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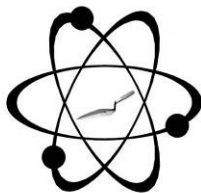
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**SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM 5MT1905 AND  
5MT4126, MONTEZUMA COUNTY, SOUTHWEST COLORADO**

by

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Colorado

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## INTRODUCTION

The analysis here of 19 artifacts from two sites in Montezuma County in southwest Colorado exhibits a mix of Jemez Mountains, New Mexico (El Rechuelos, Valles Rhyolite (Cerro del Medio), and Cerro Toledo Rhyolite) and Mount Taylor (Grants Ridge) obsidian in proportions similar to some earlier studies (see Arakawa et al. 2011; c.f. Shackley 2014; Tables 1 and 2, Figure 1).

## 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  $\mu\text{m}$  (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  $\text{min}^{-1}$  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 100 seconds livetime to generate x-ray intensity Ka-line data for elements titanium (Ti), manganese (Mn), iron (as  $\text{Fe}_2\text{O}_3^T$ ), 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 2010; 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 of 20 for obsidian artifacts to check machine calibration (Table 1).

Source assignments were made by reference to the laboratory data base (see Shackley 1995, 2005). 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 Figure 1).

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

Sample	Site	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Pb	Th	Source
1	5MT190 5	310	29 6	0	0	21	1	18	1	0	8	not obsidian
1-1	5MT190 5	594	38 2	1	15 1	11	24	73	53	24	23	El Rechuelos
1-2	5MT190 5	645	41 7	1	15 9	16	20	72	48	23	27	El Rechuelos
2-1	5MT190 5	666	39 9	1	16 2	11	46	15 8	58	27	18	Valles Rhy (Cerro del Medio)
2-2	5MT190 5	383	69 4	1	52 5	13	76	11 0	18 0	58	22	Grants Ridge-Mt Taylor
4	5MT190 5	334	17 9	0	0	14	2	15	1	2	5	not obsidian
6-1	5MT190 5	376	72 4	1	55 1	10	77	11 8	19 8	60	28	Grants Ridge-Mt Taylor
6-2	5MT190 5	890	39 4	1	16 1	10	41	15 2	48	18	16	Valles Rhy (Cerro del Medio)
1415	5MT412 6	576	37 8	1	15 6	13	44	16 7	56	21	26	Valles Rhy (Cerro del Medio)
1440	5MT412 6	783	48 5	1	16 7	17	31	73	48	29	18	El Rechuelos
1549	5MT412 6	467	47 9	1	20 6	9	61	17 3	98	33	29	Cerro Toledo Rhy
1587	5MT412 6	569 2	44 8	1	16 7	18	48	17 3	55	26	15	Valles Rhy (Cerro del Medio)
1594	5MT412 6	630	40 2	1	16 3	15	41	16 7	49	24	22	Valles Rhy (Cerro del Medio)
1602	5MT412 6	626	33 8	1	14 9	14	47	15 1	48	23	23	Valles Rhy (Cerro del Medio)
1615	5MT412 6	615	52 1	1	21 5	13	68	17 8	10 1	41	35	Cerro Toledo Rhy
1735	5MT412 6	681	41 4	1	16 5	13	45	16 8	57	24	18	Valles Rhy (Cerro del Medio)
1854	5MT412 6	638	39 0	1	15 6	17	47	16 1	52	24	25	Valles Rhy (Cerro del Medio)
1888	5MT412 6	596	41 5	1	15 7	11	23	72	42	25	24	El Rechuelos
1904	5MT412 6	662	45 2	1	19 5	13	63	17 4	90	37	27	Cerro Toledo Rhy
RGM1-S5		154 0	30 6	1	14 4	10 4	25	21 5	6	21	11	standard

Table 2. Crosstabulation of site by source. Non-obsidian excluded.

Source		Site		Total
		5MT1905	5MT4126	
Valles Rhy (Cerro del Medio)	Count	2	6	8
	% within Source	25.0%	75.0%	100.0%
	% within Site	33.3%	54.5%	47.1%
	% of Total	11.8%	35.3%	47.1%
El Rechuelos	Count	2	2	4
	% within Source	50.0%	50.0%	100.0%
	% within Site	33.3%	18.2%	23.5%
	% of Total	11.8%	11.8%	23.5%
Cerro Toledo Rhy	Count	0	3	3
	% within Source	0.0%	100.0%	100.0%
	% within Site	0.0%	27.3%	17.6%
	% of Total	0.0%	17.6%	17.6%
Grants Ridge-Mt Taylor	Count	2	0	2
	% within Source	100.0%	0.0%	100.0%
	% within Site	33.3%	0.0%	11.8%
	% of Total	11.8%	0.0%	11.8%
Total	Count	6	11	17
	% within Source	35.3%	64.7%	100.0%
	% within Site	100.0%	100.0%	100.0%
	% of Total	35.3%	64.7%	100.0%



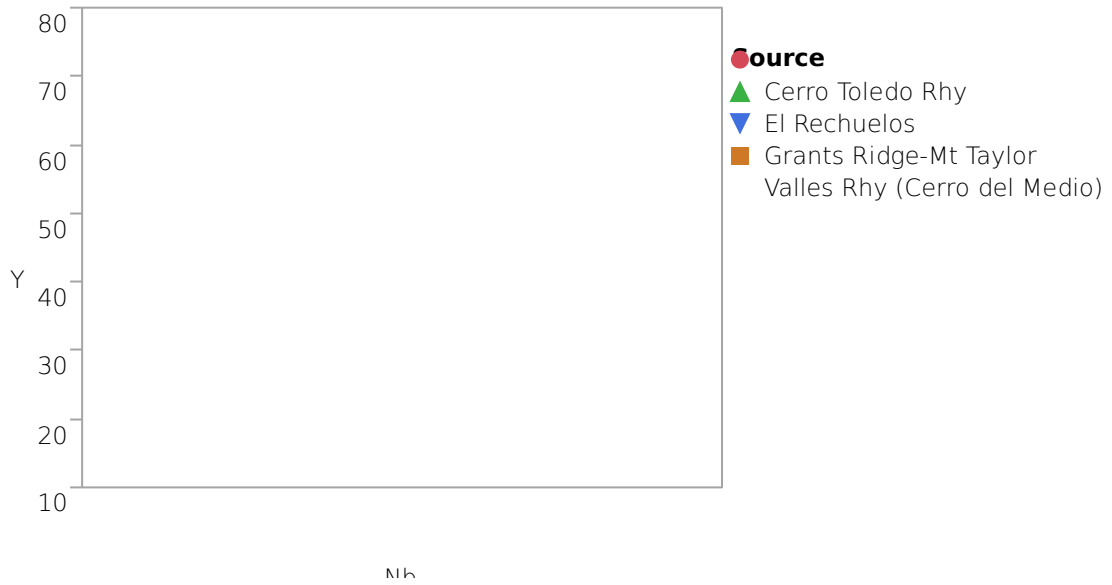


Figure 1. Nb versus Y bivariate plot of the elemental concentrations for the archaeological specimens. Confidence ellipses are at 95%.