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Changing Obsidian Sources at the Lost Dune And McCoy Creek Sites, Blitzen Valley, Southeast Oregon

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Seventeen known and four unknown sources among 90 obsidian artifacts were identified from the Lost Dune and McCoy Creek sites on the east side of Blitzen Valley, Harney County, Oregon. Changing distributions and abundances of obsidian sources identified in four prehistoric periods (3,500-2,000 B.P., 2,000-500 B.P., A.D. 1400s and A.D. 1500s) suggest eastern Blitzen Valley people used a limited resource area in the middle two periods. For the period from 2,000 to 500 B.P., obsidian was identified only from sources in and adjacent to Harney Basin and in the northern Catlow Valley—the "western Malheur/Catlow" area. Then, briefly in the A.D. 1500s, pottery-using visitors brought to Lost Dune ample obsidian from sources well east of Harney Basin in the Owyhee River drainage.

Seemingly out-of-place artifact classes or materials in archaeological sites call for explanation. It is sometimes the unexpected—anomalies—that bring attention to important patterns in the past. The Lost Dune site (35HA792) lies at the northern end of Blitzen Valley, which forms a long southern alcove to Harney Basin in Harney County, southeastern Oregon (Figure 1). Lost Dune yielded more than 600 Shoshonean brown ware sherds known as Intermountain Ware (Pippin 1986). This is nearly 100 times more than from any other Oregon site (Endzweig 1989). One to a few sherds occur in five other Harney and Malheur County sites; four of the sites are over 100 km. to the east near the Owyhee River (Alice Bronsdon, personal communication 1999). The ware, however, is well known farther east in Late Prehistoric assemblages dating after A.D. 1300 in southern Idaho and Northern Nevada (Fowler 1968; Plew and Bennick 1990). Because Intermountain ware is not documented elsewhere in Harney Basin, Lost Dune might record some sort of late incursion into the basin. Sources of obsidian artifacts were used to learn if the Lost Dune occupants made use of the same imperishable resources as contemporaries in Blitzen Valley, or if the occupants were in more ways than pottery strangers to the valley where we found their sherds and tools.

The Lost Dune site is located 8 km. south of Malheur Lake and 4 km. east of the Blitzen Valley

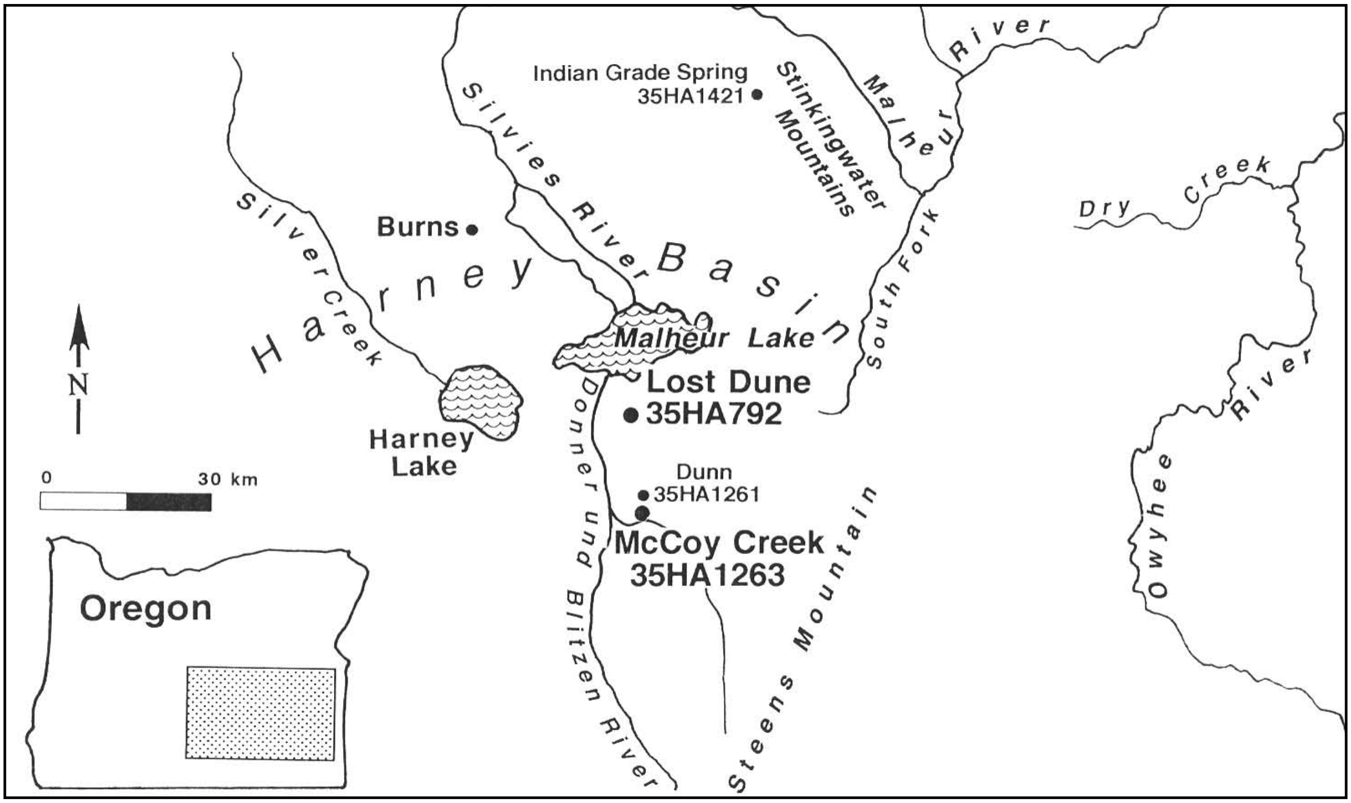

Figure 1. Study area.

marsh with its meandering Donner und Blitzen River. The McCoy Creek site (35HA1263) lies next to the marsh 19 km. south of Lost Dune and 7 km. east of the river, and has the most fully documented Late Prehistoric component (Component III) in Harney County (Musil 1995). To compare Late Prehistoric obsidian use at Lost Dune to nearly contemporaneous obsidian use in the Blitzen Valley, we analyzed 26 of the obsidian artifacts from slightly earlier Component III from McCoy Creek. To compare these to yet earlier obsidian use in the Blitzen Valley, we also analyzed 19 Archaic style projectile points we collected from the surface of Lost Dune.

We report here the geologic source identification by nondestructive X-ray fluorescence analysis (XRF) of 63 obsidian-like artifacts, including one of fine-grained andesite, from three prehistoric periods at Lost Dune, and of the 26 obsidian artifacts from McCoy Creek, along with obsidian hydration band measurement of 26 projectile points and one flake tool from Lost Dune. We also date obsidian assemblages with radiocarbon-dated cultural stratigraphy for two periods, and with combined projectile point typology and hydration band measurements for two others.

The Sites

At Lost Dune, Thomas and others (1983) found clusters of sherds scattered on the surface in a low-elevation shallow depression of sagebrush-covered sandy hummocks, along with obsidian and chert tools, broken and partly burned bone, and bovid tooth enamel. Washington State University (WSU), with support from the Burns District Bureau of Land Management (BLM), tested the site in 1994, and between 1995 and 1997, they excavated a buried cultural layer containing pottery, flaked obsidian and chert, ground stone, and bison remains (Lyons and Mehringer 1996).

In 1988, Heritage Research Associates, Inc., Eugene, Oregon, excavated the McCoy Creek and nearby Dunn (35HA1261) sites for the Malheur National Wildlife Refuge (Musil 1990, 1991). McCoy Creek is a multi-component site situated at the south edge of Diamond Swamp on the east side of Blitzen Valley. The site contains Late Archaic house pits and a near-surface Late Prehistoric component.

Stratigraphy and Chronology

At Lost Dune, each of 10 widely separated excavation blocks contained the same two sediment strata. The upper 15 to 30 cm. (Stratum 1) grades downward from loose massive aeolian sand to firm laminar loamy sand lying unconformably atop a hard blocky deflated soil formed in aeolian sand (Stratum 2). Most cultural materials and the apparent surface from which the hearths were dug were in a zone of the upper stratum 5 to 10 cm. thick, 1-15 cm. below the surface. Hearths had been dug to the abrupt contact with the hard Stratum 2 surface. Radiocarbon dates from five hearths cluster around 330 years B.P. and calibrate to tree-ring dates in the A.D. 1500s. Buried material, associated with a hearth at each of six blocks, included much broken bone, some of it charred, and tooth enamel, sherds from four brown-ware pots, Desert Side-notched projectile points, and other flaked stone tools and waste flakes of obsidian and chert.

Obsidian in the near-surface stratum included cores, utilized blades, core preparation flakes, Desert Series points and associated preforms made from blades. Forty-one preforms from buried and surface contexts represent all stages of Desert Series point production, from blank preparation by snapping blades in half to notching. The buried obsidian and most obsidian artifacts on the site surface appear to be products of a single kind of blade core reduction known in southeastern Oregon only at a handful of late prehistoric contexts near Harney and Malheur Lakes (Lyons 1998) (Elston and Dugas 1993). Small waste flakes of a dark fine-grained andesite in the buried stratum also visually match eight partly edge-worn flake tools from the surface that are struck from non-patterned cores. In addition, bifaces and bifacial reduction products of white, olive and mottled brown-to-green cherts were found both in the near-surface stratum and on the site surface.

We found only one buried component, and there were no artifacts at the contact between the soft sand and the underlying hard soil surface. Because of this and because the visual stone varieties, artifact types, and distribution of obsidian blade core products and chert bifacial reduction products on the surface appear to match those in the hearth-bearing stratum, we assume most of the artifacts on the site surface are associated with the buried artifacts deposited in the A.D. 1500s. Surface artifacts probably not associated with the A.D. 1500s component include 20 archaic-style projectile points, two much-worn obsidian flake tools made on large bifacial thinning flakes, and seven much-worn bifaces and flake tools of a sugary opaque obsidian (see below, Earlier-Style Artifacts).

