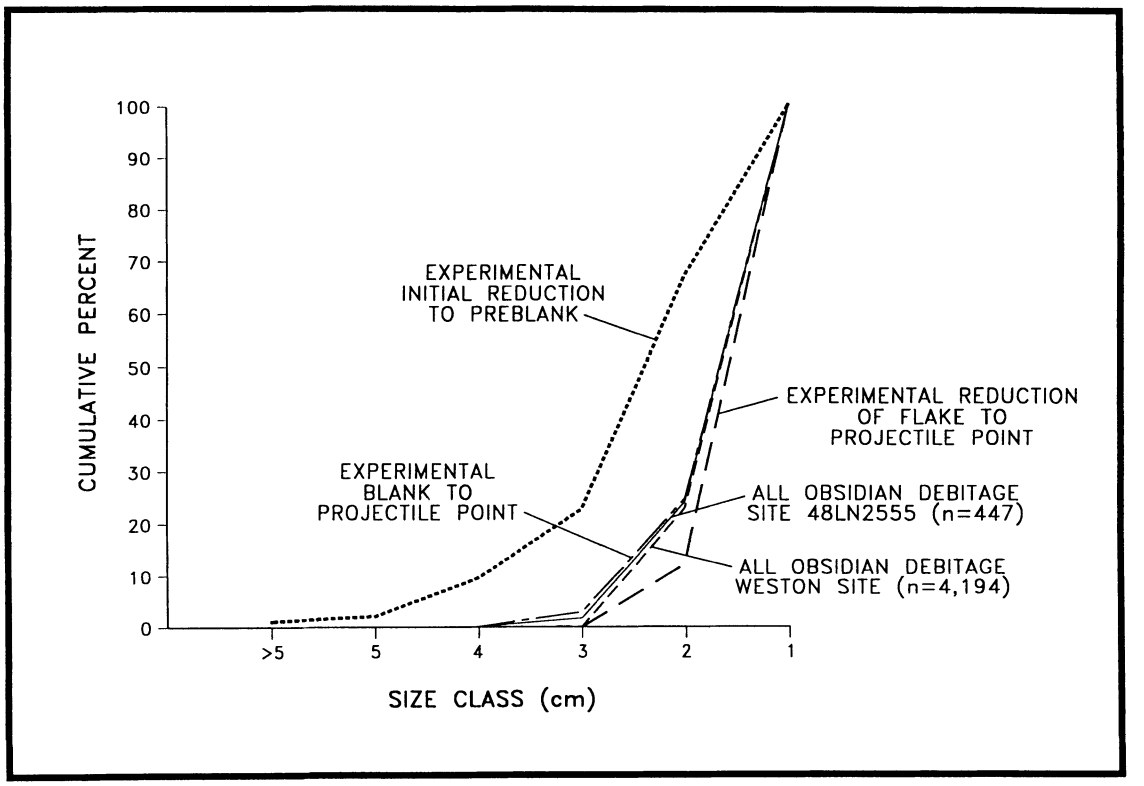

Figure 6. Cumulative percentage curves of flake size for obsidian debitage from the Weston site and 48LN2555 compared to experimental curves.

were indeed the predominant source for most tools. However, site occupants still used obsidian transported considerable distances—up to 700 km from the source. For obsidian to have been transported such long distances, it must have been quite valuable to outweigh the high transport costs.

One important determinant of the value of a material is its mechanical properties and its appropriateness for the tool to be manufactured (Beck and Jones 1990). Of the various materials, obsidian knaps very well and forms the sharpest edge, but it is quite brittle and becomes dull quickly. Given the mechanical characteristics of obsidian, it would have been most valuable for cutting tools that needed to be knapped easily. Tool forms made of obsidian are often similar to those of other material types, suggesting that tool function may not be the only criterion for obsidian selection. Obsidian may have been valued and transported long distances because it was an exotic different from other more easily obtained materials and due to its special flaking characteristics.

