Title
Source Provenance of Obsidian Artifacts from the Spring Creek Site (CA-SHA-69), Shasta County, California

Permalink
https://escholarship.org/uc/item/3p66q1cb

Author
Shackley, M. Steven

Publication Date
2014-05-01

Supplemental Material
https://escholarship.org/uc/item/3p66q1cb#supplemental

Copyright Information

GEOARCHAEOLOGICAL XRF LAB

GEOARCHAEOLOGICAL X-RAY FLUORESCENCE SPECTROMETRY LABORATORY
8100 Wyoming Blvd., Ste M4-158 Albuquerque, NM 87113
USA

SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM THE SPRING CREEK SITE (CA-SHA-69), SHASTA COUNTY, CALIFORNIA

The ca. 950 year old Glass Mountain (East Glass Mountain chemical group here) obsidian flow on the east rim of the Medicine Lake caldera in northeastern California (entire ridge in center of image). The entire ridge in the background is composed of a glassy breccia with single blocks as much as 3 meters in height. Abundant core reduction and biface preform production is evident everywhere (Dillian 2002).

by

M. Steven Shackley, Ph.D., Director
Geoarchaeological XRF Laboratory
Albuquerque, New Mexico

and

Richard E. Hughes, Ph.D., Director
Geochemical Research Laboratory
Portola Valley, California

Report Prepared for

Heidi Shaw
ENPLAN
Redding, California

16 May 2014

INTRODUCTION

The analysis here of 63 obsidian artifacts from the Spring Creek Site (CA-SHA-69) in Shasta County, California indicates a nominally diverse assemblage dominated by the Grasshopper Flat/Lost Iron Well (GF/LIW) chemical group in the Medicine Lake Highlands.

Given the expertise of Dr. Richard Hughes in this region both in archaeology and the understanding of the geochemical sources of archaeological obsidian, Hughes interpreted the data analyzed by Shackley in Albuquerque, and assigned the samples to source.

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

All archaeological samples are analyzed whole. 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; Shackley 2011).

All analyses for this study were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer, located at the University of California, Berkeley. It is equipped with a thermoelectrically Peltier cooled solid-state Si(Li) X-ray detector, with a 50 kV, 50 W, ultra-high-flux end window bremsstrahlung, Rh target X-ray tube and a 76 µm (3 mil) beryllium (Be) window (air cooled), that runs on a power supply operating 4-50 kV/0.02-1.0 mA at 0.02 increments. The spectrometer is equipped with a 200 l min^{-1} Edwards vacuum pump, allowing for the analysis of lower-atomic-weight elements between sodium (Na) and titanium (Ti). Data acquisition is accomplished with a pulse processor and an analogue-to-digital converter. Elemental composition is identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities and net peak intensities above background.

For the analysis of mid Zb condition elements Ti-Nb, Pb, Th, the x-ray tube is operated at 30 kV, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity Ka-line data for elements titanium (Ti), manganese (Mn), iron (as $Fe_2O_3^T$), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). Not all these elements are reported since their values in many volcanic rocks are very low. Trace element intensities were converted to concentration estimates by employing a quadratic calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements but Fe where a derivative fitting is used to improve the fit for iron and thus for all the other elements. When barium (Ba) is analyzed in the High Zb condition, the Rh tube is operated at 50 kV and up to 1.0 mA, ratioed to the bremsstrahlung region (see Davis 2011; Shackley 2011). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1995, 2005; also Mahood and Stimac 1991; and Hughes and Smith 1993). Nineteen specific pressed powder standards are used for the best fit regression calibration for elements Ti-Nb, Pb, Th, and Ba, include G-2 (basalt), AGV-2 (andesite), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (hawaiite), STM-1 (syenite), QLO-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), NOD-A-1 and NOD-P-1 (manganese) all US Geological Survey standards, NIST-278 (obsidian), U.S. National Institute of Standards and Technology, BE-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France, and JR-1 and JR-2 (obsidian) from the Geological Survey of Japan

(Govindaraju 1994). RGM-1 a USGS obsidian standard from Glass Mountain, Medicine Lake Highlands is analyzed during each sample run of 20 to check stability of machine calibration (Table 1).

