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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM MESCALERO CAVE (LA 11033), CENTRAL NEW MEXICO

by

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INTRODUCTION

The analysis here of five obsidian artifacts from probable Middle Archaic contexts at Mescalero Cave indicates a diverse assemblage including obsidian artifacts originally procured from one of the sources originating in Valles Caldera in northern New Mexico. While some of the obsidian could have been procured as secondary deposits in the Rio Grande alluvium 135 km west, one of the sources is not available as secondary deposits.

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).

The trace element analyses were performed in the Archaeological XRF Laboratory, Department of Earth and Planetary Sciences, University of California, Berkeley, using a Spectrace/ThermoNoran™ QuanX energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with an air cooled Rh x-ray target with a 125 micron Be window, an x-ray generator that operates from 4-50 kV/0.02-2.0 mA at 0.02 increments, using an IBM PC based microprocessor and WinTrace™ reduction software. The x-ray tube is operated at 30 kV, 0.16 mA, 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^T), thorium (Th), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Weight percent iron ($Fe_2O_3^T$) can be derived by multiplying ppm estimates by 1.4297(10⁻⁴). Trace element intensities were converted to concentration estimates by employing

a least-squares calibration line 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). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1995, 2002a; also Mahood and Stimac 1991; and Hughes and Smith 1993). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGV-1 (andesite), GSP-1, SY-2 (syenite), BHVO-1 (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), all US Geological Survey standards, and BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). In addition to the reported values here, Ni, Cu, Zn, and Ga were measured, but these are rarely useful in discriminating glass sources and are not generally reported.

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. Table 1 shows a comparison between values recommended for RGM-1 as of 1 December 2002. RGM-1 is analyzed during each sample run to check machine calibration. With refinements to the calibration, the deviation will improve, although the measurements for the mid-Z elements is within 1 percent.

Trace element data exhibited in Tables 1 and 2, and Figure 1 are reported in parts per million (ppm), a quantitative measure by weight. Source nomenclature is from Baugh and Nelson (1987), Glascock et al. (1999), and Shackley (1988, 1995, 1998, 2002a; see also <http://obsidian.pahma.berkeley.edu/swobsrsrcs.htm>).

GEOCHEMICAL RESULTS AND SUMMARY

While it is certainly expectable that the obsidian raw material used to produce these artifacts is from the Jemez Mountains in northern New Mexico, the presence of Valle Grande Rhyolite glass is more interesting. The long term study of the secondary distribution of the rhyolite glasses from Quaternary sources in and around the Valles Caldera indicates that Valle Grande, as the most recent event, has not eroded outside the caldera wall (Shackley 2002a, 2002b). While El Rechuelos, and most definitely Cerro Toledo Rhyolite glasses have been eroding into the Chama and Rio Grande systems respectively for over 1 million years, Valle Grande has not, except for some very small marekanites that occur as a result of the pyroclastic eruption near Los Alamos (Shackley 2002a, 2002b). Any Valle Grande obsidian recovered in archaeological contexts must have been procured at or near the primary sources of Valle Grande (i.e. Cerro del Medio) on the caldera floor. If these Middle Archaic knappers procured their raw materials as part of annual movements, then this would include a range with a radius of over 295 km, well within that suggested for the Middle Archaic in the Southwest (Shackley 1990, 1996; Vierra 1994). Further evidence suggesting direct procurement from the Valles Caldera area is the angular to sub-rounded cortex on the secondary flake or bipolar core, FS 1054, that was produced from Cerro Toledo Rhyolite obsidian. Secondary deposits of this source, even as near to the caldera as Tijeras Canyon in Albuquerque, all exhibit sub-rounded to rounded cortex (Shackley 2002a). The evidence, while not as solid as I would like, suggests that at least some of this obsidian was procured directly rather than through exchange. In any event, the Valle Grande obsidian had to have been procured originally from the caldera floor, regardless of the means with which it came to Mescalero Cave.

