SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM 13th CENTURY CONTEXTS AT THE LOS GIGANTES SITE, NORTHWEST NEW MEXICO

by

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Report Prepared for

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INTRODUCTION

The analysis here of obsidian artifacts from the Los Gigantes site in northwest New Mexico indicates a relatively diverse source provenance for the artifacts, particularly given the small sample size (n=14). While most of the artifacts were produced from obsidian procured from the nearby Mount Taylor Volcanic Field, some of the artifacts were also produced from obsidian from northern New Mexico, and northern Arizona.

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

This assemblage was analyzed on a Spectrace/Thermo QuanX energy-dispersive x-ray spectrometer at the Archaeological XRF Laboratory, Department of Earth and Planetary Sciences at the University of California, Berkeley. All samples were analyzed whole with little or no formal preparation. 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 spectrometer is equipped with an electronically cooled Cu 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, 0.14 mA, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (as Fe^T), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Weight percent iron (Fe$_2$O$_3$^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 (1992, 1995, 2003; also Mahood and Stimac 1990; 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, and JR-1 and JR-2 obsidian standards from the Japan Geological Survey (Govindaraju 1994). In addition to the reported values here, Ni, Cu, Zn, Th, and Ga were measured, but these are rarely useful in discriminating glass sources and are not generally reported.

The data from both systems 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. An analysis of RGM-1 analyzed during each run is included in Table 1. Source nomenclature follows Shackley (1988, 1995, 1998, 2005). Further information on the laboratory instrumentation can be found at: http://www.swxrlab.net/. Trace element data exhibited in Table 1 are reported in parts per million (ppm), a quantitative measure by weight (see also Figures 1 and 2).

**DISCUSSION**
Specific Comments on the Assemblage

The dominance of obsidian artifacts produced from the Mount Taylor sources in sites in this area is common, the mix of northern New Mexico and northern Arizona sources is also quite common (Howell and Shackley 2003; Shackley 1998, 2005; Figures 3 and 4 here). Additionally, the trace element chemistry suggests that the Horace Mesa aphyric glass was preferred over Grants Ridge vitrophyric glass, a procurement pattern that seems to be common in the region whenever it was possible to procure Horace Mesa over Grants Ridge (Shackley 1998, 2005). It is generally a better media for tool production, although it occurs in much smaller quantities, so like the Valle Grande Rhyolite source discussed below, was probably targeted specifically by visiting the primary source rather than procuring Grants Ridge obsidian common in secondary context in the river basins of New Mexico (Shackley 2005).

With regard to the two Valles Caldera (Jemez Mountains) sources in the assemblage, Cerro Toledo Rhyolite and Valle Grande Rhyolite obsidian, Valle Grande does not erode outside the caldera proper, and so must have been originally procured in the caldera. Cerro Toledo Rhyolite obsidian has been eroding into the Rio Grande River system for over 1 million years and is available as knappable nodules all the way to Chihuahua (Church 200; Shackley 2005. It is impossible to determine whether the artifacts in this collection were procured from primary or secondary contexts.

Government Mountain obsidian from the San Francisco Volcanic Field in northern Arizona is one of the best raw materials for flaked stone tool production in the Southwest and has been found at Chaco, and as far east as Socorro.

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Table 1. Elemental concentrations and source assignments for the archaeological specimens and international standards. Some of these samples are near the size restrictions for EDXRF analysis and so the elemental concentrations of some samples deviate from the reported source standards slightly (see Davis et al. 1998).

<table>
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<th>Mn</th>
<th>Fe</th>
<th>Rb</th>
<th>Sr</th>
<th>Y</th>
<th>Zr</th>
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RGM1-S1 1480 308 13108 148 116 27 209 8 standard
RGM1-S1 1606 300 13026 149 111 19 219 12 standard
Figure 1. Rb, Sr, Zr three-dimensional plot of the elemental concentrations for the archaeological specimens. See the Rb versus Nb biplot below for clarity in discriminating the Jemez Mountains sources.
Figure 2. Rb versus Zr biplot showing the inferred separation of the Cerro Toledo Rhyolite and Valle Grande Rhyolite obsidian (see Shackley 2005).
Figure 3. Distribution of obsidian source provenance.
Figure 4. The northern Arizona/northern New Mexico region and sources of archaeological obsidian with the relative location of the site.