

UC Berkeley

Archaeological X-ray Fluorescence Reports

Title

An Energy Dispersive X-ray Fluorescence (EDXRF) Analysis of 36 Obsidian Artifacts from Three Sites in Clark County, Nevada (Ck-4440, 4580, and 4589)

Permalink

<https://escholarship.org/uc/item/48b665x7>

Author

Shackley, M. Steven

Publication Date

1991-12-02

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-NonCommercial License, available at <https://creativecommons.org/licenses/by-nc/4.0/>

**AN ENERGY DISPERSIVE X-RAY FLUORESCENCE (EDXRF)
ANALYSIS OF 36 OBSIDIAN ARTIFACTS FROM THREE SITES IN
CLARK COUNTY, NEVADA (Ck-4440, 4580, and 4589)**

by

M. Steven Shackley

Lowie Museum of Anthropology
University of California, Berkeley

2 December 1991

INTRODUCTION

The analysis of 36 archaeological specimens recovered from three sites indicates that the vast majority of obsidian was procured from one of two geochemically related sources in the Mineral Mountains, Beaver County, Utah. The one stemmed projectile point (Gypsum) recovered from Ck-4589 was produced from glass procured from one of the sources at Coso in eastern California.

ANALYSIS AND INSTRUMENTATION

Three samples from Ck-4440 and eight samples from Ck-4580 were considered too small to yield accurate results and were not analyzed. Three other small samples were analyzed with potentially spurious results.

The trace element analyses were performed in the Department of Geology and Geophysics, University of California, Berkeley, using a Spectrace 440 (United Scientific Corporation) energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with a Rh x-ray tube, a 50 kV x-ray generator, with a Tracor X-ray (Spectrace) TX 6100 x-ray analyzer using an IBM PC based microprocessor and Tracor reduction software. The x-ray tube was operated at 30 kV, .20 mA, using a .127 mm Rh primary beam filter in an air path at 250 seconds livetime to generate x-ray intensity data for

reported elements lead (Pb), thorium (Th), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from the analysis of up to 26 international rock standards certified by the U.S. Bureau of Standards, the U.S. Geological Survey, Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1989). Further details concerning the petrological choice of these elements in Southwestern obsidians is available in Shackley (1988, 1990).

The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards. Table 1 shows a comparison between values recommended for two international rock standards, one rhyolite (RGM-1) and one obsidian (NBS-278). One of these standards is analyzed during each sample run to insure machine calibration. The results shown in Table 1 indicate that the machine accuracy is quite high, and other instruments with comparable precision should yield comparable results.

Trace element data exhibited in Tables 1 and 2 are reported in parts per million (ppm), a quantitative measure by weight. Source probability is based on a comparison with 1-sigma levels of variability. Although Pb and Th ppm concentrations were reported, they generally are not used as diagnostic indicators given their general lack of inter-source variability. Table 2 exhibits the trace element concentrations for the 36 samples. Figures 1, 2, and 3 display various aspects and plots of the data. All samples except four were assignable to source, three of which were too small to yield accurate results. One sample

from Ck-4589 (-2) appears to not be a rock of silicic origin, and in my estimation is not an artifact.

DISCUSSION

The distribution of the provenience of obsidian sources in the assemblage is not highly diverse. The two source areas, Coso, California, and the Mineral Mountains, Utah are approximately equidistant from southern Clark County, Nevada. If Ck-4589 dates to the Late Archaic, and the Ck-4440 and 4580 sites date to later ceramic periods, then the source distribution appears to exhibit some time sensitivity.

It does appear that the obsidian was procured from some of the closest known obsidian sources, although the Modena Area locality near Modena, Iron County, Utah is physically the nearest source (Nelson 1984). This source is not as adequate for tool production as the Mineral Mountain glass, particularly Wild Horse Canyon and Pumice Hole Mine, and is quite distinctive megascopically and chemically.

The contracting-stem point (Gypsum) recovered from Ck-4589 was produced from Coso material a few hundred kilometers northwest of the site. This is a common raw material for Late Archaic points in the western and southern Great Basin (see Hughes 1985; 1988). More interesting, perhaps, is the derivation of material from sources in the Mineral Mountains of Beaver County, Utah for the two sites exhibiting ceramics. This deserves some discussion.