At McCoy Creek, Musil (1995) distinguished three cultural components. Component III comprises the upper 20 cm. of sediment. It contains Rosegate Series, Small Stemmed Series, and Desert Series projectile points, other flaked stone, and small ground stone implements. Charcoal from the floor of a burned Component III wickiup dates to 480 ±70 B.P. (Musil 1995:97).

Earlier-Style Artifacts

Since 1980, we have collected 69 Desert Series projectile points from the surface at Lost Dune, and excavated nine. The Lost Dune surface also yielded 20 projectile points of apparently older styles, including 7 Elko Series, 1 Northern Side-notched, 1 Humboldt Series, and 11 Rosegate Series points (one Rose Spring point is chert; all other older-style points are obsidian). Rosegate Series points are generally considered younger than the other, larger types, and they are probably older than Desert Series points at Lost Dune (Elston and Katzer 1990). Although Musil (1995:170) recovered a few Rosegate Series points along with a majority of Desert Series and Small Stemmed Series points from the McCoy Creek Component III, eight of the nine projectile points from the surfaces and buried contexts of Lost Dune's excavation blocks were Desert Side-notched, and the ninth is a small unclassifiable base. We suspect that either people used Lost Dune's older style points during an Archaic-period occupation for which we found no buried evidence, or the Late Prehistoric occupants scavenged old points at other sites and re-used them along with the many Desert Series points. Buried components associated with the Archaic style projectile points could be under the hard surface of Stratum 2, below which we did not excavate.

METHODS

Sampling

Although we did not find a buried component that might be contemporaneous with the archaic style projectile points, such component(s) could lie below the hard soil surface. To decrease the probability of mixing from any previous component, we drew our sample for XRF of Lost Dune's Period IV obsidian assemblage from buried and surface-collected products of blade core reduction. We analyzed all nine blade cores and core fragments (100 per cent, two of them excavated), and randomly drew 11 of 111 used blades (10 per cent, two of them excavated), 13 of 74 Desert Series and Small Stemmed Series projectile points (18 per cent, all from the surface), and 9 of 1031 small buried waste flakes (0.9 per cent). From the surface, we also analyzed one of the 8 large used flakes of dark, fine-grained andesite (12.5 per cent), and one of the two much-worn used flakes made on obsidian bifacial thinning flakes (50 per cent). As much as possible, we matched colors and textures of the obsidian sample to proportions in the larger assemblage. In addition, the nine large projectile points and ten Rosegate Series projectile points from the site surface are 100 per cent of the available obsidian artifacts from their respective periods. From the excavated McCoy Creek Component III assemblage housed at the Oregon State Museum of Anthropology, Eugene, we selected 10 of 10,442 waste flakes (0.1 per cent), 10 of 19 Desert Series and Small Stemmed Series projectile points (53 per cent), and all 6 preforms/bifaces (100 per cent) by accession number and, where possible, from separate proveniences.

Obsidian Hydration

To test for use of scavenged projectile points at Lost Dune, we asked Tom Origer of the Anthropological Studies Center, Sonoma State University, California, to measure obsidian hydration band thicknesses of 19 older-style projectile points, five Desert Series points, one Small Stemmed point, and one unclassifiable point from Lost Dune. Origer cut each sample to include both a worn edge and central scar surfaces. In contrast to uniform band thicknesses on the Desert Series points, if older points were scavenged and re-used at Lost Dune, some might show thinner hydration bands at edges used after scavenging than on original manufacturing scars near the center of each point. Skinner also measured hydration bands on CN775, one of the two much-worn flake tools from the Lost Dune surface that are made on obsidian bifacial thinning flakes.

X-ray Fluorescence Spectroscopy

With major support from Burns District BLM, Skinner (Northwest Research Obsidian Studies Laboratory) analyzed 62 of the obsidian artifacts from Lost Dune and McCoy Creek by x-ray fluorescence spectroscopy (XRF). Using the same analytical technique, Hughes (Geochemical Research Laboratory; 1996; 1999) analyzed 27 obsidian specimens from Lost Dune's pottery component. Methods are in Skinner (1999b, 2000) and Hughes (1986).

Initially Unknown Obsidian Sources

Initial XRF analysis of 50 artifacts assigned 14 of them (28 per cent) to unknown sources.

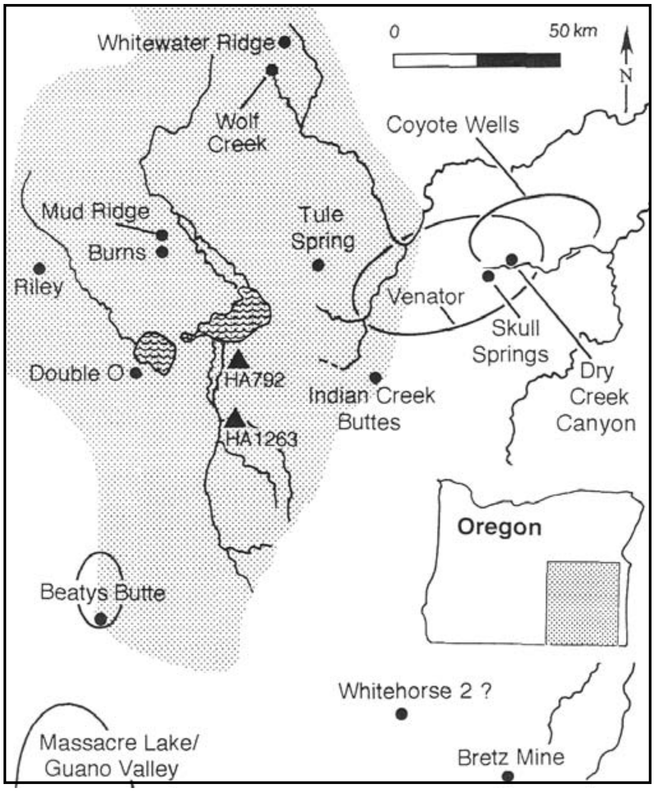

Figure 2. Obsidian sources identified from Lost Dune and McCoy Creek.

Then, in 1998, Richard Hughes (written communication) located and characterized the Coyote Wells and Indian Creek Buttes obsidian sources (Figure 2). After at least eight Lost Dune artifacts were reassigned to Coyote Wells, Skinner and Lyons visited the area near Coyote Wells in search of more sources for Blitzen Valley artifacts and to determine the geochemical variability and geographic extent of the Coyote Wells and Venator sources. We located the Coyote Wells East and Skull Springs obsidian sources, the Dry Creek Canyon andesite, and two other previously unstudied obsidian sources—Wildcat Creek and Sourdough Mountain. In the area southeast of the Indian Grade Spring site (see Figure 1), Thomas and Lyons found the two previously unknown sources accounting for 82% of tested obsidian from Indian Grade Spring (Jenkins and Connolly 1990:112-115). In 1998, a crew directed by Thomas located the Tule Spring source (formerly Unknown Group 1 at Indian Grade Spring). Then, in 1999, Lyons located obsidian matching Unknown Group 2 at Curtis Creek, 3 km. east of Indian Grade Spring. Appendix A summarizes trace element abundances and gives sampling locations of all discussed obsidian sources.

RESULTS

Hydration Bands on Older-Style Projectile Points

All obsidian projectile points with measurable hydration bands (Table 1), including those of the 19 Archaic-style projectile points, have hydration rims with narrow band measurement ranges. Although we placed hydration sample cuts where steep scarring and wear were evident, the hydration bands failed to distinguish more than one period of use or modification on any point. The 26 points are from eight sources, and rates of hydration are known to vary among sources; still, the sorted hydration bands fall into groups whose rank order is consistent with regional type chronologies (Elston & Katzer 1990). Desert Series points and the Small Stemmed Series point (Musil 1995:120-123) have the thinnest bands (1.0 - 1.7 microns), those on Rosegate Series points are thicker (2.4 - 3.5), and those on Elko, Humboldt and Northern Side-notched points are thickest (3.8 - 5.7). Thus, the older-style points from the surface at Lost Dune were not reused by those who came with pottery, but were left by earlier people.

This result, obtained after we completed excavation, increases the possibility that one or more archaic components lie buried under the hard soil surface. Any upward mixing of artifacts from such components with our Period IV sample would decrease the differences between the Period IV sample and other period samples, especially Periods I and II. Thus, actual differences between Period IV and the other periods might be equal to or greater than what we observed in the samples (Matthew Root, personal communication).

The band on a large dorsal scar of the one utilized flake was 5.7 - 5.7 microns, while that on a short scar caused by use was 3.6 - 3.7. This suggests the flake was already centuries

Table 1
OBSIDIAN HYDRATION BAND MEASUREMENTS FROM NINETEEN CLASSIFIED PROJECTILE POINTS (ORIGER 1999) AND ONE FLAKE (SKINNER 2000) FROM LOST DUNE

Specimen	Projectile Point or Other Artifact Type	Mean Band Thickness	Range
CN971	Desert Side-notched	1.0	0.2
CN909	Desert Side-notched	1.1	0.1
CN917	Small Stemmed Series	1.1	0.2
CN923	Cottonwood	1.2	0.1
CN903	Cottonwood	1.4	0.1
CN912	Desert Side-notched	1.7	0.1
P13	unclassifiable point	1.8	0
CN1065	Rosegate Series	2.4	0.2
CN897	Rosegate Series	2.5	0.3
P44	Rosegate Series	2.5	0.1
P40	Rosegate Series	3.4	0.1
CN918	Rosegate Series	3.5	0.2
CN775	large much-utilized flake	3.7 and 5.6	0.1 and 0
P2	Elko Series	3.8	0.4
CN1008	Elko Series	3.8	0
P4	Elko Series	4.9	0.1
CN958	Elko Series	5.4	0.1
A39	Elko Series	5.7	0.4
CN983	Northern Side- notched	5.7	0.2
P36	Rosegate Series	no visible band	
P46	Rosegate Series	no visible band	
P47	Rosegate Series	no visible band	
CN666	Rosegate Series	no visible band	
CN919	Rosegate Series	no visible band	
P41	Humboldt Series	no visible band	
P50	Elko Series	no visible band	
CN906	Elko Series	no visible band	

to millennia old when someone scavenged and reused it at about the time Rosegate Series points were replacing the Elko Series. All eight projectile points with no measurable hydration bands are made of sugary opaque volcanic stone: five of them are the opaque variant of Venator obsidian, one is an opaque variant of Beatys Butte obsidian, and two are the same opaque unknown (Appendix B).

