

UC Berkeley

Archaeological X-ray Fluorescence Reports

Title

SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM FROM THE STEWARD SITE (41PT519), NORTH TEXAS

Permalink

<https://escholarship.org/uc/item/6fr1r27d>

Author

Shackley, M. Steven

Publication Date

2019-12-12

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-ShareAlike License, available at <https://creativecommons.org/licenses/by-sa/4.0/>



GEOARCHAEOLOGICAL XRF LAB
A GREEN SOLAR FACILITY

GEOARCHAEOLOGICAL X-RAY FLUORESCENCE SPECTROMETRY LABORATORY
8100 Wyoming Blvd., Ste M4-158
USA

Albuquerque, NM 87113

SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM THE STEWARD SITE (41PT519), NORTH TEXAS

by

M. Steven Shackley, Ph.D., Director
Geoarchaeological XRF Laboratory
Albuquerque, New Mexico

Report Prepared for

Arlo McKee
Texas Historical Commission
Austin, Texas

12 December 2019

INTRODUCTION

The analysis here of five obsidian artifacts from 41PT501 in north Texas indicates that all the artifacts were produced from the Cerro Toledo Rhyolite obsidian source in the Jemez Mountains of northern New Mexico (Table 1 and Figure 1). Cerro Toledo Rhyolite obsidian along with Valles Rhyolite (Cerro del Medio) obsidian was the most commonly procured from the Jemez Mountains sources (Shackley 2005; Shackley et al. 2016).

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 American 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.

REFERENCES CITED

- Davis, L.B., S.A. Aaberg, J.G. Schmitt, and A. M. Johnson, 1995, *The Obsidian Cliff Plateau Prehistoric Lithic Source, Yellowstone National Park, Wyoming*. National Park Service, Division of Cultural Resources Selection Series 6, Denver, Colorado.
- Davis, M.K., T.L. Jackson, M.S. Shackley, T. Teague, and J. 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. Stimac, 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.S., 1988, Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study. *American Antiquity* 53:752-772.
- Shackley, M. S., 1995, Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60(3):531-551.
- Shackley, M.S., 2005, *Obsidian: Geology and Archaeology in the North American Southwest*. University of Arizona Press, Tucson.
- Shackley, M.S., 2011, An Introduction to X-Ray Fluorescence (XRF) Analysis in Archaeology. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, M.S. Shackley (Ed.), pp. 7-44. Springer, New York.
- Shackley, M.S., F. Goff, and S.G. Dolan, 2016, Geologic origin of the source of Bearhead rhyolite (Paliza Canyon) obsidian, Jemez Mountains, Northern New Mexico. *New Mexico Geology* 38:52-62.

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

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba	Ce	Source
1	940	508	11497	215	11	59	183	105	0	71	Cerro Toledo Rhy, NM
2	931	528	11173	226	9	64	184	103	0	27	Cerro Toledo Rhy, NM
3	848	460	10259	209	10	68	182	100	24	54	Cerro Toledo Rhy, NM
4	840	483	10627	209	9	61	183	107	13	52	Cerro Toledo Rhy, NM
5	780	442	9873	203	9	65	181	98	16	87	Cerro Toledo Rhy, NM
RGM1-S4	1556	296	13168	147	104	27	217	10	787	46	standard

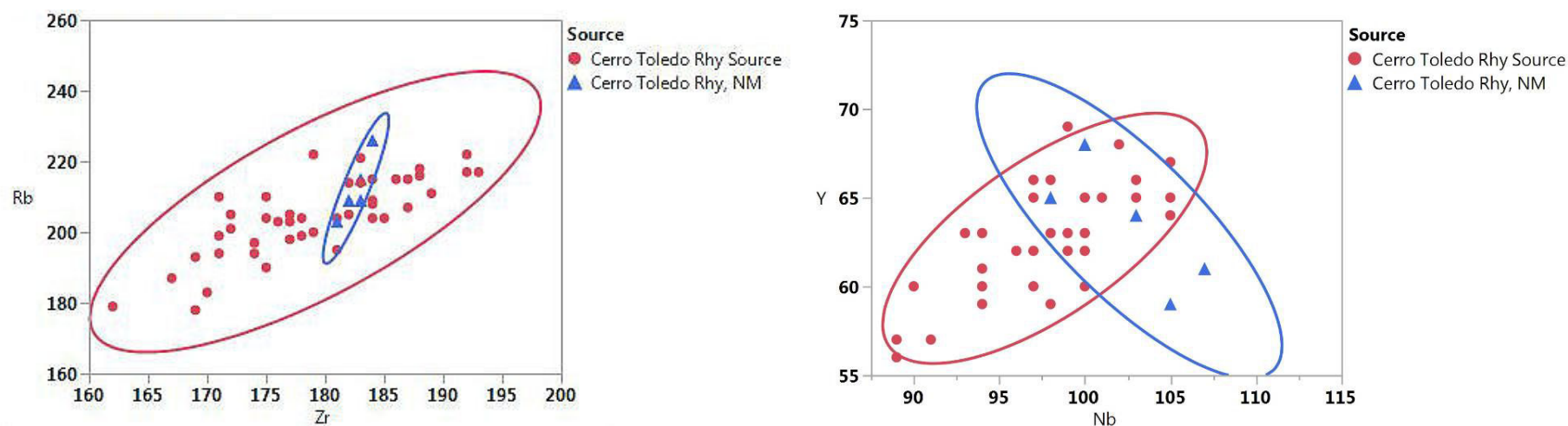


Figure 1. Zr/Rb and Nb/Y bivariate plots of the archaeological samples and Cerro Toledo Rhyolite obsidian source standards. Confidence ellipses and lines at 95%.