Mineral Mountains Obsidian Source, Utah, and Source Assignment

According to chemical analyses reported by Nelson (1984), four chemical groups are present in the Mineral Mountain Range, Beaver County, Utah. These four source groups (Kirk Canyon, Pumice Hole Mine, School Mine Area, and Wild Horse Canyon) are all located near each other on the Adamsville USGS 15' topo map. Little petrological or archaeological data is available in Nelson's (1984) report, however, the chemical data

suggest that the four groups may be magmatically related. They likely are within the same volcanic field (Cox et al. 1979; Zielinski et al. 1977). Wild Horse Canyon and Pumice Hole Mine are nearly identical in all elements and compounds measured except for slight differences in strontium and barium (Nelson 1984:Table 4). The assignment to Pumice Hole versus Wild Horse Canyon here was based on an arbitrary division at 45 ppm strontium (Table 2 and Figure 3). This is in part based on source data supplied by Nelson (1984). For purposes of deriving inferences of exchange, interaction, and procurement the close physical proximity of these two possible source groups makes the problem inconsequential.

Figures 2 and 3 exhibit concentration plots for the data derived from Ck-4440 and Ck-4580. Note the relatively good separation above and below 45 ppm strontium for those objects assigned to Wild Horse Canyon versus Pumice Hole Mine. Again, with the source data supplied by Nelson (1984) it is difficult to determine if this separation is real. The two sources appear completely mixed in the Rb/Zr plot further suggesting their close magmatic relationship. Additionally, all the specimens assigned to the Mineral Mountains sources are uniformly black and opaque, suggesting that there is little difference between the two.

The source assignments derived in this analysis indicate procurement from sources considerable distance from the sites. In the Archaic period, this may have been through direct access or exchange, and in the later periods this certainly is an effect of group interaction and exchange among Virgin Anasazi or other groups (Shackley 1990).

REFERENCES CITED

- Cox, K.G., J.D. Bell, and R.J. Pankhurst
1979 *The Interpretation of Igneous Rocks*. George Allen and Unwin, London.
- Govindaraju, K.
1989 1989 Compilation of Working Values and Sample Description for 272 Geostandards. *Geostandards Newsletter* 13 (special issue).
- Hampel, Joachim H.
1984 Technical Considerations in X-ray Fluorescence Analysis of Obsidian. In *Obsidian Studies in the Great Basin*, edited by R.E. Hughes, pp. 21-25. Contributions of the University of California Archaeological Research Facility 45. Berkeley.
- Hughes, Richard E.
1985 Obsidian Source Use at Hidden Cave. In *The Archaeology of Hidden Cave*, edited by D.H. Thomas, pp. 332-353. *Anthropological Papers of the American Museum of Natural History* 61(1).

1988 The Coso Volcanic Field Reexamined: Implications for Obsidian Sourcing and Hydration Dating Research. *Geoarchaeology* 3(4):253-265.
- McCarthy, J.J., and F.H. Schamber
1981 Least-Squares Fit with Digital Filter: A Status Report. In *Energy Dispersive X-ray Spectrometry*, edited by K.F.J. Heinrich, D.E. Newbury, R.L. Myklebust, and C.E. Fiori, pp. 273-296. National Bureau of Standards Special Publication 604, Washington, D.C.
- Nelson, Fred W., Jr.
1984 X-Ray Fluorescence Analysis of Some Western North American Obsidians. In *Obsidian Studies in the Great Basin*, edited by R.E. Hughes, pp. 27-62. Contributions of the University of California Archaeological Research Facility 45. Berkeley.
- Schamber, F.H.
1977 A Modification of the Linear Least-Squares Fitting Method which Provides Continuum Suppression. In *X-ray Fluorescence Analysis of Environmental Samples*, edited by T.G. Dzubay, pp. 241-257. Ann Arbor Science Publishers.
- Shackley, M. Steven
1990 *Early Hunter-Gatherer Procurement Ranges in the Southwest: Evidence from Obsidian Geochemistry and Lithic Technology*. Ph.D. dissertation, Department of Anthropology, Arizona State University. University Microfilms, Ann Arbor.
- Zielinski, R.A., P.W. Lipman, and H.T. Millard
1977 Minor-Element Abundances in Obsidian, Perlite, and Felsite of Calc-Alkalic Rhyolites. *American Mineralogist* 62:426-437.

Table 1. X-ray fluorescence concentrations for selected trace elements of two international rock standards. $\pm$ values represent first standard deviation computations for the group of measurements. All values are in parts per million (ppm) as reported in Govindaraju (1989) and this study. RGM-1 is a U.S. Geological Survey rhyolite (obsidian) rock standard, and NBS-278 is a National Bureau of Standards obsidian standard.