Source Assignments by Prehistoric Periods

We eventually matched all but five of the 89 analyzed obsidian and andesite artifacts from Lost Dune and McCoy Creek (Appendix B) to geochemical sources (Appendix A). Eighty-seven of the analyzed artifacts, plus one visually identified Elko point, represent four periods (Table 2); two artifacts could not be assigned to a period.

The nine Elko Series, Northern Side-notched and Humboldt Series projectile points from the surface at Lost Dune represent period I. These point styles date in southeastern Oregon from just before the fall of Mt Mazama ash (Wilde 1985:263) at 6,850 B.P. (Bacon 1983), and in some stratigraphically controlled Catlow Valley contexts (Mehringer and Wigand 1986), their latter use overlaps with the early appearance of bow technology in the form of Rosegate Series points (Pete Mehringer, personal communication 2000). They are not known, however, from excavated

Table 2
OBSIDIAN ARTIFACT SAMPLES BY FOUR PERIODS.

Period (Age B.P.)	Site	Context	Artifact Classes	Sample Size Known Source	Sample Size Unknown Source
IV (330)	Lost Dune	Pottery Component: and surface	Desert Side-notched points, cores, blade tools, waste flakes	41	2
III (500)	McCoy Creek	Component III:excvation	Desert series points bifaces, waste flakes	25	1
II (2,000 to 500)	Lost Dune	Surface	Rosegate Series points Elko and Humbolt	9	1
I (3,500 to 2,000)	Lost Dune	Surface	Series points, Northern Side-notched points	8	1
Total				83	5

deposits in the Blitzen Valley before 3,255 B.P. (Dunn site; Musil 1995). The 10 Rosegate Series points from Lost Dune represent Period II, beginning about 2,000 B.P. In a midden at Skull Creek Dunes, 60 km. to the south, two radiocarbon dates above and two below a contact separating Elko Series points from stratigraphically higher Rosegate points bracket 2,000 B.P. (Wegener 1998:17). At McCoy Creek, the lone 480±70 B.P. date (cal. A.D. 1400s) on charcoal from the wickiup floor dates Component III. Six radiocarbon dates from Lost Dune's pottery component overlap at one standard deviation and average 330± 25 B.P. (cal. AD 1500s).

Flake tool CN775 could not be assigned to a period. The 3.6 to 3.7 micron hydration band indicating its more recent use lies between the 3.5 band on Rosegate Series point CN918 and the 3.7 band on Elko Point P2. Without a calibrated hydration rate for the flake's Massacre Lake/Guano Valley obsidian, we can only suggest its reuse was in the Middle to Late Archaic Period.

Period IV Sources by Artifact Class

Obsidian artifacts from Period IV at Lost Dune do not significantly vary as to source or major source area among the products of blade core reduction represented by blade cores, used blades, Desert Series projectile points, and small waste flakes (Table 3). It appears late-period occupants reduced obsidian blade cores and used and discarded their end products with no preference as to source (Andrefsky 1994).

Obsidian Use in Four Periods

Sample Size. Our four period samples of 9, 10, 26, and 43 pieces are relatively small. Some obsidian source studies of the region (e.g., Hughes 1986; Skinner and Davis 1998) involve samples approaching 100 artifacts per component or site, although smaller samples might return significant results at the .05 level in some cases. Assignment of artifacts to chemical source groups constitutes nominal class data, commonly evaluated by the Chi-square statistic (Connolly and Jenkins 1997:245). The source locations, however, are interval- to ratio-scale data, whether expressed as x-y-z coordinates or converted to other values, such as Euclidean distances from the sources to the recovery site or compass directions from the

Table 3
PERIOD IV OBSIDIAN ARTIFACT SOURCES BY SOURCE AREA AND ARTIFACT CLASS

	Class					
Source Area and Source	**Blade Core**	**Used Blade**	**Projectile Point**	**Small Waste Point**	**Large Used Flake**	**Total**
Dry Creek area:						
Coyote Wells	2	2	4	6	0	14
Coyote Wells East	0	3	0	0	0	3
Venator	3	1	2	0	0	6
Skull Springs	1	2	2	0	0	5
Dry Creek Canyon	0	0	0	0	1	1
Dry Creek Total	6	8	8	6	1	29
Other areas:						
Massacre Lake/ Guano Valley	1	2	1	0	0	4
Whitewater Ridge	1	1	0	2	0	4
Tule Spring	1	0	1	0	0	2
Beatys Butte	0	0	1	0	0	1
Bretz Mine	0	0	1	0	0	1
Unknown	0	0	1	1	0	2
Other areas Total	3	3	5	3	0	14
Total	9	11	13	9	1	43

site. Locations can also be reduced to lower measurement level categories, such as spatial clusters, compass quadrants (Connolly and Jenkins 1997), or ordinal range classes (near and far, local and exotic, etc., (Hanes 1988:148-151). Tests of significance account for level of measurement and strength of association in addition to sample size. Thus, well chosen tests may show significance if our small samples reflect strong population differences.

Source Use by Geographic Area: the Western Malheur/Catlow Area. The Period I people at Lost Dune obtained their nine identified projectile points from widely separated sources generally along both sides of a north-south chain of mountains the Stinkingwater, Steens, and Pueblo mountains: (Table 4; see Figure 1; Figure 3a). Obsidian sources used in the two subsequent periods Period II at Lost Dune (Figure 3b) and Period III at McCoy Creek (Figure 3c) are from a single general area, and many of the sources are represented in both periods. This area (see Figure 2) is defined by obsidian use spanning ca. 1,500 years. It encompasses centrally draining Harney Basin with Harney and Malheur Lakes fed by three main tributaries (the Donner und Blitzen and Silvies Rivers and Silver Creek), current drainages of the South Fork and main branch of the Malheur River immediately east and northeast of Harney Basin, and also northern Catlow Valley to the south. Harney and Malheur Lakes overflowed down the South Fork to the Malheur River and eventually to the Pacific Ocean during the Late Pleistocene and possibly during Holocene high water events (Elston and Dugas 1992). Thus, the whole area described encompasses the western Malheur River drainage, plus the northern Catlow Valley. We speak of it as the Western Malheur/Catlow area (see Figure 2). Obsidian sources we discuss within the area include Whitewater Ridge, Wolf Creek, Tule Spring, Indian Creek Buttes, Mud Ridge, Burns, Riley, Double O, and Beatys Butte. Table 5 compares the number of obsidian

Table 4
ARTIFACTS ASSIGNED TO SOURCES[a] BY PERIOD

Chemical Type	Period I (3,500 - 2,000B.P.)		Period II (2,000 - 500 B.P.)		Period III (cal A.D. 1400s)		Period IV (cal A.D. 1500s)	
	n=	Period %	n=	Period %	n=	Period %	n=	Period %
Coyote Wells/CW East	0	0%	0	0%	0	0%	17	40%
Skull Springs	1[a]	11	0	0	0	0	5	12
Dry Creek Canyon	0	0	0	0	0	0	1	2
Venator	1	11	4	40	6	23	6	14
Whitewater Ridge & Wolf Creek	0	0	0	0	1	4	4	9
Massacre Lake/ Guano Valley	0	11	0	0	0	0	4	9
Burns and Mud Ridge	0	0	0	0	2	8	0	0
Tule Spring	1	11	1	10	0	0	2	5
Indian Creek Buttes	3	33	1	10	11	42	0	0
Beatys Butte	1	11	1	10	4	15	1	2
Double O	0	0	1	10	1	4	0	0
Riley	0	0	1	10	0	0	0	0
Bretz Mine	0	0	0	0	0	0	1	2
Whitehorse 2	1	11	0	0	0	0	0	0
Unknown	1	11	1	10	1	4	2	5
Total	9	99	10	100	26	100	43	100

Period (and dates B.P.)

[a] Elko point P4 visually matches five distinctive artifacts identified as Skull Springs by XRF; all other sources determined by XRF (from Appendix A).

artifacts from within and from outside the Western Malheur/Catlow area in each of the four periods. The Venator Source lies both within and east of this area, so we exclude Venator from the following comparison of sources within and outside the area.

The samples from periods II and III match only Western Malheur/Catlow area sources, while the Period IV sample from Lost Dune contains only 20 per cent of obsidian (7 of 35) from this area. Sixty-four percent (23 of 36) of Period IV obsidian is from a cluster of sites east of the western Malheur/Catlow area near Dry Creek (see Table 3 and Figure 2). By area, Period IV

Table 5
OBSIDIAN ARTIFACTS IDENTIFIED TO KNOWN SOURCES[b] BY AREA AND PERIOD (TABLE 2; FIGURE 2)

Period	Identified Artifacts from Geographic Areas		
	Within Western Malheur Catlow Area	Outside Western Malheur Catlow Area	Total For Period
Period IV	7	28	35
Period III	19	0	19
Period II	5	0	5
Period I	5	2	7
Area Totals	36	30	66

[b]Venator chemical type is excluded.

sources (Fig. 3d) contrast significantly with those for the previous Period III (*Pearson Chisquare* = 31.569, *df* = 1, *prob.* <.000), and with those for all three earlier periods combined (*Chisquare* = 35.867, *df* = 1, *prob.* < .000). The periods I and II samples are so small, tables including both of them separately have too many sparse cells to use probabilities based on the chisquare statistic. Still, with two of seven identified pieces from outside the western Malheur/Catlow area, Period I contrasts significantly with the following two periods combined (*Chisquare* = 7.3300, *Fisher's exact test* = 0.045) for which there are no outside area pieces. With a combined Period II and Period III sample of 24, this is just below the .05 significance limit. If a larger Period II sample were also from only the local area (which we can't predict), 24 pieces would be required to say Period II by itself is significantly different from the earlier period in obsidian source areas. With the present sample, we don't know if exclusive use of Western Malheur/Catlow area sources began with Period II at 2000 BP. Large stratigraphically controlled and well-dated samples could be examined from existing curated assemblages: for Period I, component II at the Dunn site (see Figure 1) contains a house pit feature dated to 3255±65 B.P.; and for Period II, Component II at McCoy Creek contains house pit features and has an initial date of 1900±100 B.P. (Musil 1995).

