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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM TWO SITES IN SOUTHERN COLORADO

by

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Report Prepared for

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INTRODUCTION

The analysis here of 14 artifacts from two sites in southern Colorado, while a small sample, indicates some differences in source provenance. Fulk Ranch appears to be focused on Taos Plateau and Jemez Volcanic Field sources in northern New Mexico, and the site with the prefix “RML” exhibits sources from northern New Mexico and western Wyoming.

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 in the Archaeological 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 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.

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 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 least-squares 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).

The data from the WinTrace software were translated directly into Excel for Windows software for manipulation and on into SPSS for Windows 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 for obsidian artifacts to check machine calibration (Table 1).

Source assignments were made by reference to the Berkeley data base (see Shackley 1995, 2005) and information supplied by Fred Nelson, Brigham Young University, and Skinner's Yellowstone study (2007). Little source data for some of these sources is available in print or on the web. Further information on the laboratory instrumentation can be found at: <http://www.swxrflab.net/>. Trace element data exhibited in Table 1 are reported in parts per million (ppm), a quantitative measure by weight (see also Figures 1 and 2).

This assemblage, contained a few samples with writing "white out" on both surfaces and were not analyzed. White out typically contains the analyzed elements Mn, Zn, Rb, and Nb.

DISCUSSION

The relatively small sample size hinders much inference. There are some differences in procurement, but both sites are dominated by sources in northern New Mexico (Tables 1 and 2). A first for this lab, is the presence of No Agua Peak obsidian from the Taos Plateau Volcanic Field. While it is the nearest source to both these sites, it is a low quality vitrophyric glass and rarely appears in archaeological context, even in sites in northern New Mexico and southern Colorado.

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Table 1. Elemental concentrations and source assignments for the archaeological specimens.
All measurements in parts per million (ppm).

Site/Sample	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba ¹	Source
RML-5-3	940	253	1150 5	86	252	12	79	179	49	94	Obsidian Cliff
RML-H-1	970	515	1084 3	104	210	8	65	178	96	0	Cerro Toledo Rhy.
RML-H-2	104 3	270	1271 2	104	275	13	85	182	47	90	Obsidian Cliff
RML-J-1	982	395	1016 2	63	156	11	43	162	52	30	Valles Rhyolite
RML-J-2	959	399	7674	41	149	15	23	67	48	19	El Rechuelos
RML-L-1	966	419	8044	47	157	12	23	73	47	21	El Rechuelos
RML-K(1)	934	529	1067 9	108	205	11	64	177	102		Cerro Toledo Rhy.
SP3260-15	103 5	408	1049 7	90	163	13	44	167	53		Valles Rhyolite
SPE141-1	969	402	1042 7	116	165	12	46	161	55		Valles Rhyolite
SPE152-13	959	390	1024 3	76	163	13	43	169	60	39	Valles Rhyolite
SPE252-5	844	842	7448	72	284	11	54	81	90		No Agua Pks (West)
SPE29-35	991	437	8136	55	160	13	25	68	47		El Rechuelos
SPE76-23	965	411	1026 7	130	164	9	44	160	53		Valles Rhyolite
SPE89-176	736	133	5370	15	0	17	1	13	0		glass
SPE89-214	914	357	9667	85	155	11	44	157	52		Valles Rhyolite
RGM1-S4	161 8	287	1329 9	37	145	108	25	218	9	841	standard
RGM1-S4	155 4	296	1326 4	41	149	110	26	218	9		standard

¹ Barium acquired for only those samples without sample numbers on the specimen.

Table 2. Crosstabulation of obsidian source provenance by site. Includes only obsidian artifacts.

		Site		
		FULK RANCH	RML	Total
Source	Cerro Toledo Rhy.	Count	0	2
		% within Source	.0%	100.0%
		% within Site/Sample	.0%	14.3%
		% of Total	.0%	14.3%
El Rechuelos		Count	1	2
		% within Source	33.3%	66.7%
		% within Site/Sample	14.3%	28.6%
		% of Total	7.1%	14.3%
No Agua Pks (West)		Count	1	0
		% within Source	100.0%	.0%
		% within Site/Sample	14.3%	.0%
		% of Total	7.1%	.0%
Obsidian Cliff		Count	0	2
		% within Source	.0%	100.0%
		% within Site/Sample	.0%	28.6%
		% of Total	.0%	14.3%
Valles Rhyolite		Count	5	1
		% within Source	83.3%	16.7%
		% within Site/Sample	71.4%	14.3%
		% of Total	35.7%	7.1%
Total		Count	7	7
		% within Source	50.0%	50.0%
		% within Site/Sample	100.0%	100.0%
		% of Total	50.0%	50.0%

