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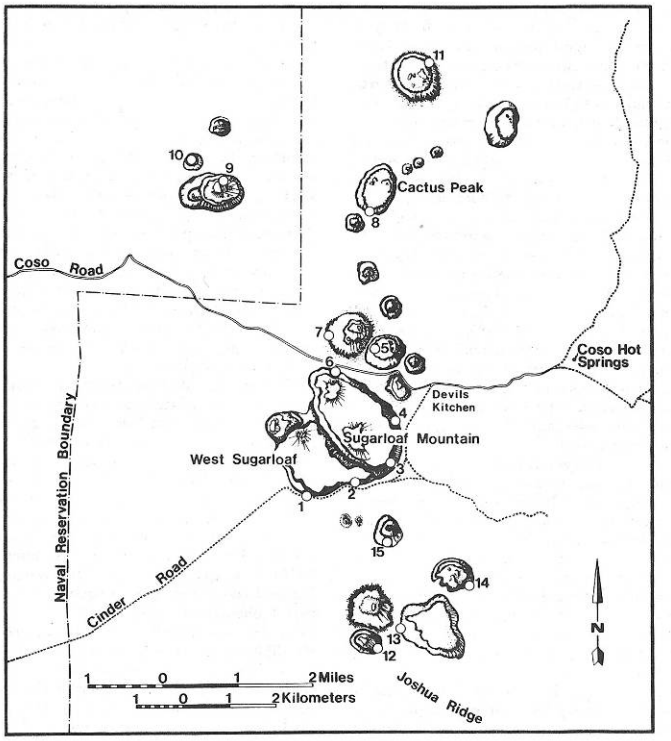
Publication Date
2019-10-02

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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM CA-INY-7833 ON THE NAVAL AIR WEAPONS STATION CHINA LAKE, INYO COUNTY, CALIFORNIA



A portion of the Coso Volcanic Field with relevant rhyolite domes (from Bacon et al. 1981; Hughes 1988)

by

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Report Prepared for

Epsilon Systems Solutions, Inc.
Ridgecrest, California

2 October 2019

INTRODUCTION

The analysis here of 42 obsidian artifacts, from CA-INY-7833 within the China Lake Naval Weapons Station indicates a relatively diverse provenance assemblage of regional obsidian sources similar to previous studies (Shackley 2014, 2015a, 2015b, 2016, 2017). In this case Sugarloaf is dominant (54.8%), followed by West Sugarloaf (35.7%) with a few artifacts produced from Joshua Ridge obsidian (9.5%; see Tables 1 and 2). These sources are approximately 30-35 km west of the site.

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 100 seconds livetime to generate x-ray intensity $K\alpha_1$-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 linear 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 (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 comparison to Ericson and Glascock (2004) and Hughes (1988; see Table 1 and Figure 1 here), as well as source standards for Sugarloaf, West Sugarloaf, and West Cactus Peak in this laboratory. Statistical data analysis progressed through Excel to SPSS (ver. 21) and JMP 12.0.1.

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Table 1. Elemental concentrations and source assignments for the samples and USGS RGM-1 obsidian standard. All measurements in parts per million (ppm) or weight percent as noted.

