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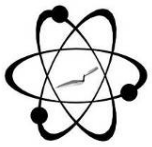
Title
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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM FROM SEVEN SITES ALONG THE MIDDLE RIO GRANDE, CENTRAL NEW MEXICO

by

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INTRODUCTION

The analysis here of 10 obsidian artifacts from four sites along the Middle Rio Grande indicates procurement from one of three sources in the Jemez Mountains, all of which are available in Quaternary sediments nearby on the eastern terraces of the Rio Grande (Shackley 2005, 2012; Table 1 and Figure 1 here). Most of the artifacts were produced from the Cerro Toledo Rhyolite obsidian source, the most commonly recovered source in Rio Grande alluvium between the Jemez Mountains and Chihuahua (Church 2000; Shackley 2012). Indeed on the Quaternary terraces on both the north and south sides of Tijeras Wash nearby, of 409 samples recovered: 93% was Cerro Toledo Rhyolite obsidian; 2% El Rechuelo Rhyolite obsidian; and 1.2% Bearhead Rhyolite obsidian, the remainder was from Canovas Canyon Rhyolite (2.4%), and Valles Rhyolite (Cerro del Medio) ≈1% (Shackley 2012).

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 $K\alpha_1$-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. 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 North Amerian obsidians is available in Shackley (1988, 1995, 2005, 2019b; 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 ≤19 for obsidian artifacts to check machine calibration (Table 1).

Source assignments were made by reference to the laboratory database (see Shackley 2005; Shackley et al. 2016). 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	Pb	Th	SOURCE
60	LA 112787	551	500	10162	43	181	10	27	81	53	28	12	El Rechuelos Rhy
1001.2	LA 112793	597	507	12153	135	216	11	60	174	100	36	24	Cerro Toledo Rhy
11	LA 112795	1600	633	12174	64	119	100	26	143	37	22	13	Bearhead Rhy
1005.9	LA 112796	540	450	11836	86	189	13	59	172	97	30	27	Cerro Toledo Rhy
1007	LA 112796	619	474	11908	148	201	10	59	172	92	36	21	Cerro Toledo Rhy
A40.1	LA 112796	634	530	12428	113	212	11	65	183	94	38	22	Cerro Toledo Rhy
20.1	LA 112797	600	470	11807	101	210	9	60	178	95	35	24	Cerro Toledo Rhy
1031.2	LA 112798	681	503	11771	94	203	9	63	180	92	32	16	Cerro Toledo Rhy
1024.3	LA 112799	584	546	12257	133	213	11	65	173	98	36	26	Cerro Toledo Rhy
1044.2	LA 112799	523	435	11637	119	196	9	62	168	95	35	29	Cerro Toledo Rhy
RGM1-S6		1484	298	13654	16	146	106	19	216	7	22	17	standard

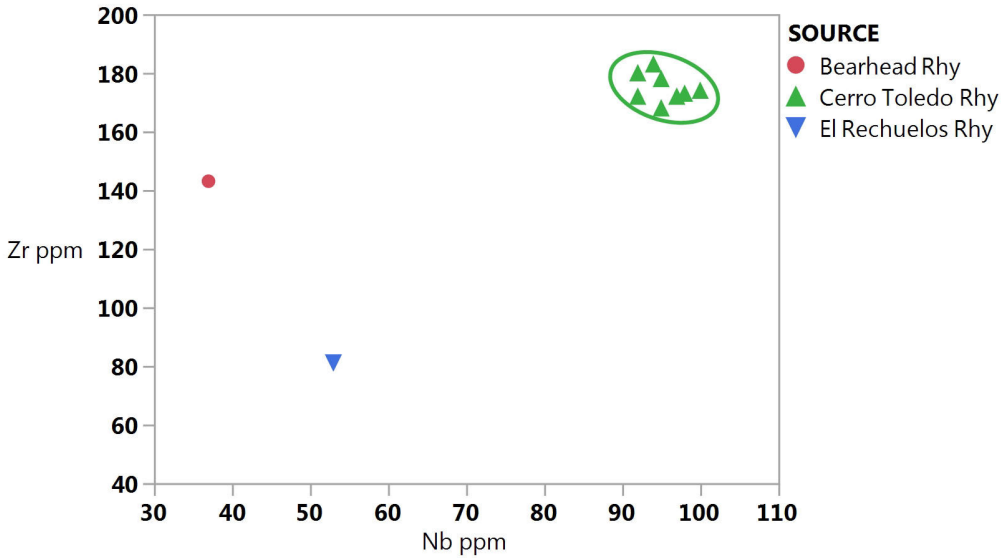


Figure 1. Nb/Zr bivariate plot of the archaeological samples from all sites. Confidence at 95%.