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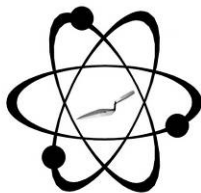
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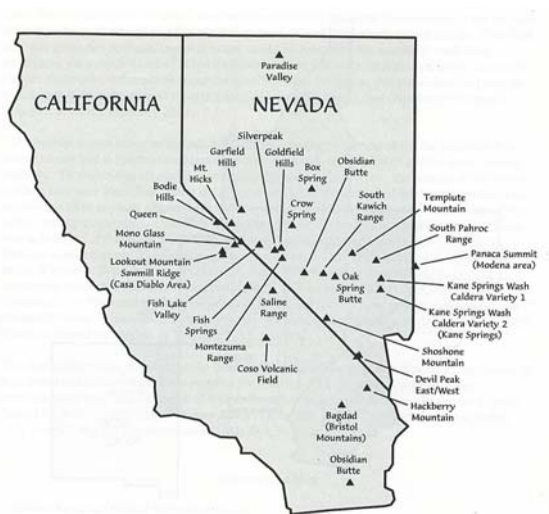
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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM ANTELOPE CAVE, MOJAVE COUNTY, ARIZONA



Known sources of archaeological obsidian in east-central California and Nevada recovered in the Nellis Air Force Base, Nevada study, including the two in this study (Haarklau et al. 2005).

by

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INTRODUCTION

The analysis here of 4 obsidian from Antelope Cave in Mojave County, northwestern Arizona indicates a diverse obsidian provenance assemblage with sources in Nevada and Utah. One sample is produced from a source that has been seen in Nevada archaeological contexts, but not yet located (see map above).

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 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 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_2O_3^T), 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 quadratic 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 2010; 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, 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 WinTraceTM 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 1).

Source assignments were made by reference to the laboratory data base (see Shackley 1995, 2005), Nelson and Tingey (1997), and Skinner (2005). Further information on the laboratory instrumentation can be found at: <http://www.swxrflab.net/>. Trace element data exhibited in Table 1 are reported in parts per million (ppm), a quantitative measure by weight.

DISCUSSION

The source provenance is expectable with some of the nearest sources (Panaca Summit, Modena on the Nevada-Utah border, and Kane Spring Wash Caldera, both in southeastern Nevada (see map image above). These sources occurred commonly in southern Nevada sites, particularly evident in the large study on Nellis Air Force Base just north of Las Vegas, Nevada (Haarlau et al. 2005). The one sample that was produced from what Skinner is calling "Unknown Type B" was relatively common on sites on Nellis (Skinner 2005). It is likely located somewhere in the southern Nevada/Utah region.

It was not surprising that no Arizona sources were evident at Antelope Cave. The Colorado River and southern Grand Canyon probably served as a relatively strict boundary during the Archaic, although crossing is possible during late winter.

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

Sample	Mn	Fe	Rb	Sr	Y	Zr	N b	Ba	Pb	Th	Source
244-412	31 0	9161	19 3	82	29	11 9	22	644	24	27	Panaca Summit, Modena NV/UT
244-2105	34 0	1000 5	20 9	86	30	11 9	19	621	28	32	Panaca Summit, Modena NV/UT
244-2210	49 1	1462 4	15 2	13 3	39	32 6	31	173 4	25	24	Unknown Type B
244-2153	26 1	1183 0	19 9	24	53	17 9	38	90	26	27	Kane Spring Wash Caldera, NV (var 1)
RGM1-S4	28 0	1321 9	14 8	10 7	28	21 2	7	818	20	10	standard