Distances from Sources. When the obsidian source locations are converted to distances from sources to the sites, they reveal additional patterns of source use among the four periods. A measure of distance must account for the fact that some of the region's obsidian sources are geographically widespread, such as Venator, Coyote Wells, Beatys Butte and Massacre Lake/Guano Valley (see Figure 2). The secondary distributions of Whitewater Ridge and Wolf Mountain obsidians, and of Beatys Butte obsidian (Pete Mehringer, personal communication 1998), are also considerable and are currently under study. Prehistoric people could have obtained such a dispersed obsidian at its nearest possible source location (Hughes 1998; Shackley 1998). Thus, we conservatively measure each distance from our closest sampling location (Appendix B, Figure B-1).

We initially compared mean source-to-site distances among the four periods (Table 6). Table 7 is a matrix of t-test probabilities for the distance means in all pairs of periods and for those in Period I vs. Periods II and III combined. Distances in the Period I sample are not significantly more than the shorter distances in either the following period or the following two periods combined.

In the Period IV pottery component, however, distances from sources to site abruptly increased 35 per cent (60 to 92 km.). Probabilities .014, .000 and .000 show significant difference between the Period IV distances and those in

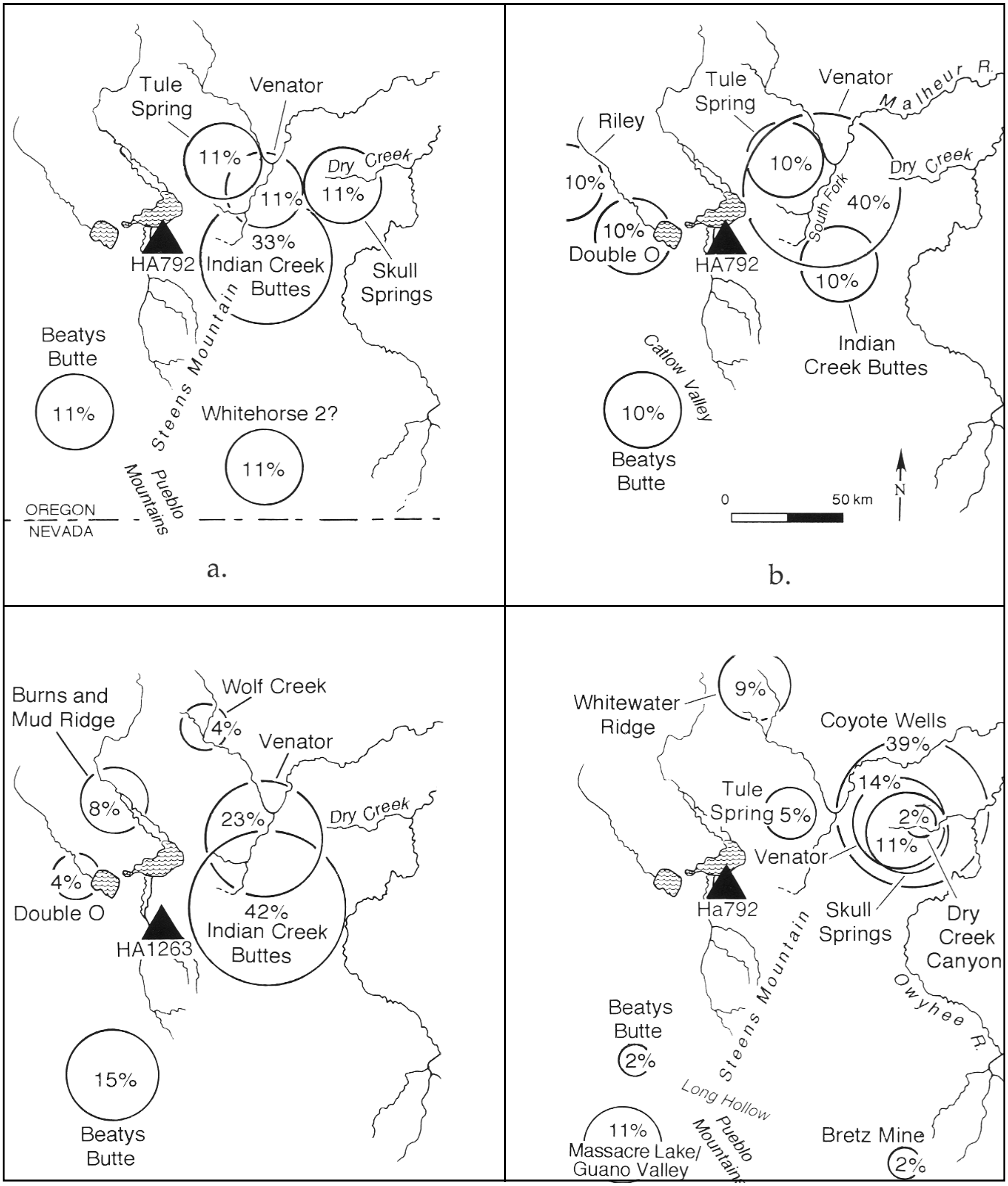

Figure 3. Proportions of obsidian sources used at Lost Dune and the McCoy Creek site in four periods (Table 2): a. Period I at Lost Dune, 3,500 to 2,000 B.P.; b. Period II at Lost Dune, 2,000 to 500 B.P.; c. Period III at McCoy Creek (cal. A.D. 1400s); d. Period IV at Lost Dune (cal. A.D. 1500s). Areas enclosed by circles show relative proportions.

Table 6

MEAN AND SKEWNESS OF DISTANCES FROM SOURCES TO SITE BY FOUR PERIODS.

Period	Identified Sample	Mean Distance to Site	Skewness
IV:330 BP	41	92 ± 27 km	0.181
III: 500	25	60 ± 16	1.043
II: 2000 to 500	8	55 ± 17	1.855
I: c. 3500 to 2000	9	67 ± 25	0.598

Table 7

MATRIX OF T-TEST PROBABILITIES FOR PAIRS OF SOURCE-TO-SITE DISTANCE MEANS IN FOUR PERIODS, TWO-TAILED.

	Period I	Period II	Period III
Period IV	.014	<.000	<.000
Period III	.318	.410	
Period II	.217		
Periods II and III	.214		

every other period. The difference is even more apparent in the shape of the dispersion of distances: histograms of source-to-site distance frequencies in the combined first three periods and in the fourth period (Figure 4a, b) differ markedly. That for combined periods I, II and III is one-tailed (skewness =1.220), showing commonly observed distance decay: source use decreases with increasing source-to-site distance (Renfrew 1977). This is consistent with biological and social models of activity and movements centered on some kind of central location (Haynes 1974:101). For each of periods I, II and III, the central location may have been the site or a location near it. The shortest distance is 44 km. because there are no useful obsidian sources any closer to the sites. The mode of 47 is the most meaningful measure of central tendency. Decay in distances from the spatially discontinuous sources is still apparent in periods II and III combined when the Period I sample is removed (Figure 4c, d).

Distance frequencies for Period IV, on the other hand, approach a normal distribution with low skewness centered around a mode of 96 km. from Lost Dune. This is twice the mode for periods I-III. The roughly normal distribution suggests at least that the obsidian brought to Lost Dune by the pottery-using bison butcher was obtained during movements and activities not centered near the point of recovery. The predominant source locale was western Dry Creek. Sixty-four percent of non-Venator Period IV artifacts (23 of 36) are from three Dry Creek sources, but only one artifact of 31 from the Period I, II, and III sample (3 per cent) is from Dry Creek (Elko point P4).

DISCUSSION

The Lost Dune Visitors

We sought to know how obsidian sources used by the late-period bison butchers at Lost Dune compared with that of their near contemporaries in the Blitzen Valley. The unique sources of their obsidian and the distances over which they brought it suggest the Lost Dune pottery people