SAMPLE	Pb	Th	Rb	Sr	Y	Zr	Nb	Ba
RGM-1 (Govindaraju 1989)	24	15.1	149	108	25	219	8.9	807
RGM-1 (this study)	23 $\pm$ 2.6	14 $\pm$ 2.4	150 $\pm$ 3.4	105 $\pm$ 1.7	26 $\pm$ 0.9	218 $\pm$ 5	9.5 $\pm$ 1.1	844 $\pm$ 48.86
NBS-278 (Govindaraju 1989)	16.4	12.4	127.5	63.5	41	295	n.r.	1140
NBS-278 (this study)	19.1 $\pm$ 0.9	14 $\pm$ 2.2	126 $\pm$ 1.9	62 $\pm$ 2.3	40 $\pm$ 2.2	280 $\pm$ 3.6	14 $\pm$ 1.4	n.a.

Table 2. X-ray fluorescence concentrations for obsidian artifacts from three sites in Clark County, Nevada. All values are in parts per million (ppm).

SITE/SAMPLE#	Pb	Th	Rb	Sr	Y	Zr	Nb	SOURCE
Ck-4440								
22-1	29.131	27.056	152.931	34.733	29.793	131.19	23.52	Wild Horse Cyn
40-1	26.579	32.539	204.504	38.7	34.574	169.727	27.269	Wild Horse Cyn
40-2	26.147	29.386	114.761	19.951	25.905	114.177	16.189	Wild Horse Cyn (sm)
44-1	40.475	32.336	170.034	65.595	26.596	190.676	13.996	Pumice Hole Mine
44-2	22.761	29.376	163.564	32.807	33.272	153.2	18.497	Wild Horse Cyn
48-1	28.976	20.734	174.317	35.667	29.361	139.379	15.506	Wild Horse Cyn
48-2	30.089	34.19	210.855	46.328	37.673	172.768	31.399	Wild Horse Cyn
58-1	27.695	33.08	165.137	61.21	21.243	114.689	16.636	Pumice Hole Mine
61-1	28.758	32.211	172.092	63.272	22.818	118.393	16.41	Pumice Hole Mine
72-1	22.728	24.18	208.392	41.226	29.792	165.364	20.448	Wild Horse Cyn
74-1	29.022	28.463	196.416	76.586	30.582	141.57	18.021	Pumice Hole Mine
1-19	32.281	33.045	214.693	89.185	27.528	143.48	17.441	Pumice Hole Mine
1-49	27.829	31.619	152.987	32.684	25.805	127.839	19.01	Wild Horse Cyn
Ck-4580								
131-1	29.139	29.245	188.917	43.306	38.838	164.371	25.431	Wild Horse Cyn
131-3	25.373	34.45	176.736	28.909	23.371	124.644	24.573	Wild Horse Cyn
132-1	24.51	14.785	120.573	16.492	16.639	123.774	10.461	Wild Horse Cyn (sm)
132-2	23.824	0	115.113	10.328	33.312	126.323	16.406	too small
133-1	31.583	37.608	223.508	45.192	37.784	178.858	31.303	Wild Horse Cyn
133-3	27.94	25.432	188.213	35.311	26.973	150.801	17.594	Wild Horse Cyn
133-6	19.296	0	123.606	19.308	22.998	129.214	16.754	too small
134-1	26.682	17.554	103.713	26.252	17.496	92.826	6.302	too small
134-2	29.653	31.595	191.134	45.645	27.942	148.945	17.138	Wild Horse Cyn
135-1	33.377	31.173	169.812	33.794	31.024	132.289	18.64	Wild Horse Cyn
136-1	23.352	20.836	179.767	42.698	32.859	151.525	23.281	Wild Horse Cyn
141-1	28.667	25.709	152.626	33.531	29.642	134.744	26.517	Wild Horse Cyn
141-2	32.396	18.231	173.363	35.485	33.968	141.295	13.225	Wild Horse Cyn
141-3	26.036	21.551	195.164	42.744	30.441	162.517	18.014	Wild Horse Cyn
143-3	25.915	32.399	186.721	34.802	39.347	161.678	14.775	Wild Horse Cyn
150-1	26.83	33.976	205.509	44.222	37.802	167.941	25.60	Wild Horse Cyn
150-2	27.097	38.333	200.788	39.554	40.718	171.69	30.479	Wild Horse Cyn
150-3	37.316	33.193	183.209	29.476	30.662	147.238	13.939	Wild Horse Cyn
152-2	28.562	36.814	217.18	35.048	43.15	165.616	27.683	Wild Horse Cyn
153-2	30.678	22.083	183.56	33.821	30.826	148.603	23.771	Wild Horse Cyn
152-3	27.106	6.848	154.958	34.054	33.055	122.813	7.768	Wild Horse Cyn
Ck-4589								
2	15.028	11.901	7.878	11.944	7.464	35.574	3.721	not obsidian
6	32.58	43.297	272.041	6.065	55.345	158.56	45.28	Coso