Source assignments were made by plotting the quantitative composition estimates in Table 1 against the Zr/Sr parameters of archaeologically significant obsidians identified in this part of northern California. The correspondences indicate that most of the artifacts were manufactured from obsidian of the Grasshopper Flat/Lost Iron Well chemical type (GF/LIW in Table 1) of the Medicine Lake Highland (Hughes 1986: Table 8) with a smaller number matching the Zr/Sr parameters of East Medicine Lake (EML in Table 1) volcanic glass from the Highland. Four artifacts correspond to the chemical profile of Buck Mountain obsidian (BM in Table 1) from the Warner Mountains (Hughes 1986: Table 7), and one other specimen (no. 43-003-1) has a trace element composition unlike any of the geological reference standards in Hughes' current regional reference collection. We note that several of the artifact-to-chemical type attributions (*sensu* Hughes 1998) in Table 1 are accompanied by a ?; this uncertainty may be the result of Sr enrichment due to surface incrustation of a calcium carbonate-like substance on some artifacts which Shackley was unable to remove completely. While this prevented us from making more precise attributions for these artifacts, we are nonetheless confident that they derive from the Medicine Lake Highland Volcanic Field.

REFERENCES CITED

Davis, M.K., T.L. Jackson, M.S. Shackley, T. Teague, and J. Hampel

2011 Factors Affecting the Energy-Dispersive X-Ray Fluorescence (EDXRF) Analysis of Archaeological Obsidian. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M.S. Shackley, pp. 45-64. Springer, New York.

Dillian, Carolyn D.

2002 *More than Toolstone: Differential Utilization of Glass Mountain Obsidian*. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Berkeley.

Govindaraju, K.

1994 1994 Compilation of Working Values and Sample Description for 383 Geostandards. *Geostandards Newsletter* 18 (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.

Hildreth, W.

1981 Gradients in Silicic Magma Chambers: Implications for Lithospheric Magmatism. *Journal of Geophysical Research* 86:10153-10192.

Hughes, Richard E.

1986 *Diachronic Variability in Obsidian Procurement Patterns in Northeastern California and Southcentral Oregon*, University of California Publications in Anthropology 17. Berkeley and Los Angeles.

1998 On Reliability, Validity, and Scale in Obsidian Sourcing Research. In *Unit Issues in Archaeology: Measuring Time, Space, and Material,* edited by A. F. Ramenofsky and A. Steffen, pp. 103-114. Salt Lake City, University of Utah Press**.**

2014 Energy Dispersive X-ray Fluorescence Analysis of Obsidian Projectile Points from CA-Sha-4169/H, Shasta County, California. Geochemical Research Laboratory Letter Report 2014-33. Portola Valley, CA.

Hughes, Richard E., and Robert L. Smith

1993 Archaeology, Geology, and Geochemistry in Obsidian Provenance Studies. *In Scale on Archaeological and Geoscientific Perspectives*, edited by J.K. Stein and A.R. Linse, pp. 79-91. Geological Society of America Special Paper 283.

Mahood, Gail A., and James A. Stimac

1990 Trace-Element Partitioning in Pantellerites and Trachytes. *Geochemica et Cosmochimica Acta* 54:2257-2276.

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.

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
1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60(3):531-551.

2005 *Obsidian: Geology and Archaeology in the North American Southwest*. University of Arizona Press, Tucson.

2011 An Introduction to X-Ray Fluorescence (XRF) Analysis in Archaeology. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M.S. Shackley, pp. 7-44. Springer, New York.