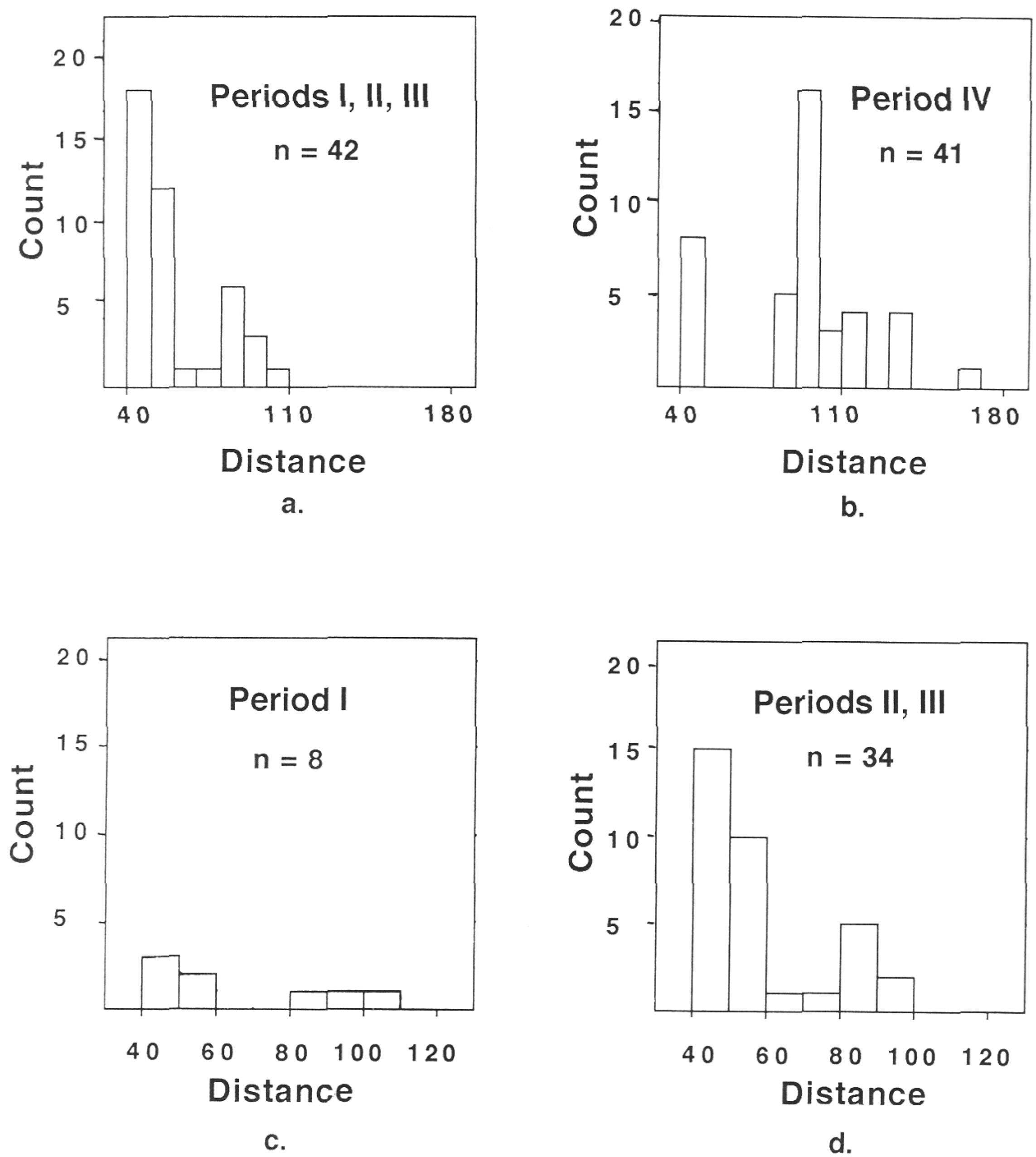

Figure 4. Histograms of artifact source-to-site distance frequencies: a. Periods I, II and III combined; b. Period IV; c. Period I; d. Periods II and III combined.

were visitors to the Blitzen Valley. The rarity of Dry Creek-area sources in prior Blitzen Valley contexts, including earlier human presence at Lost Dune, suggests Dry Creek was formerly beyond the area used by people frequenting the east side of the valley. By contrast, the Lost Dune bison butchers carried obsidian acquired near an Owyhee River tributary, well outside the Western Malheur/Catlow area. If the Lost Dune Period IV folks were actually Blitzen Valley regulars, why would they possess so much Dry Creek obsidian when good sources known to them lay between Lost Dune and Dry Creek (i.e., Venator, Tule Spring and Indian Creek Buttes)? Perhaps Dry Creek was their base camp area, or an upland part of their usual foraging range. They even could have come by Dry Creek en route from yet more distant locales, particularly if these places had little good obsidian.

We allow that part of the difference between the Period IV and the other period assemblages could be due to the sorting of events: Period IV probably contains obsidian used on a single trip or a series of related trips, while obsidian from the previous periods may represent all movement and exchange by which obsidian was brought to the sites over centuries. Still, among artifacts representing all movement and exchange, a few long distance trips or contacts might be in evidence, but Lost Dune's nine Period II Rosegate Series points and the 26 Period III artifacts from McCoy Creek fail to betray any contact outside the western Malheur/Catlow area.

Western Malheur/Catlow Area Limited Travel

In establishing a chronologically controlled base line of obsidian-source use in the Blitzen Valley, we found evidence suggesting a limited obsidian resource area beginning by about 2,000 B.P. Human use of obsidian from within the western Malheur/Catlow area in the period 2,000-to-500 B.P. is also documented at the Indian Grade Spring site, in the northeast corner of the area (see Figure 1). Radiocarbon dates for occupation there extend from 2,000±90 to 530±60 (Jenkins and Connolly 1990:53), essentially the same period. Jenkins and Connolly (1990:112) note that the obsidian sources identified at Indian Grade Spring "suggest that prehistoric human populations who used the Indian Grade Spring site ranged throughout an area comparable to that documented in the ethnographic record for the Harney Valley Paiute." The ethnographic area they speak of is essentially the western Malheur/Catlow area, with the addition of Alvord Valley (cf. Whiting 1950:18 with Figure 2).

In/out area comparisons of obsidian use in periods II and III of this study suggest people at those times confined most of their movements or obsidian trade contacts to the western Malheur/Catlow area. In addition, the decay of artifact frequencies by source-to-site distance suggests people accessed distant parts of the area less frequently than central ones. Weide (1968, 1974) used related distance decay of basalt to propose a former band territory in Warner Valley, immediately southwest of the western Malheur/Catlow area. Among hand samples in undated assemblages, she identified an aphanitic basalt from Rabbit Basin on the west side of Warner Valley. She used the basalt's fall-off below 30 per cent among all basalt in separate sites to trace the border of the North Warner Subsistence Network, her prehistoric band territory. Like Renfrew (1977), Weide showed distance decay using *percentages* of a given source within many sites. In particular, she monitored the critical fall-off proportion to trace the territory boundary. Somewhat differently, we use *distances* from all sources to specific sites in two ways: (1) average distances compare ranges of resource use among periods; and (2) distance frequency distributions suggest a component's spatial relationship to former resource areas.

The possible limitation of most resource use in some former periods within each of two northern Great Basin geographic areas does not necessarily translate to band territories with culturally maintained boundaries. Rather, the distance decay we found *within* the western Malheur/Catlow area suggests distance partly controlled centrifugal movement: people using a particular low-lying wetland commonly foraged only so far as the surrounding upland areas having the resources they needed. In turn, the periodically stable distribution of upland resource areas that cluster around major wetlands may have determined archaeologically recognizable use areas in some periods.

Both environmental and social developments could change these areas over time. Thus, we sought to understand obsidian use at Lost Dune in both its geographical and chronological settings. Following some 1500 years of obsidian use largely contained within the western Malheur/Catlow area, pottery-users came to Lost Dune in the sixteenth century A.D. with ample obsidian from the Owyhee River drainage far to the east. Their appearance at Lost Dune suggests there may have been winds of change in southeastern Oregon and northern Great Basin land use just prior to the impact of Europeans on the North American continent.

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APPENDIX A: SOUTHEAST OREGON OBSIDIAN SOURCES

In this appendix, we present geographic and geochemical summary data for selected obsidian sources located in the general region of the Lost Dune and McCoy Creek sites. With the exception of the Burns, Massacre Lake/Guano Valley, and Riley sources (Hughes 1985, 1986; Skinner 1983), the geochemistry of the sources reported here has not been previously presented in the literature. Several of the source locales were found using the brief descriptions provided by Sappington (1981a, 1981b).

The diagnostic trace elements that are reported here are those that are most often used to characterize obsidian sources in this region. Reported trace element values for artifacts commonly show more compositional variability than source specimens because of less than optimal target geometry, the presence of surface residues, small physical size, and the larger numbers and more randomly collected population of analyzed artifacts relative to source reference samples.

Please note that geochemical and geoarchaeological studies of most of these sources are actively underway and that future interpretations of the analytical data may vary slightly from those presented here. Further information concerning obsidian source research at Oregon obsidian sources may be found at www.obsidianlab.com.

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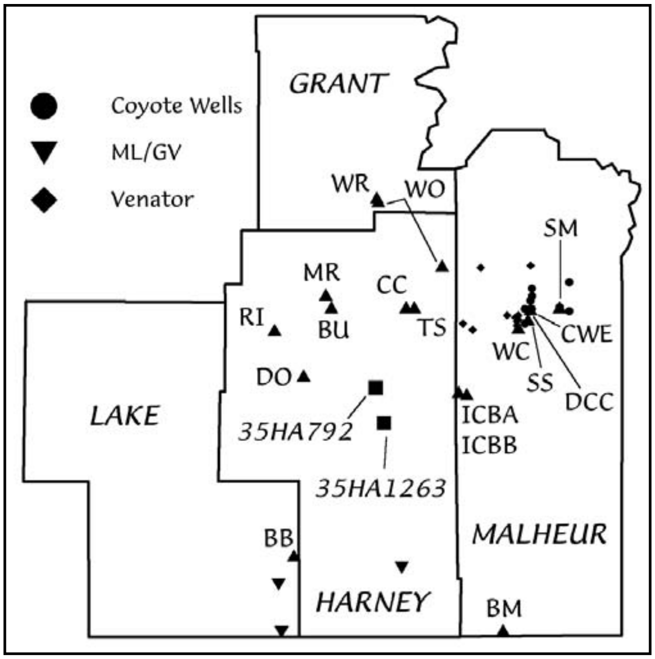

Figure B-1. *Generalized locations of selected obsidian sources in Grant, Lake, Harney, and Malheur counties, southeast Oregon. Abbreviations are the same as those used in Table B-1. Several of these sources (i.e., Coyote Wells, Massacre Lake/ Guano Valley, and Venator) are associated with geographically widespread and incompletely mapped ash-flow deposits. The Whitehorse 2 source is currently known only from analyzed cortex flakes and is not shown on the map.*

