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**SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM LA 44496,
CHAVEZ COUNTY, NEW MEXICO**

by

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Report Prepared for

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INTRODUCTION

The provenance analysis here of fourteen obsidian artifacts from LA 44496, Chavez County, New Mexico indicates that all the samples were procured from one of the three major sources in the Jemez Mountains, Cerro Toledo Rhyolite, El Rechuelos, or Valles Rhyolite (Cerro del Medio; see Shackley 2005). While Cerro Toledo and El Rechuelos are available as secondary deposits in Rio Grande Quaternary alluvium, Valles Rhyolite is only available in the Valles Caldera proper, except for a few very small nodules seen as far south as Albuquerque, but not as far south as Las Cruces (Church 2000; Shackley 2012). Additionally, many of the artifacts exhibit remnant angular cortex and are of a size too large for nodules available below Albuquerque (Shackley 2005, 2012). Much of the obsidian raw material could have been procured directly or through exchange through the corridor east of the Sandia Mountain chain, through large sites like Paako.

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

The archaeological sample was 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).

Trace Element Analyses

Trace element analyses were conducted to aid in the determination of rock type. All analyses for this study were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer, located in 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 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 $K\alpha$ -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. 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 and SPSS software for statistical manipulation. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 a USGS rhyolite standard is analyzed during each sample run for obsidian artifacts to check machine calibration (Table 1). Source assignments were made by reference to Shackley (1995, 2005) and data at the laboratory (<http://swxrflab.net/swobsrscs.htm>; see Table 1 and Figure 1 here).

REFERENCES CITED

- Davis, K.D., T.L. Jackson, M.S. Shackley, T. Teague, and J.H. Hampel
2011 Factors Affecting the Energy-Dispersive X-Ray Fluorescence (EDXRF) Analysis of Archaeological Obsidian. In *X-ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M.S. Shackley, pp. 45-64. Springer, New York.
- Govindaraju, K.
1994 1994 Compilation of Working Values and Sample Description for 383 Geostandards. *Geostandards Newsletter* 18 (special issue).
- Hampel, Joachim H.
1984 Technical Considerations in X-ray Fluorescence Analysis of Obsidian. In *Obsidian Studies in the Great Basin*, edited by R.E. Hughes, pp. 21-25. Contributions of the University of California Archaeological Research Facility 45. Berkeley.
- Hildreth, W.

- 1981 Gradients in Silicic Magma Chambers: Implications for Lithospheric Magmatism. *Journal of Geophysical Research* 86:10153-10192.
- Hughes, Richard E., and Robert L. Smith
 1993 Archaeology, Geology, and Geochemistry in Obsidian Provenance Studies. In *Scale on Archaeological and Geoscientific Perspectives*, edited by J.K. Stein and A.R. Linse, pp. 79-91. Geological Society of America Special Paper 283.
- Mahood, Gail A., and James A. Stimpac
 1990 Trace-Element Partitioning in Pantellerites and Trachytes. *Geochemica et Cosmochimica Acta* 54:2257-2276.
- McCarthy, J.J., and F.H. Schamber
 1981 Least-Squares Fit with Digital Filter: A Status Report. In *Energy Dispersive X-ray Spectrometry*, edited by K.F.J. Heinrich, D.E. Newbury, R.L. Myklebust, and C.E. Fiori, pp. 273-296. National Bureau of Standards Special Publication 604, Washington, D.C.
- Schamber, F.H.
 1977 A Modification of the Linear Least-Squares Fitting Method which Provides Continuum Suppression. In *X-ray Fluorescence Analysis of Environmental Samples*, edited by T.G. Dzubay, pp. 241-257. Ann Arbor Science Publishers.
- Shackley, M. Steven
 1988 Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study. *American Antiquity* 53(4):752-772.
 1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60(3):531-551.
 2005 *Obsidian: Geology and Archaeology in the North American Southwest*. University of Arizona Press, Tucson.
 2011 An Introduction to X-Ray Fluorescence (EDXRF) Analysis in Archaeological Obsidian. In *X-ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M.S. Shackley, pp. 7-44. Springer, New York.
 2012 The Secondary Distribution of Archaeological Obsidian in Rio Grande Quaternary Sediments, Jemez Mountains to San Antonito, New Mexico: Inferences for Prehistoric Procurement and the Age of Sediments. Poster presentation at the Society for American Archaeology, Annual Meeting, Memphis, Tennessee.

