SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM THREE SITES IN SOUTHERN ARIZONA

by

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INTRODUCTION

The analysis here of 15 obsidian artifacts from three sites near the U.S./Mexican border in southern Arizona exhibits a very diverse source provenance assemblage (Tables 1 and 2 and Figure 1). The sources present are from northern Chihuahua, northern Sonora, and western and southern New Mexico. The presence of Gwynn/Ewe Canyon obsidian from the Mogollon Mountains in western New Mexico is somewhat of a conundrum with no easy explanation as discussed below.

Figure 1. Sources of archaeological obsidian in the North American Southwest and immediate surrounding regions, and approximate site locations (adapted from Shackley 2005). Source localities and sizes are approximate.
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 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 Ka-line data for elements titanium (Ti), manganese (Mn), iron (as Fe₂O₃), 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 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, 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).

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. RGM-1 a USGS obsidian standard is analyzed during each sample run of ≤20 for obsidian artifacts to check machine calibration (Table 2).
Source assignments were made by reference to the laboratory data base (see Shackley 1995, 2005). See http://swxrflab.net/swobsrscs.htm for updated source data. Further information on the laboratory instrumentation and source data can be found at: http://www.swxrflab.net/ (see Appendix Table for all data and Figure 2 in text). Trace element data exhibited in Table 2 are reported in parts per million (ppm), a quantitative measure by weight.

DISCUSSION

Obsidian source provenance in the US/Mexican borderlands is always difficult (Shackley 2005). There are a number of sources in Sonora and Chihuahua that appear in the archaeological record, but remain unlocated. This situation is slowly improving, but remains a stubborn issue between access due to political trouble in northern Mexico, and the rural environment in areas such as the Sierra Madre Occidental (see Hinojosa-Prieto et al. 2015). Luckily for this study, the artifacts in the assemblage were all produced from known sources in the greater region (see Tables 1 and 2 and Figures 1 and 2).

Table 1. Crosstabulation of source by site (see Table 2 below for raw data).
Some of these sources, however, are a considerable distance from the sites (see Figure 1). Selene, Sonora, Los Jagüeyes, Chihuahua, and Gwynn/Ewe Canyon, western New Mexico are 300-500 km distant, and the nearest source, Los Vidrios, Sonora, and Antelope Wells/El Berrendo are more that 150 km east or west (directly opposite). In my experience, this is unusual. If the sites are Archaic, this could be a result of high residential mobility, but no chronological information was available.

![Figure 2. Rb versus bivariate plots of the archaeological specimens (all samples, left, and Antelope Wells and Los Jagüeyes samples only, right, providing clarity).](www.escholarship.org/uc/item/6zd5v1m1)

Most vexing is the presence of Gwynn/Ewe Canyon, a source in the Mogollon-Datil Volcanic Province of western New Mexico. The source area, located at an elevation of over 2300 m AMSL, is above the effective elevation for maize cultivation, and indeed no large sites are present in the area. It is a good area for hunting large mammals, however. It is one of the rarest Mogollon-Datil obsidian sources found in the archaeological record, particularly compared to the sources at Mule Creek, sources actually closer to the project sites (Shackley 2005, 2014). I did acquire Ba in addition to the mid-Z elements to ensure source assignment, and the composition of these artifacts are well within the source standard data (see Shackley 1995, and
http://swxrflab.net/gwyncyn.htm). Nevertheless, the obsidian assemblages at these sites are very diverse and interesting in a number of archaeological and geological areas.
REFERENCES CITED


Table 2. Elemental concentrations for the archaeological specimens and USGS RGM-1 standard. All measurements in parts per million (ppm).

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