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Appendix: Source Analysis of Obsidian Samples

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THE trace element analysis of the obsidian specimens listed in the accompanying table was conducted at the Department of Geology, University of California, Davis. This work was performed on a Kevex 0700 energy dispersive X-ray fluorescence (XRF) unit, using a rhodium (Rh) tube with a rhodium target at 33 kilovolts and 1.70 milliamps to analyze for rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). A germanium (Ge) target at 17 kilovolts and 1.70 milliamps was used to analyze for manganese (Mn) and iron (Fe). This unit has a silicon (lithium) detector and is used in conjunction with a Kevex Micro-X 7000 multichannel analytical spectrometer.

This obsidian assemblage from the McCue site was analyzed in two different lots over an extended period of time. The first group of samples included all pieces submitted, and these were assigned to sources on the basis of the tripolar ratio of Rb, Sr, and Zr. This is an older analytical method that is no longer employed. The second group consisted of specimens reanalyzed with a semi-quantitative technique, used to produce ppm (parts per million) values for the elements under consideration. The five artifacts in this group originally were assigned to a group of six different possible source areas: Fletcher (Mineral County, Nevada), Bodie Hills (Mono County, California), Silver Peak (Esmeralda County, Nevada), Pine Grove Hills (Lyon County, Nevada), Bagdad (San Bernardino County, California), and Eureka

(Inyo County, California). These could not be distinguished on the basis of the tripolar method of analysis. The semi-quantitative data separated all but a group of two of the sources (Bodie Hills and Fletcher) into which also fell the five reanalyzed specimens.

Employing the ratio method, the samples were run for 100 live-seconds with the Rh target and for 200 live-seconds with the Ge target, and the resulting spectra were stripped of their backgrounds. Integrated intensities were calculated for the elements under analysis for each sample. The intensity for each peak of the sample then was divided by the Rb peak intensity for the Rh target elements, and those values were converted into percentages (Table 1). Intensities for the Ge target elements were divided by the Mn peak intensity, and the ratios were used for analysis. The results of this analysis are qualitative in that the standards with known quantities of trace elements were not run for comparison.

Using the semi-quantitative method, the samples were run for 200 live-seconds each with the Rh and Ge targets, and the resulting spectra were stripped of their backgrounds. Integrated intensities were calculated for the elements under analysis for each sample. Rh target intensities were divided by the integral of the target peak, and those values were used to calculate the elemental quantities given in the accompanying table. The intensities for the Ge target elements were divided by the Mn peak intensity, and the ratios were used for analysis.

Normally, in controlled geological studies a rock is crushed into a powder and pressed into a pellet. That prepared sample has a homogeneous distribution of constituent elements and is perfectly flat, providing the appropriate geometry for consistent and systematic results. Archaeological materials often cannot be treated in this manner, so a form of "ratio" analysis must be used to compensate for their elemental distribution (glasses are assumed to have homogeneous distributions) and imperfect geometry (i.e., they lack a perfectly flat surface). As part of these XRF "quantitative" analyses, rock standards with known quantities of constituents are used in association with this initial procedure and are analyzed similarly. The results are used to calculate a linear regression formula into which sample ratios are entered and "quantitative" values obtained. This is a sound method, although it is not a replacement for more detailed and accurate techniques (see Andermann and Kemp 1958; Nielson 1979). It also has been found that different machines and techniques can produce slightly varying numerical results, due, in part, to the particle-size effects of the variously processed rock standards. Direct comparisons between laboratories are, therefore, problematic.

DATA AND DISCUSSION

The results of the initial analysis with the ratio technique revealed a diverse assemblage of obsidian sources. No fewer than ten different sources are represented, most of which fall into the "unknown" category (Table 2).

Twenty-nine specimens were analyzed and twelve appear to have come from known source areas. Four pieces were from the Coso volcanic field in Inyo County, California, and one was from Obsidian Butte in Imperial County, California; both of these source areas are consistent with the proximity of the sources and the site (Fig. 1). There is no significant problem with the Coso material in terms of its comparability of ratios with other sources, but recent evidence suggests that different areas of the Coso volcanic field may be distinguishable on