Table 3. Frequency distribution of assigned obsidian source provenience for Ck-4440 and Ck-4580.

<u>Source</u>	<u>Frequency</u>	<u>Percent</u>
Wild Horse Cyn	26	76.5
Pumice Hole	5	14.7
UNKNOWN (small)	3	8.8
	-----	-----
TOTAL	34	100.0

Figure 1. Frequency and proportional histogram of obsidian source provenience for Ck-4440 and Ck-4580.

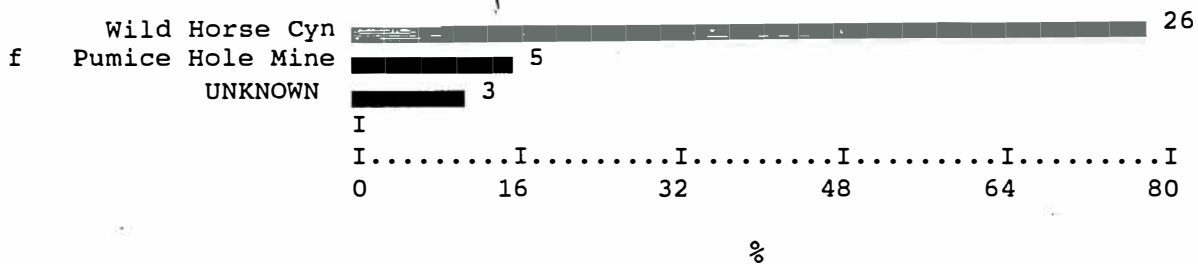


Figure 2. Rb versus Sr concentration plot for obsidian artifacts recovered from Ck-4440 and Ck-4580 (W= Wild Horse Canyon; P= Pumice Hole Mine; U= unassignable specimens due to small size).

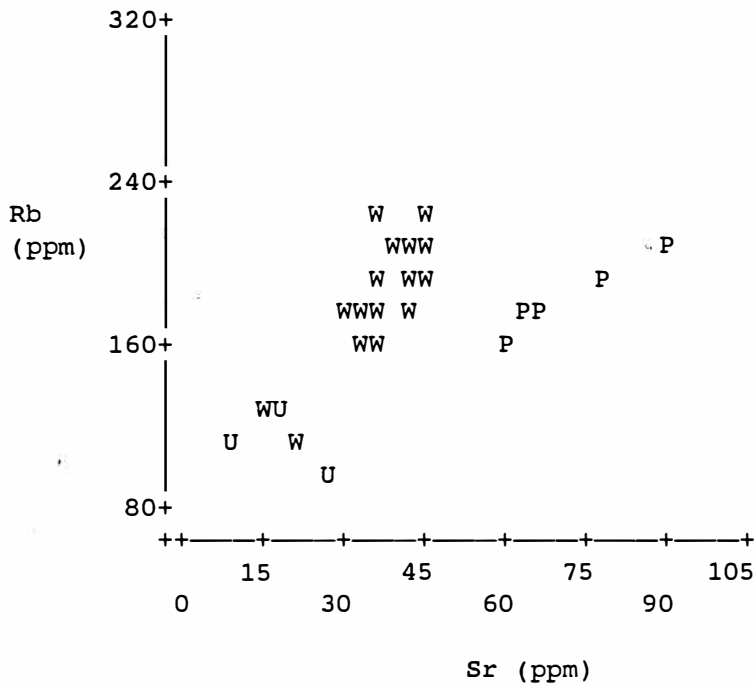


Figure 3. Rb versus Zr concentration plot for obsidian artifacts recovered from Ck-4440 and Ck-4580 (W= Wild Horse Canyon; P= Pumice Hole Mine; U= unassignable specimens due to small size).

