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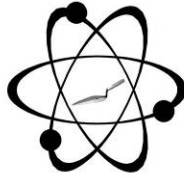https://escholarship.org/uc/item/9998n7kv

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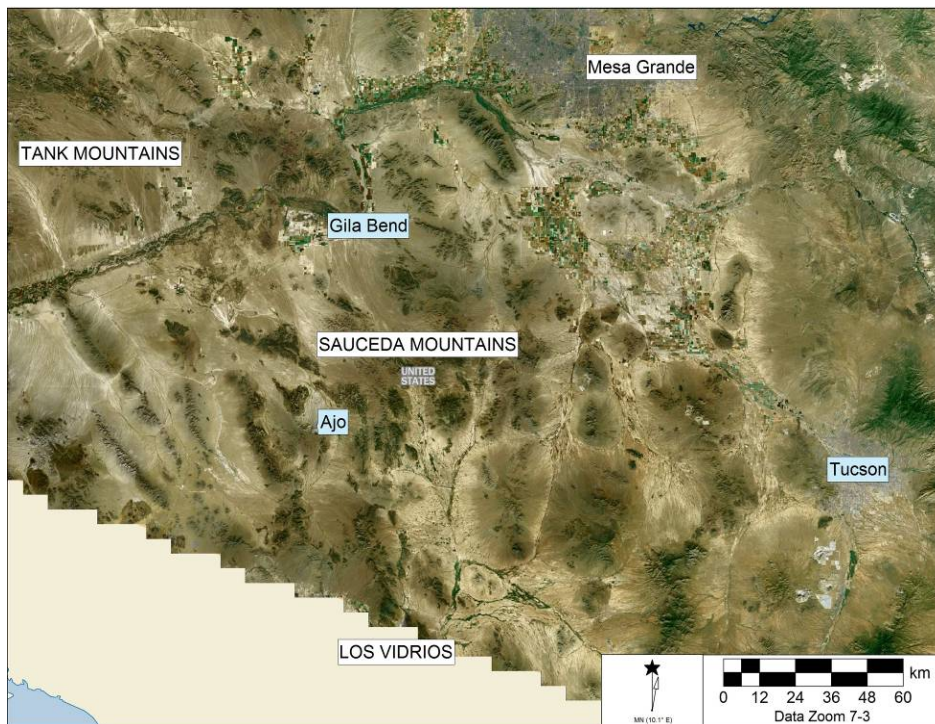2018-08-10

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GEOARCHAEOLOGICAL X-RAY FLUORESCENCE SPECTROMETRY LABORATORY
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SOURCE PROVENANCE OF ARCHAEOLOGICAL OBSIDIAN FROM MESA GRANDE (AZ U:9:25 ASM), MESA, ARIZONA

Orthophoto of Mesa Grande and the three obsidian sources present in the assemblage (in capitals)

by

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INTRODUCTION

The analysis here of 23 obsidian artifacts from Mesa Grande (AZ U:9:25 ASM), central Arizona displays a typical Classic Period Hohokam obsidian artifact assemblage (Table 1 and Figure 1; Mills et al. 2013; Shackley 2005). The assemblage is completely dominated by Sonoran Desert sources including Sauceda Mountains and Tank Mountains in western Arizona, and Los Vidrios in northern Sonora (Shackley 1988, 1989, 1991, 1995, 2005). Tank Mountains is relatively rare in Phoenix Basin sites and may reflect connections with the Patayan (Shackley 1991, 2018). Also typical of a Classic Period assemblage is the absence of Superior (Picketpost Mtn) obsidian, the source nearest to Mesa Grande (Mills et al. 2013; Shackley 2005).

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 2011a).

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 from 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.

Trace Element Analysis

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 100 seconds livetime to generate x-ray intensity $K\alpha_1$-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 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 2011a). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1991, 1995, 2005; c.f. 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 and into SPSS ver. 21 and JMP 12.0.1 for statistical manipulation. The USGS rhyolite standard RGM-1 is analyzed during each sample run for obsidian artifacts to evaluate machine calibration (Table 1). Source assignments were made by reference to source data at http://swxrflab.net/swobsrcs.htm and Shackley (1991, 1995, 2005; Kibler et al. 2014).

Table 1. Elemental concentrations and probable source assignments for the archaeological obsidian, and RGM-1 a USGS rhyolite standard. All measurements in part per million (ppm).