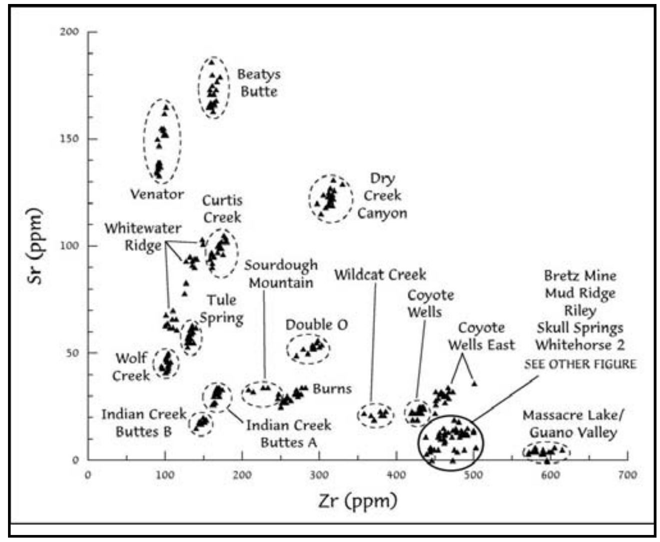

Figure B-2. *Scatterplot of strontium (Sr) plotted versus zirconium (Zr) for all sources summarized in Table B-1. A maximum of 20 randomly selected samples from each source is shown. Individual sources that are not clearly distinguishable are in this scatterplot are easily separable when additional trace elements or peak ratios are considered (see Figure B-3).*

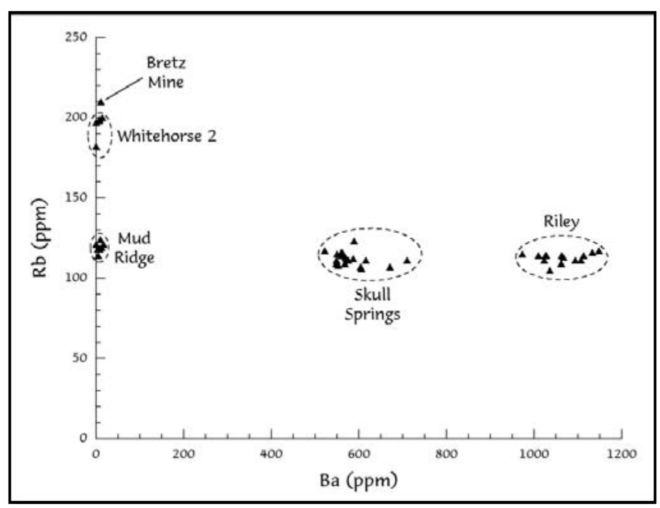

Figure B-3. *Scatterplot of barium (Ba) plotted versus rubidium (Rb) for sources not easily distinguishable in Figure B-2.*

Table A- 1
SUMMARY OF RESULTS OF NONDESTRUCTIVE X- RAY FLUORESCENCE ANALYSIS OF GEOLOGIC SOURCE SAMPLES OF OBSIDIAN IDENTIFIED AT THE LOST DUNE AND MCCOY CREEK SITES

		Peak Ratios		Trace Element Concentrations (parts per million) [a]						
Geochemical Source	**N=**	**Fe: Mn**	**Fe: Ti**	**Zn**	**Rb**	**Sr**	**Y**	**Zr**	**Nb**	**Ba**
Beatys Butte (BB)	64	33.5 ± 5.4	38.7 ± 4.6	35 ± 5	129 ± 5	175 ±14	15 ± 1	161 ± 4	11 ± 1	965 ± 54
Bretz Mine (BM)	1	67.0 ± 0	73.7 ± 0	199 ± 0	210 ± 0	6 ± 0	90 ± 0	503 ± 0	11 ± 0	11 ± 0
Burns (BU)	75	49.9 ± 3.2	44.4 ± 1.4	49 ± 7	125 ± 5	29 ± 2	44 ± 2	259 ± 9	30 ± 2	563 ± 49
Coyote Wells	34	36.5 ± 1.1	47.8 ± 2.0	86 ± 7	115 ± 4	23 ± 4	62 ± 2	431 ± 7	31 ± 2	831 ± 25
Coyote Wells East (CWE)	21	32.6 ± 0.8	52.4 ± 2.7	115 ± 8	108 ± 4	30 ± 2	69 ± 2	461 ± 11	32 ± 2	1156 ± 55
Curtis Creek (CC)	17	46.9 ± 1.4	42.5 ± 1.8	39 ± 6	118 ± 4	98 ± 4	30 ± 1	169 ± 7	11 ± 2	1426 ± 49
Double O (DO)	13	68.6 ± 3.5	36.5 ± 1.5	39 ± 3	166 ± 8	53 ± 2	37 ± 3	291 ± 8	18 ± 2	849 ± 60
Dry Creek Canyon (DCC)	21	59.7 ± 2.03	0.2 ± 0.9	42 ± 5	143 ± 5	123 ± 4	30 ± 2	313 ± 7	18 ± 2	963 ± 37
Indian Creek Buttes A (ICBA)	41	48.2 ± 1.9	84.0 ± 4.2	57 ± 6	180 ± 4	31 ± 3	54 ± 2	166 ± 3	31 ± 2	75 ± 15
Indian Creek Buttes B (ICBB)	9	44.5 ± 1.7	99.5 ± 7.0	58 ± 6	188 ± 5	18 ± 2	57 ± 3	147 ± 4	34 ± 2	171 ± 20
Massacre L./ Guano Valley (ML/ GV	116	22.6 ± 1.1	42.3 ± 1.2	141 ± 11	228 ± 9	4 ± 1	91 ± 3	590 ± 16	33 ± 2	7 ± 7
Mud Ridge (MR)	7	70.9 ± 2.1	96.4 ± 1.7	95 ± 7	119 ± 3	4 ± 2	76 ± 2	445 ± 4	48 ± 1	8 ± 5
Riley (RI)	14	32.7 ± 0.9	59.5 ± 2.2	89 ± 8	113 ± 3	11 ± 1	60 ± 2	459 ± 7	25 ± 2	1063 ±49
Skull Springs (SS)	17	31.0 ± 0.9	65.5 ± 2.9	139 ± 8	113 ± 4	14 ± 2	74 ± 2	484 ± 10	33 ± 2	582 ± 40
Sourdough Mountain (SM)	6	51.7 ± 5.4	40.3 ± 1.6	38 ± 6	135 ± 3	32 ± 2	38 ± 1	236 ± 24	22 ± 2	467 ± 39
Tule Spring (TS)	43	41.0 ± 1.3	49.6 ± 3.3	35 ± 5	130 ± 4	58 ± 2	32 ± 2	132 ± 4	12 ± 2	1110 ± 62
Venator (VE)	85	16.5 ± 2.4	89.1 ± 16.0	50 ± 6	105 ± 4	142 ± 12	28 ± 2	94 ± 4	13 ± 2	886 ± 55
Whitehorse 2	5	50.6 ± 0.9	98.6 ± 6.7	95 ± 9	195 ± 7	4 ± 2	67 ± 2	473 ± 13	33 ± 1	6 ± 5
Whitewater Ridge (WR)	409	42.4 ± 14.5	47.4 ± 8.0	36 ± 6	119 ± 6	79 ± 14	26 ± 3	122 ± 13	11 ± 3	1451 ± 116
Wildcat Creek (WC)	8	35.7 ± 0.8	46.3 ± 2.7	84 ± 8	119 ± 3	22 ± 1	63 ± 3	376 ± 9	32 ± 2	715 ± 25
Wolf Creek (WO)	165	35.4 ± 1.9	59.1 ± 4.2	33 ± 5	131 ± 5	45 ± 2	27 ± 1	103 ± 3	10 ± 2	1027 ± 47

[a] Standard deviation is computed only from calculated trace element values and does not include analytical uncertainties.

APPENDIX B

Table A-1
TRACE ELEMENT CONCENTRATIONS AND SOURCE DESIGNATIONS FOR OBSIDIAN ARTIFACTS FROM LOST DUNE (35HA795) AND MCCOY CREEK (35HA1263) COMPONENT III, DETERMINED BY X-RAY FLUORESCENCE ANALYSIS.

Site and Catalog No.		Horiz. Proven-ience	Vert. Proven-ience	Proven-ience	Class	Chemical Type	Period	source to site km	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	Fe %	Fe/ Mn	Fe/Ti	Refer-ence
LD: P9	?	surface	DSN point	Coyote Wells	IV	96	91	25	110	22 3	58 2	414 4	28 2	890 14	1454 26	586 13	2.22 .09	37	nm			Hughes 1996, 1999
LD: P14		surface	DSN point	Unknown	IV		56 4	15 3	105 3	162 3	28 2	96 3	10 2	1034 14	998 21	674 13	1.69 0.12	25	n m			Hughes 1996
LD: P15		surface	DSN point	Venator	IV	47	50 4	14 3	101 3	129 3	29 2	82 3	13 2	883 14	576 15	676 13	1.24 .12	18	n m			Hughes 1996
LD: P16		surface	DSN point	Venator	IV	47	55 4	18 3	103 3	150 3	26 2	94 3	12 2	956 14	513 18	657 13	1.35 .12	20	n m			Hughes 1996
LD: P18		surface	DSN point	Skull Springs	IV	88	138 5	18 3	111 3	12 3	75 2	494 4	32 2	620 13	1429 17	987 13	3.09 .12	32	n m			Hughes 1996
LD: P21		surface	DSN point	Coyote Wells	IV	96	87 4	19 3	108 3	19 3	57 2	406 4	30 2	865 13	nm	602 13	2.35 0.09	37	n m			Hughes 1996, 1999
LD: P29		surface	DSN point	Skull Springs	IV	88	137 5	22 3	108 3	12 3	76 2	485 4	33 2	585 13	1429 18	1000 13	3.11 .12	32	n m			Hughes 1996
LD: P30		surface	DSN point	Massacre Lake/Guano Valley	IV	130	152 5	22 3	222 4	3 3	95 2	598 5	31 2	0 12	n m	n m	n m	25	n m			Hughes 1996
LD: P43		surface	DSN point	Coyote Wells	IV	96	84 4	21 3	104 3	17 3	58 2	404 4	26 2	839 13	1292 24	550 12	2.11 0.09	37	n m			Hughes 1996, 1999
LD: P54		surface	DSN point	Beatys Butte	IV	96	47 4	12 3	127 3	165 3	15 2	163 4	10 2	1041 14	n m	n m	n m	n m	n m			Hughes 1996
LD: P56		surface	DSN point	Coyote Wells	IV	96	92 4	16 3	113 3	21 3	63 2	432 4	31 2	852 13	1289 24	578 12	2.12 0.09	37	n m			Hughes 1996, 1999
LD: CN908		surface	DSN point	Bretz Mine	IV	162	174 8	46 3	214 4	6 7	93 3	506 7	29 2	19 15	992 96	306 47	2.18 0.11	71.5	69.5			Skinner 1999b
LD: CN917		surface	small stemmed point	Tule Spring	IV	48	34 7	22 3	143 3	57 7	29 3	136 7	11 2	1083 16	473 96	189 47	0.67 0.11	43.4	48.1			Skinner 1999b