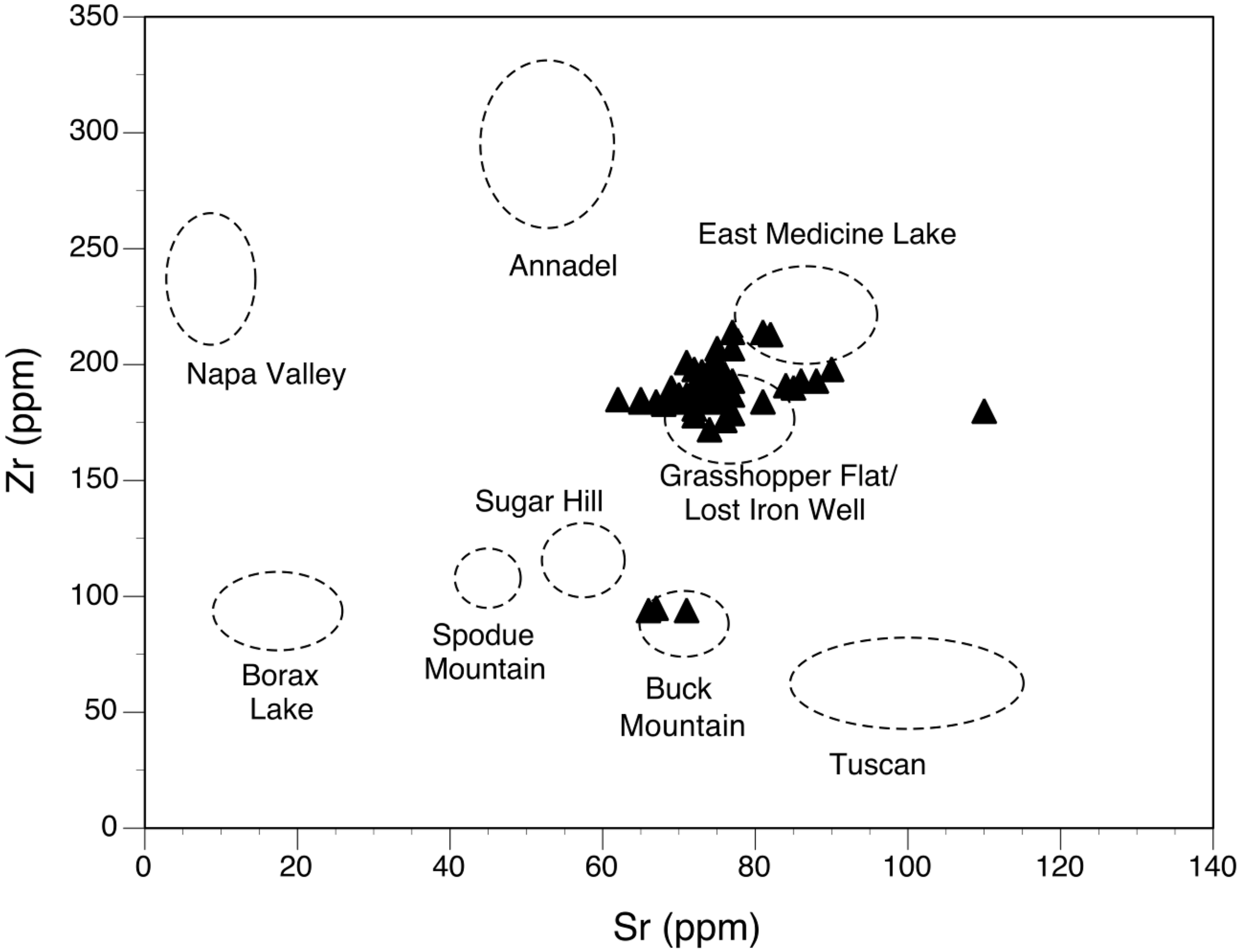
Table 1. Elemental concentrations and source assignments for the archaeological specimens and USGS RGM-1 obsidian standard. All measurements in parts per million (ppm). Ba acquired for some samples to enhance discrimination.

SAMPLE	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th	SOURCE
11-001	302	10763	44	140	76	28	184	11		28	20	GF/LIW
11-002	278	9418	51	131	77	29	179	11		25	16	GF/LIW
11-003	268	9606	33	109	62	26	185	13		21	11	GF/LIW
11-004-1	291	11512	69	141	68	27	183	10		27	21	GF/LIW
11-004-2	332	10805	66	136	74	28	184	10		28	14	GF/LIW
11-005	330	11822	69	140	74	29	186	13		26	12	GF/LIW
13-000	361	10180	58	149	70	29	184	12		25	16	GF/LIW
14-000	308	12783	38	150	82	30	213	10		29	24	EML?
15-001-1	274	10243	39	135	71	26	201	12		25	13	EML?
15-001-2	317	9539	60	134	74	26	172	12		25	19	GF/LIW
15-002-1	305	11484	37	146	73	27	197	14		27	19	GF/LIW?
15-002-2	351	13327	49	157	77	34	207	12		31	20	EML
15-003-1	414	7623	77	116	71	16	94	13	834	23	10	BM
15-003-2	352	14511	69	151	84	28	191	10		28	18	GF/LIW
19-001	318	11500	48	157	76	27	188	12		28	24	GF/LIW
19-002-1	309	11155	40	140	77	29	187	14		26	15	GF/LIW
19-002-2	320	13042	59	128	71	30	181	14		26	20	GF/LIW
19-003	289	10999	55	143	74	30	185	12		28	18	GF/LIW
19-007	319	11453	58	150	73	31	195	13		31	14	GF/LIW?
19-013	316	11790	45	138	75	27	189	12		26	16	GF/LIW
19-014	310	11080	44	139	72	33	184	13		27	10	GF/LIW
22-002	333	12186	45	150	75	29	201	12		29	18	EML?
22-003	323	11233	80	131	67	28	184	10		27	17	GF/LIW
22-004-1	277	9359	40	125	67	27	176	8		24	8	GF/LIW
22-004-2	338	11759	50	141	75	30	188	14		26	15	GF/LIW
24-001	354	12309	55	146	90	30	198	15		26	15	EML?
24-002	333	11915	73	142	75	26	191	10		28	15	GF/LIW

