SOURCE PROVENANCE OF OBSIDIAN FROM HONEY BEE VILLAGE, AZ BB:9:88 (ASM), AND SLEEPING SNAKE, AZ BB:9:104 (ASM), TUCSON BASIN, ARIZONA

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Cite as:

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2012 Source Provenance of Obsidian from the Honey Bee Village, AZ BB:9:88 (ASM), and Sleeping Snake, AZ BB:9:104 (ASM), Tucson Basin, Arizona. <http://www.archaeologysouthwest.org/ap48>.

INTRODUCTION

The analysis presented here of obsidian artifacts from these two Hohokam Sedentary period (A.D. 950-1150) sites in the Tucson Basin, Honey Bee Village, AZ BB:9:88 (ASM), and Sleeping Snake Ruin, AZ BB:9:104 (ASM), is quite diverse, including sources from the Sonoran Desert, the San Francisco Volcanic Field, and the eastern Arizona/western New Mexico region. The mix of sources is similar to other obsidian assemblages from this period in the Tucson Basin.

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). More essentially, these data, through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

The trace element analyses were performed in the Geoarchaeological XRF Laboratory, Department of Anthropology, University of California, Berkeley, using a ThermoScientific *Quant'X* energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with a ultra-high flux peltier air cooled Rh x-ray target with a 125-micron beryllium (Be) window, an x-ray generator that operates from 4-50 kV/0.02-1.0 mA at 0.02 increments, using an IBM PC based microprocessor and WinTrace™ 4.1 reduction software. The spectrometer is equipped with a 2001 min^{-1} Edwards vacuum pump for the analysis of elements below titanium (Ti). Data are acquired with a pulse processor and analog to digital converter. This is a significant improvement in analytical speed and efficiency beyond the former Spectrace 5000 and *QuanX* analog systems (see Davis et al. 1998; Shackley 2005).

For Ti-Nb, Pb, Th elements, the mid-Zb condition is used operating the x-ray tube 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 $K\alpha_1$-line data for elements titanium (Ti), manganese (Mn), iron (as Fe^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, however, because their values in many volcanic rocks is very low.

Trace element intensities were converted to concentration estimates by utilizing 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 U.S. 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 except Fe, where a derivative fitting is used to improve the fit for iron and thus for all the other elements. When barium (Ba) is acquired, the Rh tube is operated at 50 kV and 0.5 mA in an air path at 200 seconds livetime to generate x-ray intensity $K\alpha_1$-line data, through a 0.630-mm Cu (thick) filter 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, 1990, 1992, 1995, 2005; also Hughes and Smith 1993; Mahood and Stimac 1990). A suite of 17 specific standards used for the best fit regression calibration for elements Ti-Nb, Pb, and Th, 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), BCR-2 (basalt), TLM-1 (tonalite), SCO-1 (shale), all U.S 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).

Data from the WinTrace software were translated directly into Excel for Windows software for manipulation and into SPSS for Windows for statistical analyses when necessary (Figure 1). To evaluate these quantitative determinations, machine data were compared with measurements of known standards during each run. RGM-1 is analyzed during each sample run for obsidian artifacts to check machine calibration (Table 1). Other appropriate standards from the above list are used for other volcanic rocks. Source assignments were made by reference to Archaeological XRF Lab standards as reported in Shackley (1995, 1998, 2005). One sample from Honeybee Village (189) was burned, and it incorporated too much depositional matrix to obtain reliable elemental concentrations and could not be assigned to source (see Table 1).

