Title
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Author
Shackley, M. Steven

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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM STONE AXE PUEBLO (AZ Q:2:22 ASM) AND BLACK AXE PUEBLO (AZ Q:01:320 ASM), PETRIFIED FOREST NATIONAL PARK, NORTHERN ARIZONA

by

M. Steven Shackley
Professor and Director
Geoarchaeological XRF Laboratory
Department of Anthropology
University of California, Berkeley

Report Prepared for

Petrified Forest National Park, Arizona

and

Assistant Professor Greg Schachner
Department of Anthropology
University of California, Los Angeles

8 December 2009
updated 10 September 2010
INTRODUCTION

The analysis here of 22 obsidian artifacts (10 from UCLA and 12 from the Petrified Forest National Park collection) indicates a very diverse provenance assemblage with sources from northern Arizona, northern New Mexico, and western New Mexico (Table 1). The mix of sources did not change statistically with the addition of the 10 artifacts submitted by the National Park in September, 2010.

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 Scientific 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 Fe₂O₃ reported elementally), 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 Davis et al. 1998). 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-1 (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, BR-1 (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 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 (1995, 2005; see Table 1 and Figure 1 here), as well as source standard data at Berkeley.

DISCUSSION

This analysis is a textbook example of the validity of larger sample sizes. The original two samples analyzed from the National Park indicated that the direction of procurement was to the east (Shackley 2009; see Table 1 here). With the addition of just 20 more samples, source material from four separate regions is evident; northern Arizona, northwestern New Mexico, north-central New Mexico, and western New Mexico. All of these regions were occupied by different cultural groups in the Late Classic. While it is impossible to know what portion of these raw materials were procured through direct access or some form of exchange, it does indicate contact throughout the Southwest. This pattern is somewhat more similar to the Silver Creek area to the west that was dominated by Government Mountain source material (Shackley 2008).
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Figure 1. Zr versus Rb bivariate plot of the elemental concentrations for the archaeological specimens from this study.