Title
SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM FOUR ARCHAEOLOGICAL SIES IN WYOMING

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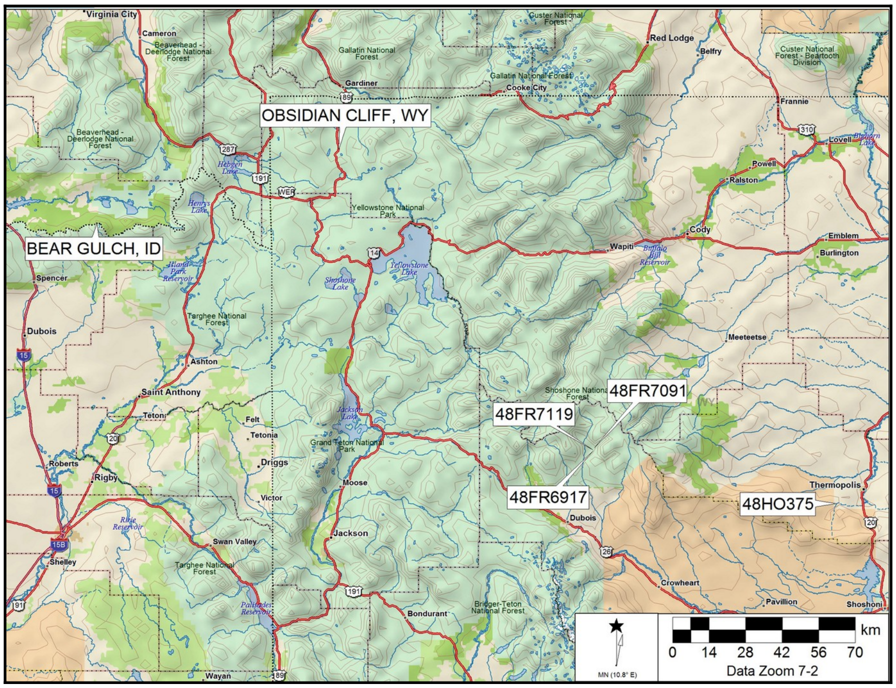

Location of project sites and the two sources of archaeological obsidian in the assemblage

by

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INTRODUCTION

The analysis here of 30 obsidian artifacts from four sites in Wyoming is dominated by Obsidian Cliff, Yellowstone Volcanic Field obsidian, and a few from Bear Gulch, in the Centennial Mountains of northeastern Idaho (Table 1). This combination of sources is common in archaeological contexts in the region, and in previous results from the Caldwell Creek Site (48FR7091; Shackley 2014).

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 Geoarchaeological XRF Laboratory, Albuquerque, New Mexico. 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 from 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.

Trace Element Analysis

The analysis for 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 Kα-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. 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, and 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).

Statistical and Graphical Source Assignment.

The data from the WinTrace™ software were translated directly into Excel for Windows software for manipulation and on into JMP 12.0.1 for statistical analyses. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 a USGS obsidian standard is analyzed during each sample run of ≤ 20 for obsidian artifacts to check machine calibration (Table 1).

Source assignments were made by reference to the laboratory data base and Davis et al. (1995). Further information on the laboratory instrumentation and source data can be found at: http://www.swxrflab.net. Trace element data exhibited in Table 1 and Figure 1 are reported in parts per million (ppm), a quantitative measure by weight.

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Table 1. Elemental concentrations for the archaeological samples and USGS RGM-1 rhyolite standard. All measurement in parts per million (ppm).

Sample	Site	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Source
33	48FR6917	946	246	11661	205	264	12	81	178	38	32	Obsidian Cliff, WY
34	48FR6917	908	273	12010	151	278	11	82	182	45	48	Obsidian Cliff, WY
35	48FR6917	830	236	10831	152	239	12	69	166	48	0	Obsidian Cliff, WY
3725	48FR7091	889	242	11266	93	260	12	78	181	53	0	Obsidian Cliff, WY
3729	48FR7091	933	249	12280	141	269	10	77	175	50	0	Obsidian Cliff, WY
3731	48FR7091	851	263	11041	102	246	11	79	171	48	0	Obsidian Cliff, WY
3735	48FR7091	944	254	10508	88	235	11	79	171	46	45	Obsidian Cliff, WY
3743	48FR7091	1027	274	11998	108	257	12	78	173	49	15	Obsidian Cliff, WY
3745	48FR7091	837	249	10528	78	237	15	72	166	43	2	Obsidian Cliff, WY
3748	48FR7091	910	270	11634	92	267	11	86	180	49	29	Obsidian Cliff, WY
3753	48FR7091	906	271	12464	100	273	10	81	184	51	4	Obsidian Cliff, WY
3754	48FR7091	865	282	12203	100	279	14	80	178	49	42	Obsidian Cliff, WY
3758	48FR7091	896	257	11754	93	265	10	76	181	49	25	Obsidian Cliff, WY
3764	48FR7091	882	241	11664	107	263	12	78	181	49	23	Obsidian Cliff, WY
3766	48FR7091	919	271	11387	112	261	12	81	175	53	16	Obsidian Cliff, WY
3767	48FR7091	850	258	11419	95	269	10	82	181	50	33	Obsidian Cliff, WY
3769	48FR7091	956	256	11933	92	267	14	72	180	41	41	Obsidian Cliff, WY
3770	48FR7091	859	265	11628	106	256	10	76	178	48	16	Obsidian Cliff, WY
3772	48FR7091	841	230	10158	84	233	14	78	169	51	30	Obsidian Cliff, WY
3773	48FR7091	887	253	11598	111	267	10	75	182	42	0	Obsidian Cliff, WY
3775	48FR709	958	248	11483	88	258	16	83	169	50	0	Obsidian Cliff,