Studying how prehistoric hunter-gatherers manufactured, used, and transported obsidian tools should provide a clearer understanding of various aspects of curation at varying distances from the obsidian sources, thereby exemplifying the role of raw material distribution in the overall technological organization. The remains recovered from individual sites, however, are only part of the total assemblage of implements hunter-gatherers used at a particular location (Nelson 1991). Only items discarded, lost, or abandoned will likely be found. Nonlocal valued items will especially be saved, transported to new locations, and never purposely abandoned (Bamforth 1986). Therefore, an understanding of the kinds of activities associated with the production, transport, and maintenance of flaked stone tools made of nonlocal materials will have to be inferred from the analysis of discarded or lost materials. Even debris resulting from these activities would be in limited quantities on sites

located far from the obsidian source.

The Weston site and 48LN2555 have the highest percentage of obsidian artifacts and debitage of the discussed sites. The Weston site contained an average of about 40% obsidian artifacts with some components approaching 68% obsidian. About 9% of the artifacts from 48LN2555 were obsidian. Both sites are in southwest Wyoming near the Idaho-Wyoming state line, the nearest sites to the eastern Idaho obsidian, though the predominant obsidian used at the Weston site was from Bear Gulch, over 300 km from the site. Malad, the source for all the obsidian at 48LN2555, is 135 km from the site.

To understand the stages of obsidian reduction that occurred at these two sites, cumulative percentages of various sizes of obsidian flaking debris were plotted and compared with curves developed from experimental studies (Figure 6). These replications included the bifacial reduction of chert and quartzite nodules to final projectile point form, and the removal of flakes from a large core and the bifacial reduction of these flakes into final projectile point form (Smith 1999). For the experiment, the reduction continuum was divided into the four stages: preblank, blank, preform, and final biface (projectile point). At the completion of each stage, the reduction was stopped and the resulting debitage was bagged and analyzed separately. The kinds and amount of debris produced from each of the various stages of the biface and flake reduction were plotted as cumulative percentage curves. The curves for debitage size arranged from largest to smallest proved to be the best indicator of reduction stage, which corresponds with Stahle and Dunn's (1982) findings. Though small flakes dominate all stages of reduction, fewer large flakes are produced during the later stages, thereby indicating that assemblages limited to small flakes represent the late stages of reduction.

As Figure 6 shows, the cumulative percentage curve for total obsidian debitage from both sites mirrors the experimental curve for debris resulting from reducing a blank to a projectile point. Though not an exact match, the experimental curve for the reduction of a flake into a projectile point is also similar. Most likely, prehistoric hunter-gatherers brought prepared biface blanks or flake blanks to the site and then reduced them into a more final form. Separate plots of percentages of various sizes of obsidian debitage from each block and component at the sites created similar curves, indicating that the same obsidian reduction activities occurred at the sites over the past 3,000 and 5,000 years.

The 24 obsidian tools (18 projectile point or final biface fragments, one preform fragment, one blank fragment, two indeterminable biface fragments, and two flake tools) recovered from the Weston site were small fragments, with the largest only 1.8 cm in size. The 13 obsidian tools (four projectile point fragments, two projectile point fragments that refitted, three final biface tip fragments, and four flake tools) from Site 48LN2555 were also small fragments with most less than 2 cm in size. The small size of these artifacts suggests that the prehistoric inhabitants valued obsidian highly and removed most implements from the sites, leaving behind only small unusable fragments. The obsidian assemblage also lacked bifaces in the early stages of reduction, again indicating that only the later stages of obsidian reduction occurred at the sites.