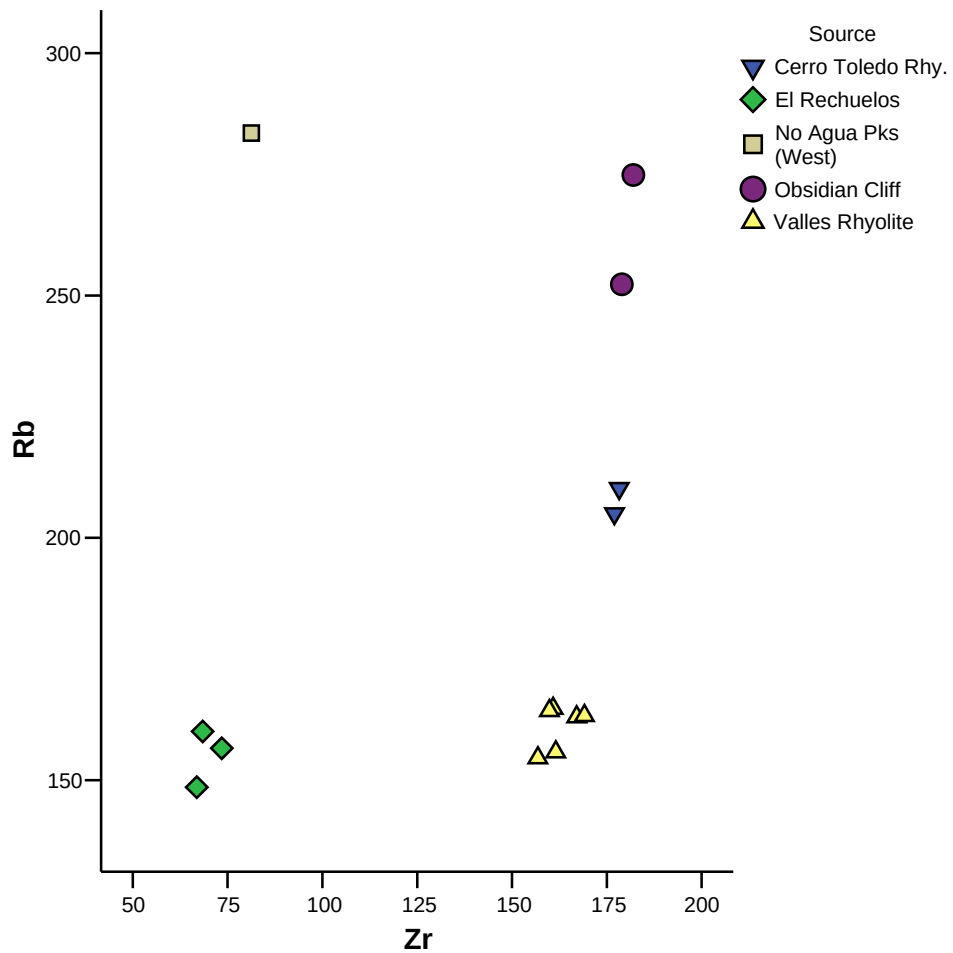


Figure 1. Zr versus Rb, bivariate plot of the elemental concentrations for all archaeological specimens. Non-obsidian removed.

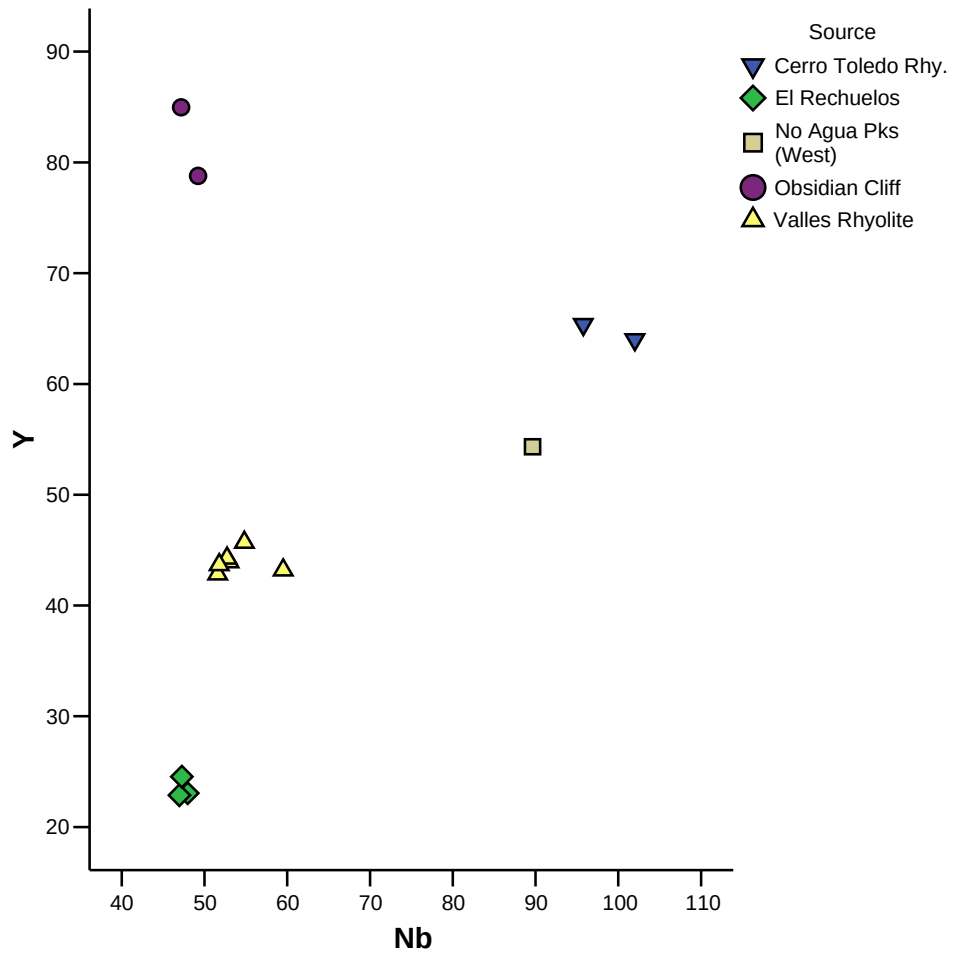


Figure 2. Nb versus Y bivariate plot of the specimens, more effectively discriminating the Jemez Volcanic Field sources (see Shackley 2005).