24-003	316	11591	39	150	76	30	193	13		29	18	GF/LIW?
25-000	317	12944	70	148	76	26	191	13		29	20	GF/LIW
29-001-1	267	9965	45	139	65	30	184	10		26	15	GF/LIW
29-001-2	314	11441	51	137	69	25	190	9		27	24	GF/LIW
29-002	340	12403	100	142	72	30	181	11		30	26	GF/LIW
30-000	319	11534	55	155	72	27	188	9		28	20	GF/LIW
3-001	291	10365	35	140	71	28	184	13		26	18	GF/LIW
3-003	305	11357	71	144	71	24	185	10		27	24	GF/LIW
3-005-1	400	13123	106	161	88	30	193	14		30	18	GF/LIW
3-005-2	295	11171	63	141	72	31	189	11		27	21	GF/LIW
3-006	310	12356	83	148	81	26	214	10		28	19	EML?
3-009	340	13093	50	144	74	28	198	11		28	23	GF/LIW?
33-002-2	289	11434	59	139	73	27	184	13		24	18	GF/LIW
33-003-1	332	11839	44	153	74	27	196	10		27	20	GF/LIW?
33-007	346	12255	90	150	75	28	186	13		30	26	GF/LIW
33-008	322	11673	76	148	72	28	190	9		29	18	GF/LIW
36-000	347	12550	59	155	77	29	193	13		28	12	GF/LIW
SAMPLE	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th	SOURCE
38-001	394	6772	36	110	66	19	94	11	872	24	11	BM
38-003-1	391	6997	62	110	71	16	94	13	766	23	10	BM
38-003-2	293	12049	48	140	74	28	191	12		26	12	GF/LIW
38-007	322	12299	61	153	77	27	214	12		29	18	EML?
38-008	293	11095	37	140	73	30	186	9		28	17	GF/LIW
4-000	300	11613	38	144	72	31	198	11		28	16	GF/LIW?
42-001	361	12492	78	151	85	26	190	12		28	20	GF/LIW
43-001-1	308	11675	44	145	75	27	207	14		27	22	EML?
43-001-2	336	11951	45	149	76	28	196	15		31	21	GF/LIW?
43-002	303	11293	109	140	71	26	187	12		30	15	GF/LIW
43-003-1	404	10942	84	162	110	29	180	11	895	25	21	Unknown
43-003-2	363	14447	96	151	86	30	193	13		29	24	GF/LIW

43-004	363	12444	95	141	81	28	184	12		26	20	GF/LIW
53-000	384	6878	63	114	67	18	95	13	669	23	14	BM
54-000	330	10522	44	139	70	23	187	10		27	19	GF/LIW
6-001-1	331	11500	56	143	77	29	187	8		28	14	GF/LIW
6-001-2	291	10432	46	139	72	30	190	11		26	18	GF/LIW
6-002-1	298	11385	54	143	72	29	189	15		26	22	GF/LIW
6-002-2	283	10677	77	136	72	28	178	11		26	11	GF/LIW
RGM1-S4	308	12897	37	147	104	25	223	15		24	13	
RGM1-S4	309	12914	40	152	102	25	221	11		25	14	
RGM1-S4	280	13062	34	148	104	22	224	11		24	23	
RGM1-S4	294	12935	39	149	102	24	225	11	804	24	15	

Figure 1. Bivariate plot of Zr/Sr concentrations for archaeological specimens from CA-Sha-69. Source composition ranges of archaeologically significant obsidians in northern California from Hughes (2014).



Dashed lines represent the range of variation measured in geological obsidian source samples. Filled triangles plot the artifacts listed in Table 1. Source composition ranges from Hughes (2014).