The blanks that the hunter-gatherers brought to the two sites were probably initially reduced at the quarry location for anticipated transport to residential locations for further reduction. This procedure is consistent with Binford and O'Connell's (1984) observations of the Alyawara of Australia working in a stone quarry. The Alyawara produced blanks at the quarry for tool types that they perceived to have long use-lives and that would constitute a special component of an individual's personal gear. In contrast to these long use-life tools, they also carried cores from the quarry for producing more expedient tools as needed at the residential camp. As argued by Kelly (1988), biface blanks are ideal for long use-life tools. Bifaces are also useful as cores, especially when the raw material is scarce in areas, which would be the case for obsidian at sites far from the source. The reduction of raw material to biface blanks at the quarry allows for the transport of material with the greatest total amount of area while minimizing the weight of the stone carried (Kelly 1988). Transporting obsidian in the form of smaller flake blanks may even be more efficient in terms of maximizing the tool's potential utility relative to the cost of transport (Kuhn 1994). It is unclear whether the hunter-gatherers

brought biface or flake blanks to the sites for further reduction.

In contrast to the Weston site and 48LN2555, less than 1% of the total recovered artifacts and debitage were obsidian at the remaining sites in the sample. The obsidian at these remaining sites is pressure and bifacial thinning flakes less than 2 cm in size, except for one small indeterminate biface fragment from the Hatten site and a projectile point and biface fragment from 48CK1416. All of these are less than 2 cm in size. The presence of only a few small flakes at these sites suggests that unrecovered obsidian tools were brought to the sites in finished form and were maintained to a limited extent, then removed from the sites. The use of obsidian at these sites appears to have focused on only the repair and maintenance of highly valued implements transported from location to location. Mobile hunter-gatherers probably maintained and transported these obsidian implements as individuals personal gear that was kept with them virtually wherever they went (Kuhn 1992). As expected, because of the value of the exotic material, only the smallest waste flakes and exhausted or broken tool fragments were discarded at any one location.

The above evidence shows that hunter-gatherers treated the nonlocal and exotic obsidian differently depending on distance from the source. This exemplifies contrasting aspects of what has been lumped into the concept of curation (Nelson 1991; Odell 1996). Curation at sites near and far from the sources involves different objectives and behaviors (Figure 7). Behaviors near the quarry first involved the reduction of obsidian into blanks for anticipated further reduction. Hunter-gatherers then carried the blanks to the relatively nearby sites for production into more finished tools. They conserved the obsidian, removing most tools from the sites for later use, and only discarded tools too fragmentary to be shaped into useful implements. In contrast, the occupants at the other sites transported, conserved, maintained, and repaired more completed tools, probably as personal gear. The former sites were used for making obsidian tools, while the latter sites were locations for using and repairing previously manufactured implements. The concept of curation includes each of these behaviors: preparation and transportation of the potential source of tools (bifaces blanks or cores), manufacture of tools for later use, and the conservation and repair of completed tools. These behaviors were at least partly influenced by the availability of material and distance from the source. However, sites such as 48HO550 and the Hatten site are as close to Obsidian Cliff as the Weston site is to Bear Gulch. This suggests that actual distance as the crow flies is not the limiting factor; rather, the territory the hunter-gatherers covered during their annual round affected curation behavior.

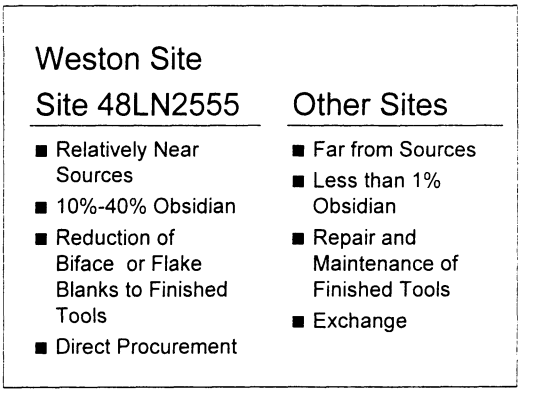

Figure 7. Differences in obsidian use compared between sites near and far from sources. Curation at the two site groups involve different behaviors and objectivess.

