



GEOARCHAEOLOGICAL XRF LAB

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**SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM CA-SCR-276, SANTA CRUZ,  
CALIFORNIA**

by

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Report Prepared for

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## INTRODUCTION

The analysis here of 12 obsidian artifacts from SCR-276 indicates a very diverse source provenance assemblage from sources in northwestern and northeastern California, and western Nevada. This is the most diverse assemblage I have yet seen from a site the California central coast.

## 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 in the Archaeological 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  $\mu\text{m}$  (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  $\text{l min}^{-1}$  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  $\text{Fe}_2\text{O}_3^T$ ), 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 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 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, 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 for obsidian artifacts to check machine calibration (Table 1). Source assignments were made by reference to Hughes (1983), Skinner and Thatcher (2005) and source standard data at this lab (Table 1).

## DISCUSSION

Perhaps due to the age of this site (ca. 2 ky bp) the assemblage is very diverse indicating high mobility and likely contact with diverse groups to the north, northeast and east. Interestingly, while artifacts produced from the Coso Volcanic Field in Inyo County, California occurs with some frequency in central coast sites, it was absent here, while two artifacts were from sources in Esmeralda and Washoe Counties, Nevada. The assignment to the Montezuma Valley source is not confident, given that two of the elemental concentrations are slightly outside the range reported for this source (Skinner and Thatcher 2005). The data, however, do not match any published source in California, Nevada, or Oregon, and the data are relatively close to the source standard data. The artifact produced from the Duck Flat source in Washoe County, Nevada is well within the ranges as reported by Hughes (1983), and essentially southwest of the Buck Mountain source that occurs here in Modoc County, California near the Nevada state line (Hughes 1983). This source, frequently mahogany colored, is found throughout California, Nevada, and southern Oregon, likely due to its coloring.

The remainder of the artifacts were produced from one of the sources in the Sonoma Volcanic Field in Napa and Sonoma Counties, California. Napa Glass Mountain and Annadel obsidian is very common in northern and central California sites.

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

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	N b	Ba	Pb	Th	Source
1	114 6	36 9	8884	11 0	71	19	93	12	90 4	19	16	Buck Mtn, CA
2	100 6	22 3	1147 2	19 5	13	42	23 1	9	55 8	38	19	Napa Glass Mtn, CA
3	107 0	19 5	1094 7	17 7	13	42	21 8	9	57 6	35	19	Napa Glass Mtn, CA
4	157 1	36 9	1699 6	14 1	60	43	27 0	10	80 6	35	16	Annadel, CA
5	104 4	20 3	1108 4	17 7	12	42	21 8	11	56 6	37	25	Napa Glass Mtn, CA
6	847	28 0	1092 8	33 1	11	66	12 1	72	14	44	37	Montezuma Range, NV?
7	107 3	23 4	1203 8	20 2	15	42	24 2	9	57 2	40	15	Napa Glass Mtn, CA
8	107 5	25 4	1196 2	19 8	16	45	24 9	11	49 9	40	25	Napa Glass Mtn, CA
9	113 0	39 3	1681 8	16 8	9	58	36 1	18	1	41	17	Duck Flat, NV
10	120 5	24 5	1164 7	18 6	16	41	22 0	8	52 1	38	19	Napa Glass Mtn, CA
11	114 1	37 8	9018	10 9	72	17	91	8	90 0	20	8	Buck Mtn, CA
12	142 4	41 5	1915 6	15 8	61	53	29 2	15	80 2	37	14	Annadel, CA
RGM1- S4	155 9	29 1	1325 3	14 8	10 8	24	21 5	7	86 9	22	9	standard