SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM ARCHAEOLOGICAL SITES IN SOUTHERN NEW MEXICO

by

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INTRODUCTION

The analysis here of 8 obsidian artifacts from a number of sites and isolated locations in the International Border region of southern New Mexico indicates a regional procurement of obsidian plus one unusual provenance from northern Arizona. The assemblage, however, is dominated by known sources in the southern and western New Mexico region.

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).

All analyses for this study were conducted on a Thermo/ARL Quant'X EDXRF spectrometer, located in the Department of Anthropology, University of California, Berkeley. 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 trace element analyses were performed in the Geoarchaeological XRF Laboratory, Department of Anthropology, University of California, Berkeley, using a Thermo/ARL Quant'X energy dispersive x-ray fluorescence spectrometer. 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 Ka-line data for elements titanium (Ti), manganese (Mn), iron (as Fe$_2$O$_3$), 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 but Fe where a derivative fitting is used to improve the fit for iron and thus for all the other elements. When barium (Ba) is analyzed in the High Zb condition, the Rh tube is operated at 50 kV and 1.0 mA, ratioed to the bremsstrahlung region (see Shackley 2010). 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). Specific standards 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), all US Geological Survey standards, NIST-278 (obsidian), U.S. National Institute of Standards and Technology, BE-N (basalt) from the Centre.
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 when necessary. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 or RGM-2 is analyzed during each sample run for obsidian artifacts to check machine calibration (Table 1). Source assignments were made by reference to Shackley (2005), and source data in the laboratory (see Table 1 and Figures 1 through 3).

**DISCUSSION**

This obsidian assemblage from the border region here in southern New Mexico exhibits a very diverse source provenance from major sources in New Mexico (Antelope Wells, NM; and the Antelope Creek locality at Mule Creek in western New Mexico, to one sample (219) produced from Government Mountain obsidian (see Table 1 and Figures 1 through 3). While artifacts produced from Government Mountain obsidian are uncommon this far east and south, it is has been seen in Archaic contexts near Socorro, and Fence Lake in central and western New Mexico (Figure 3). Similar to the sources in the Jemez Mountains, New Mexico, this large nodule northern Arizona source has an extensive distribution in western North America (Shackley 2005:32-34). The interior flake here could be a biface thinning flake from a biface curated for some period of time.

The one piece of perlitic vitrophyre (Sample 215) is likely from one of the many vitrophyric obsidian sources in this region, such as the Florida Mountains on the border. These vitrophyric rocks are so compositionally variable it is difficult to determine the source.
One parenthetical point: The one “unidentified projectile point” (Sample 228), looks very similar to obsidian cruciforms that do appear in sites in the International four corners region. Many are ground after flaking, and this could also be a rejuvenated point as indicated, but given the presence of obsidian cruciforms in this region, it was worth mentioning.

REFERENCES CITED

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Hughes, Richard E., and Robert L. Smith

Mahood, Gail A., and James A. Stimac

McCarthy, J.J., and F.H. Schamber

Schamber, F.H.

Shackley, M. Steven


Table 1. Elemental concentrations and source assignments for the archaeological specimens. All measurements in parts per million (ppm).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Ti</th>
<th>Mn</th>
<th>Fe</th>
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<th>Sr</th>
<th>Y</th>
<th>Zr</th>
<th>Nb</th>
<th>Ba</th>
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<td>9975</td>
<td>243</td>
<td>24</td>
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<td>119</td>
<td>87</td>
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<td>82</td>
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<td>218</td>
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Figure 1. Rb, Zr, Ba three-dimensional plot for the archaeological specimens.
Figure 2. Nb versus Y biplot for the Antelope Creek assigned specimens with the distribution of Antelope Creek and Mule Mountain localities at Mule Creek, New Mexico shown for discrimination.
Figure 3. Zr, Mn, Ba three-dimensional plot of Government Mountain source data and sample 219 from the collection.