Cat#	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Pb	Th	Source
14	388	269	7677	68	227	12	47	109	41	27	33	Sugarloaf
15	597	295	9576	78	197	18	40	155	37	23	21	Joshua Ridge
16	555	303	9234	72	279	16	58	139	53	33	29	West Sugarloaf
17	469	324	8881	73	257	16	51	126	44	32	31	Sugarloaf
18	415	299	8482	130	244	15	48	119	38	31	32	Sugarloaf
19	553	297	11100	75	216	20	42	167	39	29	31	Joshua Ridge
20	419	325	9205	86	258	12	48	116	48	30	33	Sugarloaf
21	441	288	8096	76	250	14	49	113	42	35	31	Sugarloaf
22	514	297	8824	80	251	13	52	117	45	35	34	Sugarloaf
23	556	299	9672	85	278	17	50	153	50	32	33	West Sugarloaf
28.1	847	329	11072	183	291	18	52	138	49	35	35	West Sugarloaf
31.1	706	347	8990	105	246	13	50	108	48	36	38	Sugarloaf
36.1	535	290	9310	79	287	16	58	144	49	33	49	West Sugarloaf
36.2	409	266	7827	66	229	15	51	115	40	27	25	Sugarloaf
36.3	554	313	9225	84	251	13	52	119	48	31	34	Sugarloaf
42.1	482	280	8269	82	234	14	53	115	40	32	35	Sugarloaf
42.2	446	290	8212	69	250	11	47	111	48	30	41	Sugarloaf
73.1	502	302	9128	90	257	20	53	130	45	36	37	Sugarloaf
73.2	775	321	11801	166	303	22	53	143	48	38	44	West Sugarloaf
73.3	582	330	11437	145	316	14	58	148	52	39	54	West Sugarloaf
73.4	1058	324	8890	155	250	13	43	107	32	33	33	Sugarloaf
76.1	586	311	9123	103	262	15	48	114	45	46	38	Sugarloaf
76.2	597	298	10339	129	295	19	53	146	49	38	41	West Sugarloaf
76.3	812	377	12164	176	271	12	48	113	39	40	37	Sugarloaf
82.1	578	285	8920	92	249	9	47	119	41	29	30	Sugarloaf
82.2	504	316	8801	96	249	15	49	114	44	32	35	Sugarloaf
82.3	547	300	9360	119	248	12	46	120	42	35	36	Sugarloaf
92.1	459	295	8538	71	252	16	48	125	40	33	37	Sugarloaf
92.2	571	304	10473	120	293	16	59	136	53	38	33	West Sugarloaf
92.3	881	312	10752	187	289	20	52	132	39	35	31	West Sugarloaf
92.4	960	325	10258	157	246	12	41	103	40	37	36	Sugarloaf
96.1	420	280	7988	82	236	13	45	117	49	26	31	Sugarloaf
96.2	944	268	8464	117	171	15	37	134	31	25	22	Joshua Ridge
104.1	503	308	9367	82	286	17	57	146	50	31	42	West Sugarloaf
104.2	605	307	10723	163	295	14	60	143	44	34	45	West Sugarloaf
104.3	683	336	11389	141	298	12	52	140	45	43	49	West Sugarloaf
107.1	510	289	9755	99	274	15	48	140	48	35	41	West Sugarloaf
107.2	558	349	9472	71	268	13	48	123	48	32	27	Sugarloaf
107.3	511	319	9234	106	259	15	56	127	48	45	39	Sugarloaf
111.1	622	296	10302	79	209	16	41	165	42	27	22	Joshua Ridge
111.2	497	293	10006	93	273	16	57	143	47	28	38	West Sugarloaf
111.3	467	297	9318	70	281	19	57	147	40	35	33	West Sugarloaf
RGM1-H2	1465	313	12968	28	147	109	27	220	10	19	10	standard

Table 2. Frequency distribution of source provenance in the assemblage.

		Frequency	Percent
Source	Sugarloaf	23	54.8
	West Sugarloaf	15	35.7
	Joshua Ridge	4	9.5
	Total	42	100.0

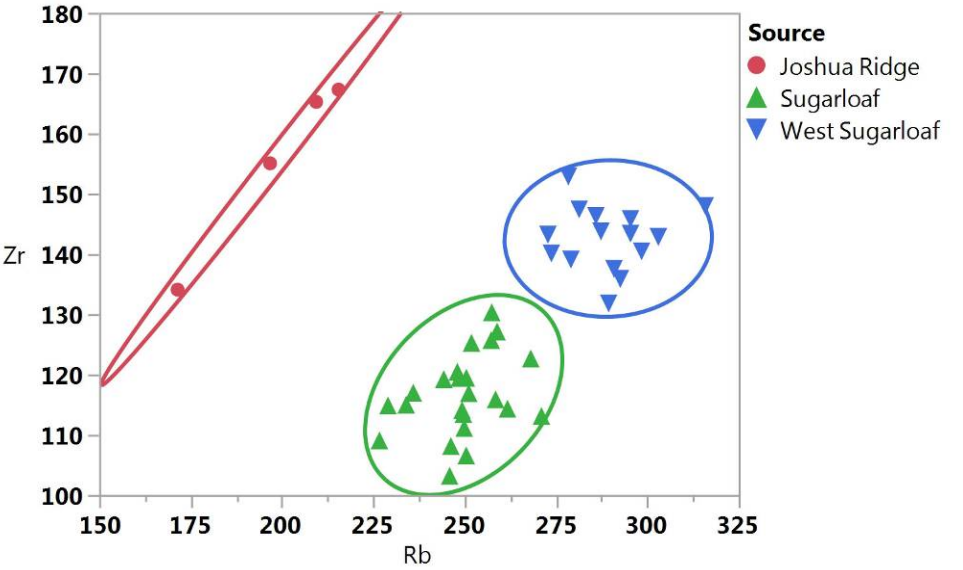


Figure 1. Rb/Zr bivariate plot of the archaeological samples. Confidence ellipses at 95%. See Hughes (1988:258-259).