DIRECT PROCUREMENT OR EXCHANGE

Most obsidian studies typically conclude with hypotheses concerning the mechanisms for obtaining obsidian over long distances (Hughes 1998). These discussions usually focus on direct procurement or exchange. Though it is probably not possible to clearly distinguish direct and exchange zones of procurement, the dichotomy between the ways mobile hunter-gatherers manufactured, transported, and maintained obsidian tools at the two sets of sites provides some clues about obsidian procurement. The transport of previously reduced biface blanks to the Weston site and 48LN2555 for reduction and the presence of 40% and 10% obsidian artifacts at the two sites suggest that the obsidian was directly procured from the source. It is unclear whether the prehistoric hunter-gatherers obtained the obsidian as part of their seasonal movements or by special task forays. Because the site inhabitants have been interpreted as fairly mobile foragers, it is likely that the obsidian was

collected during their normal seasonal round. If this is the case, the seasonal round of the occupants of the Weston site on the Bear River during the past 3,000 years included the Bear Gulch source about 300 km north of the site. This suggests that the site inhabitants had subsistence patterns focused on the river and streams of the upper Snake River area of Idaho. Tributaries of the upper Snake River would have provided easy access to the Bear Gulch source. The types of remains recovered from the Weston site also indicate general river and stream-oriented subsistence patterns similar to those recognized at excavated upper Snake River sites. The occupants of 48LN2555 over the past 5,000 years apparently followed a seasonal round that incorporated the Malad source, the nearest obsidian source at a distance of 135 km. As noted above, obsidian from both Bear Gulch and Malad was widely distributed prehistorically.

In contrast to the Weston site and 48LN2555, the inhabitants of the other discussed sites, where the few exotic obsidian tools were only repaired and maintained, probably obtained the obsidian as partially finished items through exchange. This exchange would not have to be extensively formal, but could have been embedded in their seasonal movements. It is conceivable that the mobile hunter-gatherers from sites such as the Weston site and 48LN2555 encountered peoples farther east during their seasonal round and exchanged some obsidian implements.

Hunter-gatherers used obsidian from the various sources differently. Obsidian from such major sources as Bear Gulch, Obsidian Cliff, and Malad were extensively used and exchanged as far away as the Hopewell area of Ohio and Illinois and southern Texas. These obsidians typically dominate the assemblages of most sites in Wyoming. Based on the evidence from this and other studies, some obsidian including the sources near Jackson and the Green River pebbles were exploited to a more limited extent. Obsidian from these sources usually occurs only in sites near the sources. Green River pebbles are found only on sites in the vicinity of the Green River Basin probably due to the small size of the pebbles. Likewise, Teton Pass and Fish Creek Variety 2 from the Jackson area are usually recovered from sites only within 300 km of the source and mostly in small quantities. These obsidians were probably not extensively exchanged and were most likely obtained through direct procurement.

CONCLUSION

As this study shows, mobile hunter-gatherers treated various aspects of their technological organization (that researchers typically lump under the concept of curation) differently depending on the distance of the site from the raw material source. The occupants of the sites closest to the obsidian sources manufactured more finished implements from blanks previously reduced somewhere else, probably at the quarry. In contrast, hunter-gatherers at sites farther from the source transported, conserved, maintained, and repaired more completed tools that probably served as an individual's personal gear. These differences may relate to how they obtained the obsidian, direct procurement versus exchange, and may represent disparate behaviors that are separate within the cultural system. Because of the wide range of behaviors potentially covered by the concept of curation, researchers need to state clearly what aspects of curation are being discussed (Odell 1996; Nash 1996). The results of this study also indicate that the distribution and availability of raw materials play an important role in most aspects of curation, including the production and transport of tools. Though other factors such as degree of mobility, land use patterns, and settlement organization also affect how mobile hunter-gatherers used stone tools, the distribution of raw materials is one condition that needs to be considered in understanding all aspects of curation.

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