Sample	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Source
1	1490	381	10287	83	161	80	32	197	25		Sauceda Mtns
2	613	240	11793	112	243	19	68	223	32		Los Vidrios
3	1312	360	9162	55	163	75	34	197	24		Sauceda Mtns
4	1475	418	10111	68	164	76	38	195	24		Sauceda Mtns
5	1346	377	9760	72	161	84	34	195	23		Sauceda Mtns
6	1558	378	9993	53	168	84	31	206	25		Sauceda Mtns
7	1717	348	9663	128	147	79	27	182	14		Sauceda Mtns
8	1549	414	10588	93	165	76	31	194	26		Sauceda Mtns
9	1454	376	10150	107	159	75	34	196	23		Sauceda Mtns
10	1443	392	9946	82	163	82	37	200	26		Sauceda Mtns
11	1496	374	10012	76	164	76	37	196	21		Sauceda Mtns
12	614	270	12027	112	248	19	72	219	31		Los Vidrios
13	905	493	10522	89	177	160	23	130	15	961[1]	Tank Mtns
14	764	297	13615	124	268	16	69	236	31		Los Vidrios
15	604	263	11461	116	240	23	63	212	28		Los Vidrios
16	562	238	11100	80	241	20	64	217	27		Los Vidrios
17	1449	359	9027	57	156	76	34	195	22		Sauceda Mtns
18	1563	393	10163	69	163	77	31	204	27		Sauceda Mtns
19	1671	403	11381	96	177	88	31	211	24		Sauceda Mtns
20	581	260	12018	108	248	18	68	222	35		Los Vidrios
21	658	232	11265	127	236	18	63	214	29		Los Vidrios
22	1423	417	10489	188	153	73	25	192	22		Sauceda Mtns
23	1307	353	8761	82	150	74	31	189	26		Sauceda Mtns
RGM1-S6	1496	308	13088	11	146	102	18	219	7		standard
RGM1-S4	1483	318	12969	39	148	106	23	224	9		standard

[1] Ba was acquired for this sample in order to discriminate Tank Mountains from Selene, Sonora (Kibler et al. 2014).

Table 2. Frequency distribution of obsidian source provenance from the data in Table 1.

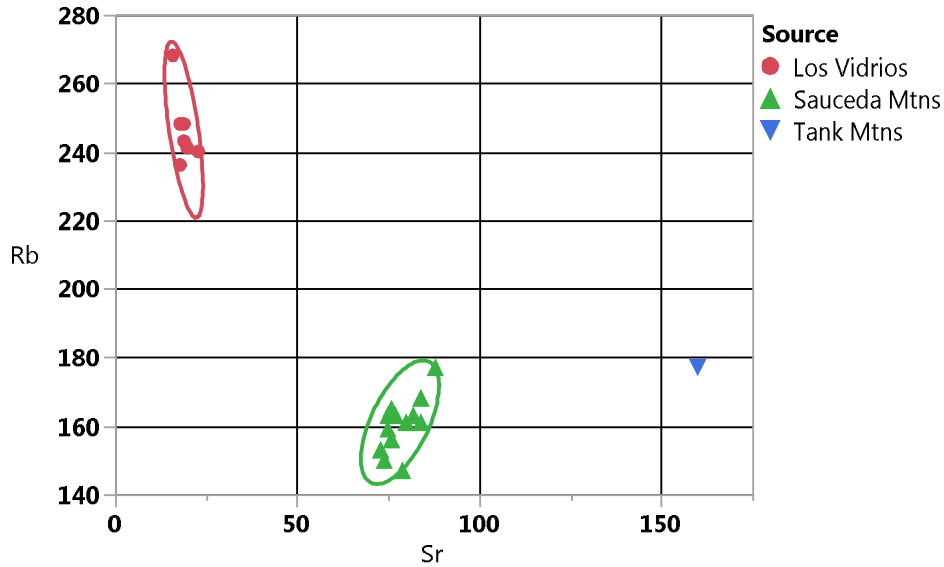|		Frequency	Percent
Source	Sauceda Mtns	15	65.2
	Los Vidrios	7	30.4
	Tank Mtns	1	4.3
	Total	23	100.0

Figure 1. Sr versus Rb bivariate plot of the distribution Mesa Grande archaeological obsidian. All measurements in parts per million (ppm). Confidence ellipses at 95%. See Table 1.

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