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

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
18	746	425	10627	162	16	25	74	47	El Rechuelos
22	663	430	10259	155	17	25	77	46	El Rechuelos
80	651	375	11566	154	14	44	167	55	Valles Rhy (Cerro del Medio)
165	763	457	12472	149	13	46	167	52	Valles Rhy (Cerro del Medio)
270-F	690	406	11898	166	16	47	168	53	Valles Rhy (Cerro del Medio)
380-A	773	433	12112	162	12	41	169	53	Valles Rhy (Cerro del Medio)
628	617	381	11753	159	14	42	165	51	Valles Rhy (Cerro del Medio)
636	696	500	12227	216	9	63	184	93	Cerro Toledo Rhy
914	653	496	12023	207	11	66	171	92	Cerro Toledo Rhy
915	728	416	12053	164	14	43	173	52	Valles Rhy (Cerro del Medio)
990	592	447	11664	206	12	61	169	93	Cerro Toledo Rhy
FEATURE 7	781	418	12264	169	17	45	169	54	Valles Rhy (Cerro del Medio)
IO	861	505	11959	199	10	62	160	90	Cerro Toledo Rhy
STR. 412	575	369	11748	162	14	40	167	51	Valles Rhy (Cerro del Medio)
RGM1-S4	1487	295	13689	150	109	24	222	13	standard

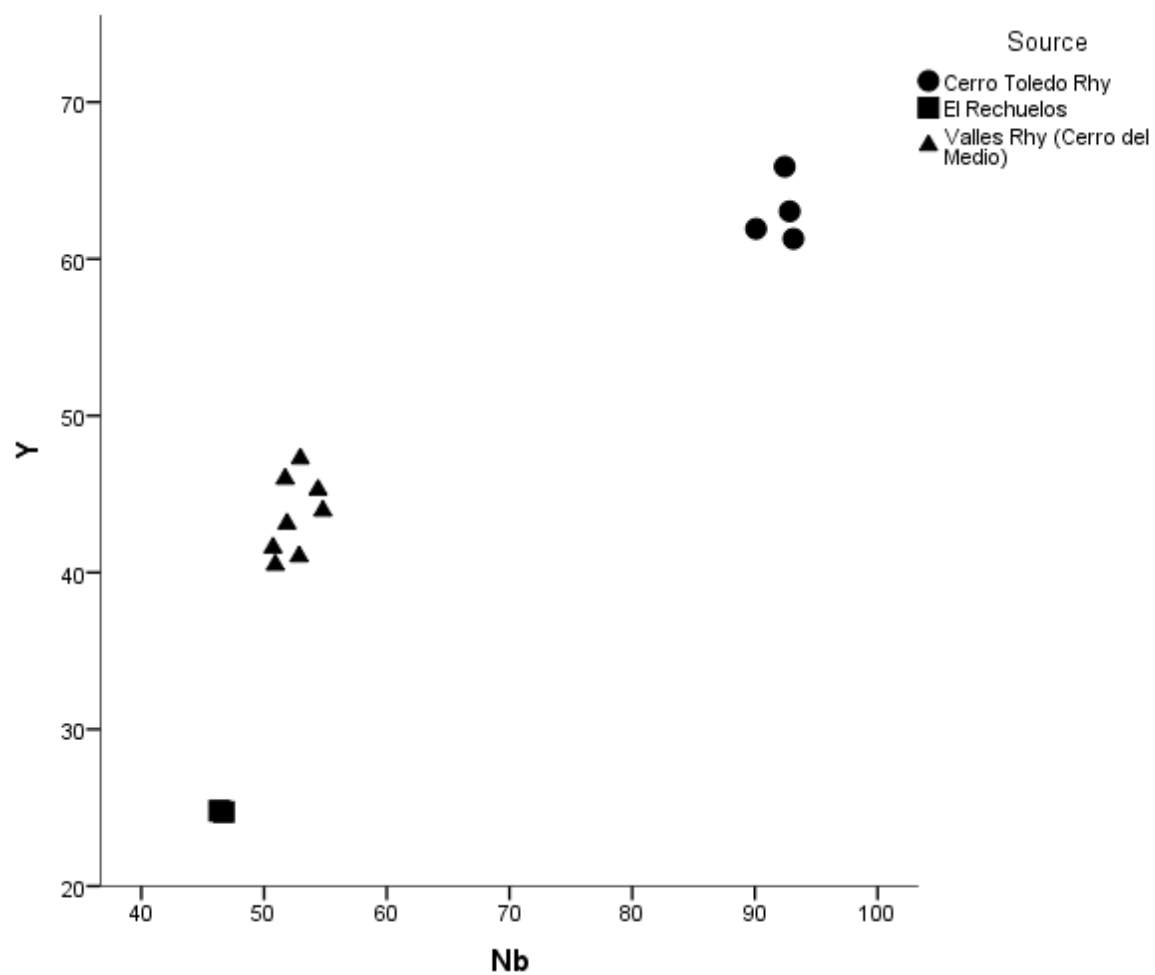


Figure 1. Nb versus Y bivariate plot of the elemental concentrations for all the archaeological specimens.