Site and Catalog No.		Horiz. Proven-ience	Vert. Proven-ience	Proven-ience	Class	Chemical Type	Period	source to site km	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	Fe %	Fe/ Mn	Fe/Ti	Refer-ence
LD: CN83	Block E	level 3	small flake	Coyote Wells	IV	96	85 4	21 3	109 3	21 3	58 2	410 4	30 2	892 14	1264 29	546 13	2.11 0.09	38	n m			Hughes 1996, 1999
LD: CN170-2	Block A	level 1	small flake	Coyote Wells	IV	96	100 4	19 3	124 3	23 3	64 2	453 4	30 2	913 14	1326 27	565 13	2.18 0.09	n m	n m			Hughes 1996, 1999
LD: CN188	Block A	level 4	small flake	Unknown	IV		48 4	13 3	82 3	13 3	58 2	270 4	30 2	116 13	1067 16	214 13	1.59 .12	n m	n m			Hughes 1996
LD: CN239	Block A	level 2	small flake	Coyote Wells	IV	96	96 4	17 3	116 3	20 3	67 2	443 4	32 2	915 14	1413 27	595 13	2.18 0.09	n m	n m			Hughes 1996, 1999
LD: CN248	Block A	surface scrape	small flake	Coyote Wells	IV	96	99 5	16 3	118 3	21 3	65 2	444 4	34 2	865 14	1547 27	601 13	2.40 0.09	n m	n m			Hughes 1996, 1999
LD: CN284	Block A	level 1	small flake	Whitewater Ridge	IV	110	45 4	16 3	119 3	88 3	25 2	126 3	7 2	1511 14	n m	n m	n m	n m	n m			Hughes 1996
LD: CN401	Block C	level 1	small flake	Coyote Wells	IV	96	107 5	27 4	118 3	20 3	62 2	431 5	28 2	848 16	n m	n m	n m	n m	n m			Hughes 1996
LD: CN509	Block F	level 4	small flake	Coyote Wells	IV	96	109 5	23 4	126 3	23 3	66 2	441 5	29 2	852 16	n m	n m	n m	n m	n m			Hughes 1996
LD: CN678	Block Z	surface scrape	small flake	Whitewater Ridge	IV	110	48 4	16 3	128 3	83 3	26 2	130 3	9 2	1423 13	728 16	300 12	1.12 .12	n m	n m			Hughes 1996
LD: CN784		surface	blade	Coyote Wells East	IV	100	96 6	15 3	96 4	27 3	59 3	424 4	28 3	1065 14	1556 28	743 13	2.61 0.09	n m	n m			Hughes 1999
LD: CN834.01		surface	blade	Coyote Wells East	IV	100	116 5	23 3	109 3	28 3	61 2	425 4	24 2	1247 16	n m	783 13	2.71 0.09	n m	n m			Hughes 1997, 1999
LD: CN974	Block C	surface	blade	Coyote Wells East	IV	100	127 4	22 3	107 3	29 3	63 2	454 4	27 3	1244 15	1464 29	729 13	2.59 0.09	n m	n m			Hughes 1997, 1999
LD: CN831.1		surface	blade	Whitewater Ridge	IV	110	40 4	14 3	113 3	83 3	23 2	125 3	7 2	1492 15	863 20	301 8	1.23 .08	n m	n m			Hughes 1997
LD: CN820		surface	blade	Massacre L./ Guano Valley	IV	130	126 4	19 3	199 3	4 3	83 2	533 4	29 3	0 14	1677 20	942 9	2.41 .08	n m	n m			Hughes 1997
LD: CN973		surface	blade	Venator	IV	47	53 4	14 3	107 3	149 3	23 2	87 3	10 2	885 13	547 19	712 9	1.41 .08	n m	n m			Hughes 1997
LD: CN843.02	Block FF	Level 1	blade	Coyote Wells	IV	96	91 7	25 2	116 3	24 7	65 3	434 7	34 2	864 13	1271 97	488 48	1.79 0.11	35.0	45.1			Skinner 1999b
LD: 4A.1	square 4A	surface	blade	Skull Springs	IV	88	145 7	28 3	107 3	14 7	73 3	469 7	31 2	600 14	1257 97	695 48	2.48 0.11	32.6	62.5			Skinner 1999b
LD: 4A.2	square 4A	surface	blade	Skull Springs	IV	88	149 7	19 3	114 3	14 7	75 3	494 7	30 2	600 13	1439 97	855 48	2.94 0.11	30.8	64.3			Skinner 1999b

Site and Catalog No.	Horiz. Proven-ience	Vert. Proven-ience	Class	Chemical Type	Period	source to site km	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	Fe %	Fe/Mn	Fe/Ti	Refer-ence
LD: 4A.3	square 4A	surface	blade	Massacre L./ Guano Valley	IV	130	177 7	41 2	244 4	5 7	95 3	609 7	37 2	0 12	1553 97	843 482.08 0.1122.4			42.8	Skinner 1999b
LD: 5-1	square 5	surface	blade	Coyote Wells	IV	96	84 7	13 3	115 3	25 7	61 3	435 7	30 2	867 13	1118 97	452 471.66 0.1135.4			47.6	Skinner 1999c
LD: CN677		surface	core	Venator	IV	47	68 7	14 3	109 3	118 7	30 3	91 7	16 2	834 13	394 96	592 480.92 0.1115.2			75.4	Skinner 1999a
LD: CN831.2		surface	core	Whitewater Ridge	IV	110	50 6	17 3	127 3	97 7	23 3	138 7	8 2	1592 15	807 97	230 470.97 0.1146.9			39.6	Skinner 1999a
LD: CN838.1		surface	core	Venator	IV	47	52 6	20 2	101 3	135 7	26 3	90 7	13 1	850 13	398 96	645 481.06 0.1115.8			85.3	Skinner 1999a
LD: CN845	Block FF	level 1	core	Coyote Wells	IV	96	89 7	25 3	112 3	23 7	62 3	430 7	32 2	818 13	1321 97	506 481.94 0.1136.3			47.0	Skinner 1999a
LD: CN969		surface	core	Massacre L./ Guano Valley	IV	130	160 7	23 3	230 4	5 7	91 3	584 7	36 2	0 12	1259 96	674 481.70 0.1123.5			43.4	Skinner 1999a
LD: CN975		surface	core	Skull Springs	IV	88	159 7	21 3	106 3	16 7	72 3	484 7	30 2	569 13	1486 97	912 48 3.11 0.11 30.4			65.7	Skinner 1999a
LD: CN1063	Block FF	level 1	core	Venator	IV	47	46 7	16 3	107 3	139 7	29 3	90 7	13 2	870 13	375 96	609 480.97 0.1115.5			83.3	Skinner 1999a
LD: A9		surface	core	Coyote Wells	IV	96	96 7	24 3	116 3	23 7	63 3	431 7	31 2	811 13	1313 97	516 461.96 0.1135.9			47.7	Skinner 1999a
LD: A65		surface	core	Tule Spring	IV	48	42 6	11 3	128 3	60 7	30 3	135 7	10 2	1162 13	645 96	248 47	0.94	41.7	48.1		Skinner 1999a
LD: CN786		surface	large used flake	Dry Creek Canyon	IV	93	46 6	10 3	140 3	119 7	31 3	313 7	18 1	963 13	2143 98	321 472.05 0.1163.7			30.6	Skinner 1999a
LD: CN775		surface	used flake	Massacre L./ Guano Valley	?	130	154 6	23 3	218 3	1 6	91 3	584 5	31 2	0 17	1356 86	816 591.91 0.1121.9			46.4	Skinner 1999a
LD: CN983		surface	NSN point	Indian Creek Buttes Var. B	I	53	47 7	22 3	190 4	0 10	58 3	141 7	38 2	18 14	200 96	137 470.41 0.1144.4			70.7	Skinner 1999b
LD: P41		surface	Humboldt point	Venator	I	47	55 7	16 3	107 3	173 7	31 3	106 7	18 2	966 13	820 96	498 471.26 0.1124.6			50.0	Skinner 1999b
LD: A39		surface	Elko point	Indian Creek Buttes Var. A	I	49	72 7	13 3	183 3	33 7	53 3	170 7	29 2	189 13	614 96	254 470.97 0.1141.5			51.8	Skinner 1999b
LD: P2		surface	Elko point	Tule Spring	I	48	41 6	11 3	134 3	59 7	32 3	132 7	13 2	1153 14	680 96	234 470.86 0.1141.3			42.1	Skinner 1999b
LD: P50		surface	Elko point	Unknown 1	I		56 4	15 3	70 3	240 3	17 2	134 3	9 2	1983 14	n m	n m	n m	28	n m		Hughes 1996