Table 1
INTEGRATED INTENSITY RATIOS AND PERCENTAGES

Cat. No.[a]	Rb/Rb	Sr/Rb	Zr/Rb	Sum	Rb%	Sr%	Zr%	Fe/Mn	Source
Projectile Points									
-680	1.00	0.0803	3.4088	4.4891	22.28	1.79	75.94	70.56	Obsidian Butte
-681	1.00	0.0179	0.8554	1.8733	53.38	0.96	45.66	56.17	Coso volcanic field
-682	1.00	0.5058	1.6418	3.1476	31.77	16.07	52.16	68.35	A
-683	1.00	3.1779	7.6348	11.8127	8.47	26.90	64.63	42.03	?
-702	1.00	0.5251	1.5240	3.0491	32.80	17.22	49.98	64.87	A
-718	1.00	0.3105	1.1715	2.4820	40.29	12.51	47.20	74.21	B
-719	1.00	0.0235	0.8599	1.8834	53.10	1.25	45.66	54.68	Coso volcanic field
-720	1.00	0.4916	1.4858	2.9774	33.59	16.51	49.90	82.07	A
Bifaces									
-770	1.00	0.6380	0.9628	2.6008	38.45	24.53	37.02	19.62	Bodie Hills/Fletcher
-771	1.00	0.0352	1.3305	2.3657	42.27	1.49	56.24	64.95	?
Edge-modified Flakes									
-660	1.00	0.0248	0.9030	1.9278	51.87	1.29	46.84	55.61	Coso volcanic field
Unmodified Flakes									
-224	1.00	0.6475	0.9105	2.5580	39.09	25.31	35.59	19.66	Bodie Hills/Fletcher
-294	1.00	0.2657	1.6757	2.9414	34.00	9.03	56.97	19.85	C
-299	1.00	0.2022	3.1474	4.3496	22.99	4.65	72.36	91.81	D
-393	1.00	0.5238	1.4683	2.9921	33.42	17.51	49.07	46.83	A
-422	1.00	0.3994	4.1312	5.5306	18.08	7.22	74.70	96.63	D
-423	1.00	0.0325	0.8540	1.8865	53.01	1.72	45.27	54.87	Coso volcanic field
-498	1.00	0.2121	3.0495	4.2616	23.47	4.98	71.56	115.16	D
-499	1.00	0.4997	1.4657	2.9654	33.72	16.85	49.43	69.18	A
-501	1.00	0.1964	1.1773	2.3737	42.13	8.27	49.60	74.41	B
-502	1.00	0.0844	0.5629	1.6473	60.71	5.12	34.17	23.48	Mono Glass Mountain
-524	1.00	0.6398	1.0449	2.6847	37.25	23.83	38.92	20.75	Bodie Hills/Fletcher
-546	1.00	0.5284	0.9190	2.4474	40.86	21.59	37.55	19.51	Bodie Hills/Fletcher
-547	1.00	0.5316	0.8429	2.3745	42.11	22.39	35.50	19.01	Bodie Hills/Fletcher
-557	1.00	0.2714	1.0774	2.3488	42.57	11.55	45.87	69.98	B
-565	1.00	0.2979	1.3268	2.6247	38.10	11.35	50.55	72.10	B
-615	1.00	0.3070	3.6546	4.9616	20.15	6.19	73.66	105.42	D
-659	1.00	0.0308	0.5767	1.6075	62.21	1.92	35.88	24.32	Mono Glass Mountain
–	1.00	0.2750	1.9160	3.1910	31.34	8.62	60.04	18.81	C

[a] All are accession number A929.

Table 2
FREQUENCY OF SOURCES REPRESENTED

Source	Frequency
Bodie Hills/Fletcher	5
Coso volcanic field	4
Mono Glass Mountain	2
Obsidian Butte	1
A	5
B	4
C	2
D	4
?	2

the basis of semi-quantitative values. It is not clear at this time, however, if those trace element clusters are discrete or if they are a product of an incomplete sampling of a broad range of values. In either case, this pattern may have implications for hydration rates.

Two specimens were assigned to the Mono Glass Mountain source and five (on the basis of the semi-quantitative technique) to either Bodie Hills or Fletcher. The remaining pieces apparently are of material from source areas yet uncharacterized at the time of the

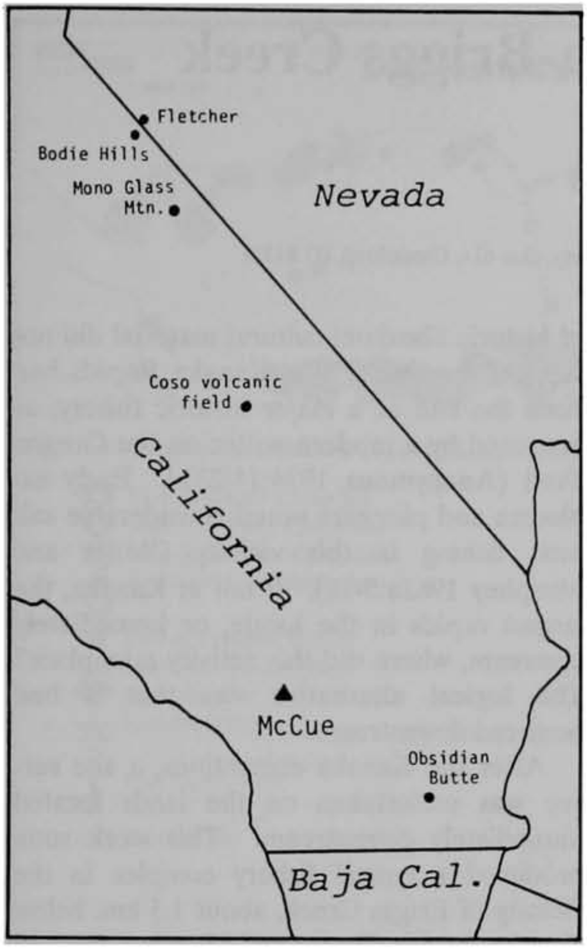

Fig. 1. Locations of obsidian source areas represented at the McCue site.

analysis. This latter group probably consists of materials obtained from some of the numerous float obsidian sources found in the desert region of southeastern California. Most of these are small nodule ("Apache tear") sources, an occurrence consistent with the technological information regarding this assemblage, which indicates use of the bipolar technique for nodule reduction (see the discussion in the main text).

The Mono Glass Mountain and the Bodie Hills-Fletcher materials appear to contradict the pattern described by the remainder of the collection. While it is not uncommon to find a significant presence of such distant "exotic" obsidians during the period in which Elko points were used in the Great Basin and other desert regions, those anomalies typically occur among the projectile points and not the other tool or debitage assemblages. The pattern found here is just the *opposite*, with most exotic material occurring in the debitage. One might construct a scenario regarding mobility strategies, exchange and resource access, curation, and tool resharpening, but at this time with this collection it may be more useful to offer a more conservative interpretation: Those specimens assigned to Mono Glass Mountain and Bodie Hills/Fletcher might be from more local, yet uncharacterized, float sources. Semi-quantitative analyses of the float sources (currently in progress) in conjunction with the major obsidians and the archaeological material will help to clarify problems such as these.

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