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Table 1. X-ray fluorescence concentrations for selected trace elements for RGM-1 (n=11 runs). \pm values represent first standard deviation computations for the group of measurements. All values are in parts per million (ppm) as reported in Govindaraju (1994) and this study. RGM-1 is a U.S. Geological Fe^T can be converted to Fe₂O₃^T with a multiplier of 1.4297(10⁻⁴) (see also Glascock 1991).

SAMPLE	Ti	Mn	Fe	Th	Rb	Sr	Y	Zr	Nb
RGM-1 (Govindaraju 1994)	1600	279	12998	15	149	108	25	219	8.9
RGM-1 (this study)	1741 \pm 37	296 \pm 11	14254 \pm 129	13 \pm 6	150 \pm 3	113 \pm 2	24 \pm 3	220 \pm 3	9 \pm 3

Table 2. Elemental concentrations for the archaeological samples. All measurements in parts per million (ppm).

SAMPLE	Ti	Mn	Fe	Th	Rb	Sr	Y	Zr	Nb	Source
FS24	1118	543	10450	25	209	0	57	181	107	Cerro Toledo Rhy
FS717	1119	379	9719	19	160	14	38	160	60	Valle Grande
FS1054	1084	487	9890	22	194	16	59	166	95	Cerro Toledo Rhy
FS1073	1428	513	12571	35	176	21	47	146	37	Valle Grande*
FS1106	1020	511	10051	15	199	0	60	179	97	Cerro Toledo Rhy
RGM-H1	1759	268	14193	14	154	113	22	220	13	standard

* This sample is quite small and the elemental concentrations are slightly outside the source standard variability for this source, but most likely derived from Valle Grande (see Davis et al. 1998).

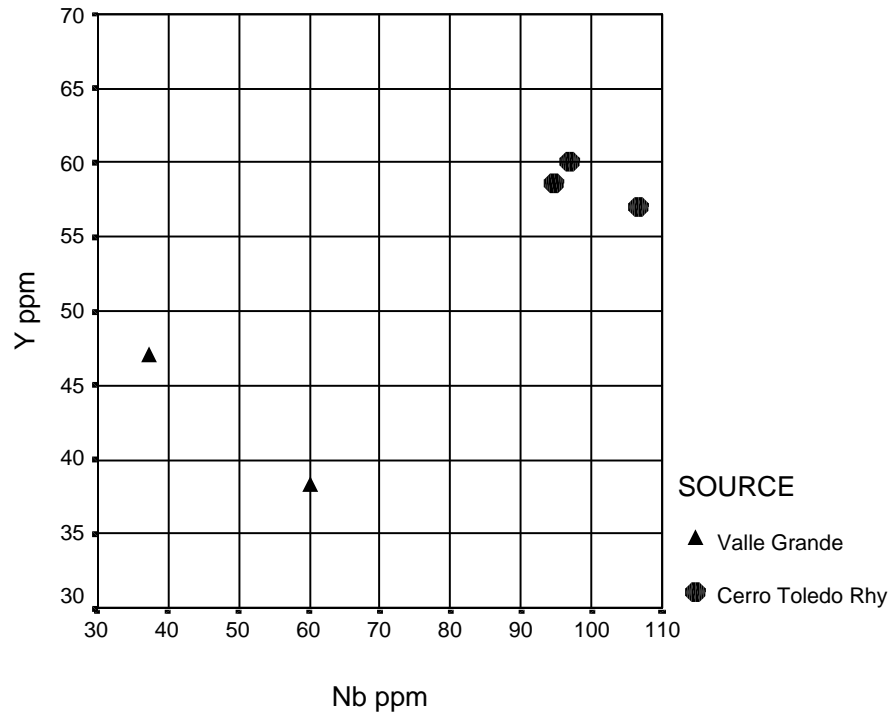


Figure 1. Y versus Nb biplot of the archaeological specimens.