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LD: CN906		surface	Elko point	Beatys Butte	I	96	29 7	14 3	122 3	168 7	14 3	155 7	4 2	998 15	642 96	221 47 0.76 0.11 39.5			39.7	Skinner 1999b
LD: CN958		surface	Elko point	Whitehorse 2	I	105	96 7	21 3	197 4	5 7	66 3	480 7	33 2	9 24	646 95	333 471.71 0.1151.4			83.6	Skinner 1999b
LD: CN1008		surface	Elko point	Indian Creek Buttes Var. B	I	53	70 7	17 3	198 4	12 7	56 3	149 7	38 2	40 13	278 95	223 470.90 0.1145.8			103.2	Skinner 1999b
LD: CN897		surface	Rose Spg. point	Beatys Butte	II	96	50 7	17 3	127 3	180 7	13 3	164 7	12 2	1044 14	861 96	303 470.92 0.1132.2			35.6	Skinner 1999a
LD: CN1065		surface	Rose Spg. point	Riley	II	68	92 9	19 5	109 4	9 7	61 3	446 7	24 2	777 13	873 96	386 471.46 0.1137.3			53.7	Skinner 1999a
LD: P36		surface	Rose Spg. point	Venator	II	47	57 7	25 3	109 3	170 7	24 3	107 7	15 2	1067 17	510 96	361 470.79 0.1123.0			51.7	Skinner 1999b
LD: P40		surface	Rose Spg. point	Indian Creek Buttes Var. A	II	49	72 7	27 3	199 4	24 7	56 3	170 7	32 2	129 14	452 95	214 470.97 0.1151.5			69.8	Skinner 1999b
LD: P44		surface	Rose Spg. point	Double O	II	44	46 7	20 3	167 4	52 7	42 3	297 7	16 2	892 15	1044 96	192 471.13 0.1168.3			35.7	Skinner 1999b
LD: P46		surface	Rose Spg. point	Venator	II	47	55 7	13 3	103 3	171 7	25 3	104 7	11 2	1049 15	553 96	375 470.88 0.1124.3			52.6	Skinner 1999b
LD: P47		surface	Rose Spg. point	Venator	II	47	52 7	14 3	106 3	172 7	26 3	102 7	15 2	1027 16	475 96	353 470.74 0.1122.2			52.2	Skinner 1999b
LD: CN666		surface	Rose Spg. point	Venator	II	47	54 7	17 3	106 3	178 7	27 3	105 7	12 2	959 16	577 96	343 470.83 0.1125.5			48.0	Skinner 1999b
LD: CN918		surface	Rose Spg. point	Tule Spring	II	48	31 7	12 3	134 3	56 7	31 3	130 7	14 2	1117 15	634 96	206 470.75 0.1142.7			39.8	Skinner 1999b
LD: CN919		surface	Eastgate point	Unknown 1	II		52 7	21 3	70 3	247 7	15 3	137 7	13 2	2043 13	888 97	380 471.22 0.1132.2			44.7	Skinner 1999a
LD: P13		surface	notched point	Bretz Mine	?	162	215 7	25 3	207 4	6 7	98 3	516 7	26 2	0 12	1200 96	366 482.72 0.1172.0			71.4	Skinner 1999b
MC: B5-2-5		upper 2 levels	DSN point	Venator	III	55	57 7	20 3	109 3	151 7	25 3	96 7	11 2	863 15	490 96	464 470.96 0.1120.8			64.2	Skinner 1999a
MC: B7-2-3		upper 2 levels	DSN point	Indian Creek Buttes Var. A	III	47	72 7	25 3	204 4	30 7	62 3	172 7	34 2	131 13	339 95	215 470.84 0.1145.3			80.8	Skinner 1999a
MC: B13-2-1		upper 2 levels	DSN point	Venator	III	55	61 7	12 3	109 3	161 7	26 3	93 7	10 2	913 16	372 95	378 470.70 0.1119.5			62.3	Skinner 1999a
MC: D9-4-2		upper 2 levls	DSN point	Indian Creek Buttes Var. B	III	52	57 7	21 3	186 4	15 7	53 3	141 7	35 2	57 14	201 95	156 470.42 0.1137.9			72.4	Skinner 1999a

Site and Catalog No.	Horiz. Proven-ience	Vert. Proven-ience	Class	Chemical Type	Period	source to site km	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	Fe %	Fe/Mn	Fe/Ti	Refer-ence
MC: D10-4a-1		upper 2 levls	DSN point	Wolf Creek	III	98	38 7	23 3	136 3	49 7	28 3	107 7	10 2	1102 16	277 95	146 470.38 0.1138.2		49.5		Skinner 1999a
MC: A-18-2-1		upper 2 levlels	DSN point	Indian Creek Buttes Var. B	III	52	61 7	19 3	196 4	14 7	61 3	149 7	38 2	46 13	276 95	192 470.69 0.1143.8		82.1		Skinner 1999a
MC: D16-2-1		upper 2 levels	DSN point	Beatys Butte	III	82	32 7	14 3	135 3	170 7	14 3	164 7	15 2	994 15	656 96	232 470.72 0.1135.4		37.0		Skinner 1999a
MC: A9-3-1		upper 3 levels	small stemmed point	Indian Creek Buttes Var. A	III	47	64 7	17 3	185 4	27 7	57 3	169 7	35 2	141 13	363 95	192 470.73 0.1145.8		66.6		Skinner 1999a
MC: D13-5-1		upper 3 levels	small stemmed point	Burns*	III	74	48 8	15 4	130 4	32 7	48 3	263 7	32 2	580 16	673 96	188 470.74 0.1147.4		37.1		Skinner 1999a
MC: D15-3-4	Feature 11	wickiup floor	small stemmed point	Indian Creek Buttes Var. A	III	47	65 8	20 4	187 4	26 7	64 3	167 7	31 2	133 14	276 95	166 470.57 0.1144.3		68.7		Skinner 1999a
MC: D9-5a-6	Feature 11	wickiup floor	biface	Mud Ridge	III	83	98 7	21 3	127 3	n m	75 3	451 7	45 2	11 15	592 95	276 471.75 0.1165.3		93.0		Skinner 1999a
MC: B7-6-4		upper 2 levels	preform	Indian Creek Buttes Var. A	III	47	60 7	23 3	189 4	31 7	53 3	167 7	31 2	164 13	450 95	241 47 1.00 0.11 46.0		72.2		Skinner 1999a
MC: B9-3-7		upper 2 levels	preform	Venator	III	55	57 7	17 3	106 3	163 7	28 3	98 7	13 2	962 14	441 96	475 470.92 0.1119.3		67.8		Skinner 1999a
MC: C4-5-1		upper 2 levels	preform	Beatys Butte	III	82	38 6	16 3	127 3	170 7	16 3	162 7	9 2	958 14	869 96	355 471.08 0.1131.1		40.9		Skinner 1999a
MC: D4-4b-1		upper 2 levels	preform	Indian Creek Buttes Var. A	III	47	61 6	22 2	192 3	27 7	59 3	168 7	34 2	123 13	405 95	250 471.09 0.1147.0		85.7		Skinner 1999a
MC: D7-4a-1		upper 2 levels	preform	Venator*	III	55	61 7	17 3	112 3	167 7	26 3	103 7	12 2	979 16	450 95	312 470.64 0.1122.5		48.3		Skinner 1999a
MC: D9/L/5a/F-11	Unit 5	L-5a	flake	Indian Creek Buttes Var. B	III	52	58 7	20 3	175 3	23 7	49 3	150 7	30 2	99 13	406 95	230 471.07 0.1151.2		84.3		Skinner 1999a
MC: D15/L-4/F11-A	Unit 9	L-4	flake	Indian Creek Buttes Var. A	III	47	61 6	22 3	191 3	29 7	57 3	168 7	29 2	198 13	636 96	287 471.39 0.1150.3		70.0		Skinner 1999a
MC: D15/L-4/F11-B	Unit 9	L-4	flake	Venator	III	55	59 7	18 3	103 3	162 7	26 3	99 7	16 2	932 14	748 96	518 481.30 0.1124.2		56.0		Skinner 1999a
MC: B5/QC/L-186S-100E		L-1	flake	Unknown	III		65 7	16 3	276 4	9 7	65 3	84 7	47 2	24 14	129 95	425 470.43 0.1111.3		109		Skinner 1999a

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MC: A13/QC/L-1-A	88S-100E	L-1	flake	Beatys Butte	III	82	39 7	19 3	129 3	175 7	15 3	164 7	11 2	993 16	618 96	273 470.78 0.1131.4		42.3		Skinner 1999a
MC: A13/QC/L-1-B88S-100EL-1			flake	Venator	III	55	57 7	22 3	112 3	175 7	30 3	107 7	15 2	913 15	533 96	467 471.06 0.1122.4		64.4		Skinner 1999a
MC: B13/QC/L-188S-102E		L-1	flake	Indian Creek Buttes Var. A	III	47	70 7	21 3	187 4	29 7	57 3	169 7	30 2	139 13	447 95	195 470.86 0.1151.8		63.1		Skinner 1999a
MC: C3-QC-L-1-A121S-66E		L-1	flake	Beatys Butte	III	82	30 7	19 3	122 3	161 7	15 3	155 7	11 2	919 14	774 96	345 471.04 0.1130.9		44.0		Skinner 1999a
MC: C3-QC-L-1-B121S-66E		L-1	flake	Double O	III	54	62 7	16 3	180 4	60 7	38 3	294 7	18 2	737 16	1206 97	220 471.37 0.1168.6		37.1		Skinner 1999a
MC: D9/L-4/F11	Unit 5	L-4	flake	Indian Creek Buttes Var. A	III	47	54 7	18 3	182 4	24 7	55 3	163 7	32 2	136 13	389 95	214 470.89 0.11 47.874.6				Skinner 1999a

LD = Lost Dune (35HA792); MC = McCoy Creek (35HA1263) Component III; nm = not measured; * = small sample. Provenience of McCoy Creek artifacts from Musil (1995).