	1											WY
104	48FR711 9	854	245	10783	96	246	11	77	175	49	6	Obsidian Cliff, WY
168	48HO375	1985	319	12984	185	163	48	40	255	52	648	Bear Gulch, ID
188	48HO375	891	247	12011	132	276	13	80	179	47	0	Obsidian Cliff, WY
206	48HO375	1833	350	13687	125	177	51	52	297	52	888	Bear Gulch, ID
258	48HO375	938	245	11719	216	253	13	74	165	44	0	Obsidian Cliff, WY
1259	48HO375	1758	346	14050	103	185	53	45	307	54	848	Bear Gulch, ID
1260	48HO375	1684	329	13402	140	175	54	44	289	59	888	Bear Gulch, ID
1261	48HO375	1256	261	12264	197	265	14	78	177	41	0	Obsidian Cliff, WY
1262	48HO375	1000	248	12023	181	273	13	74	166	45	0	Obsidian Cliff, WY
RGM1-S4		1514	307	13174	46	147	106	27	224	9	831	standard
RGM1-S4		1599	298	13317	43	144	115	29	216	3	826	standard

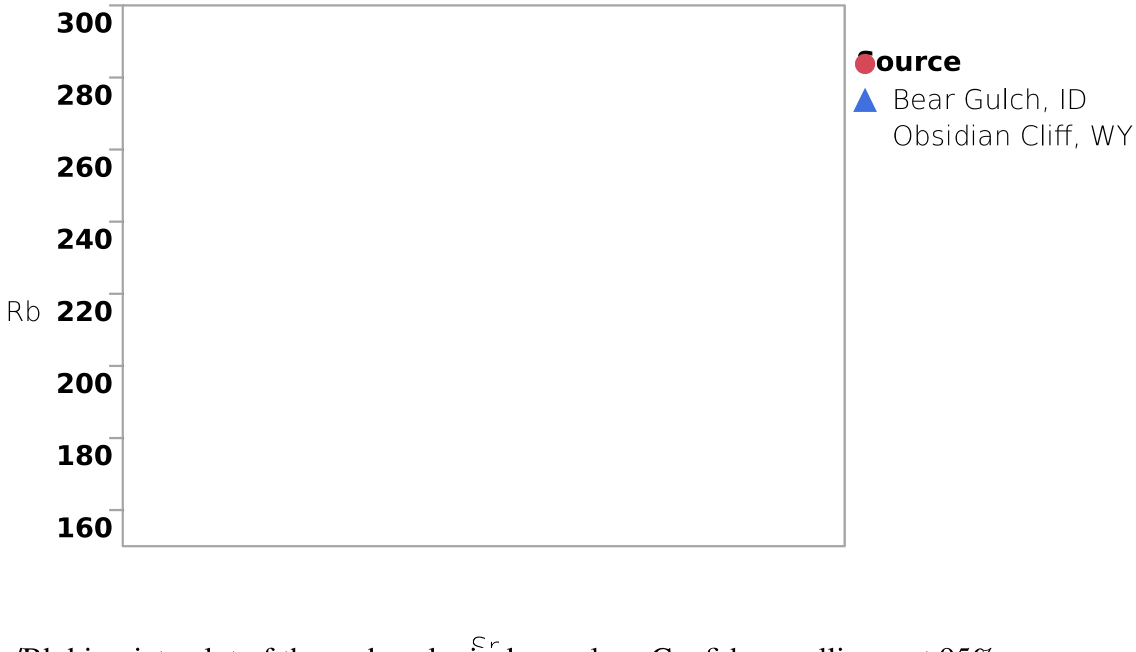

Figure 1. Sr/Rb bivariate plot of the archaeological samples. Confidence ellipses at 95%.