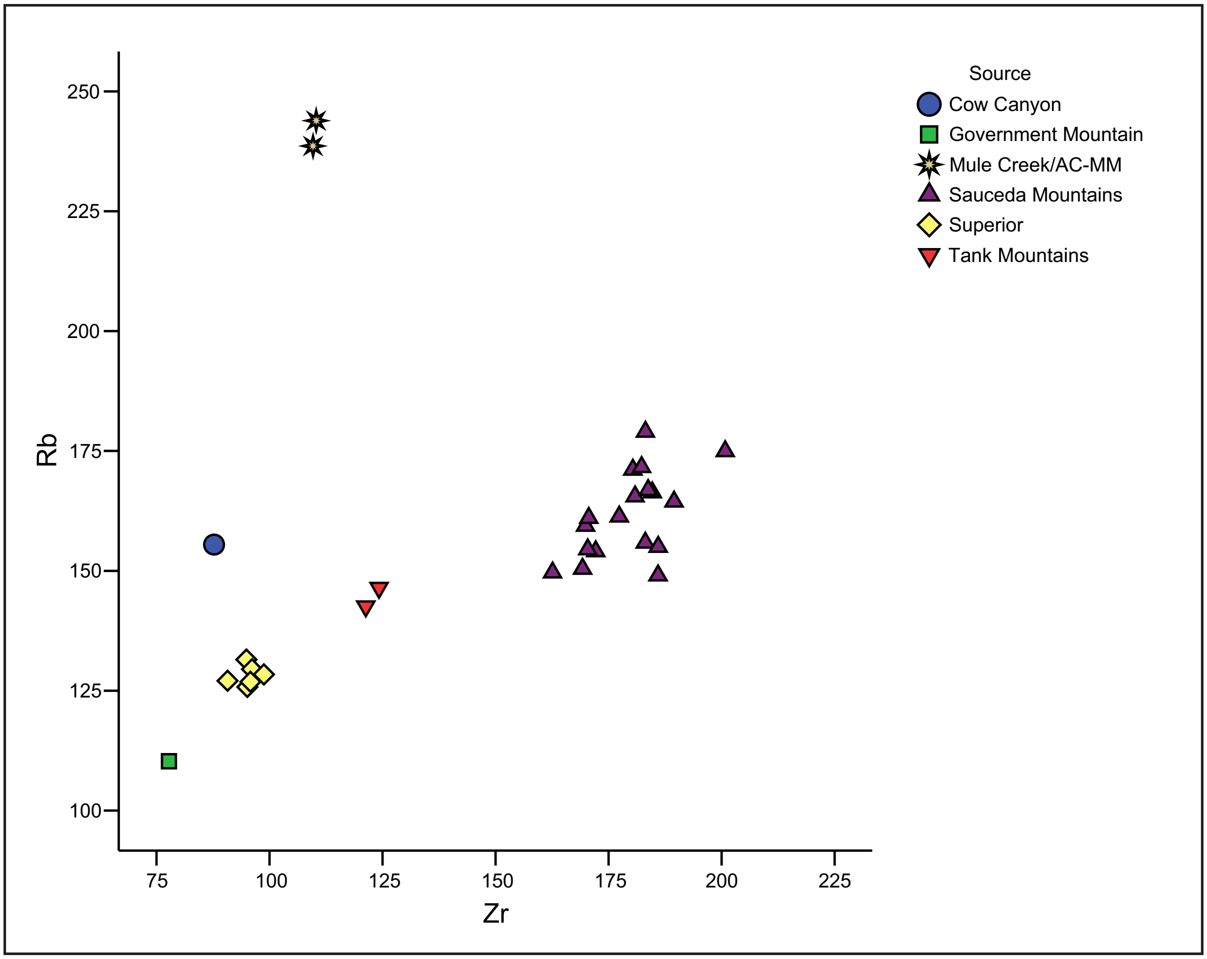

Figure 1. Zr versus Rb bivariate plot of the archaeological specimens.

DISCUSSION

The mix of sources in the Sedentary period sites is rather typical of contemporaneous sites in the region (Shackley 2005; see Figure 1 and Tables 1-2). Coconino Plateau sources, so common in contemporaneous sites in the Lower Salt River basin, are rare in the Tucson Basin; this is reflected in the current collection. More surprising, but not that rare, is the presence of Tank Mountains obsidian from Yuma County in this collection. Coupled with the dominance of Sauceda Mountains obsidian from western Maricopa County, this does not seem that out of place.

As observed elsewhere (Shackley 1998, 2005), sources from eastern Arizona (Cow Canyon/111 Ranch) and the Mule Creek sources of eastern New Mexico are available as secondary deposits at least as far west as Geronimo, Arizona, in the Gila River Quaternary sediments. Given the size of artifacts produced from these sources, it is impossible to determine if the raw material was procured from the primary sources or somewhere along the stream systems eroding those sources.

Table 1. Elemental concentrations and source assignments for the archaeological specimens (all measurements in parts per million [ppm]).

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
Sleeping Snake, AZ BB:9:104 (ASM)									
6544	664	365	8,856	244	18	40	110	26	Mule Creek/AC-MM
6950	5,329	525	7,127	126	19	25	95	31	Superior
1713	1,441	273	9,725	154	98	27	172	16	Sauceda Mountains
4141	752	548	7,242	131	20	24	95	32	Superior
1026	758	534	7,217	129	16	26	96	30	Superior
Honey Bee Village, AZ BB:9:88 (ASM)									
1366	405	502	8,601	110	78	20	78	51	Government Moutain
6396	1,258	541	7,251	127	21	25	91	28	Superior
11446	1,263	472	8,797	146	135	19	124	16	Tank Mountains
287	1,226	416	8,512	143	132	21	121	14	Tank Mountains
189	914	596	10,535	169	25	36	236	28	Burned
352-1	1,037	484	7,666	155	87	20	88	13	Cow Canyon
6663	2,131	339	11,896	179	112	28	183	19	Sauceda Mountains
6790	1,675	305	10,882	166	112	27	185	20	Sauceda Moutains
7611	731	496	6,746	127	17	27	96	29	Superior
11643	756	382	9,269	239	16	40	110	28	Mule Creek/AC-MM
7542	1,607	391	9,951	164	76	34	189	24	Sauceda Moutains
7406	1,642	431	10,567	175	75	31	201	22	Sauceda Moutains
6098	1,762	284	9,894	150	92	27	163	17	Sauceda Moutains
1911	1,677	312	10,976	166	110	29	181	21	Sauceda Moutains
1180	2,143	378	10,304	156	70	32	183	17	Sauceda Moutains
7436	1,916	308	10,306	159	101	23	170	18	Sauceda Moutains
6954	1,763	324	11,206	167	108	26	184	21	Sauceda Moutains
645-1	1,921	313	10,788	171	110	28	180	18	Sauceda Moutains
589	1,627	361	10,213	155	71	32	186	22	Sauceda Moutains
6033	1,775	287	10,140	154	102	26	170	16	Sauceda Moutains
7263	1,572	297	9,830	150	99	24	169	19	Sauceda Moutains
645-2	1,826	315	10,970	172	104	24	182	17	Sauceda Moutains
352-2	1,572	302	10,497	161	105	26	177	21	Sauceda Moutains
7567	1,854	314	10,804	161	105	24	171	17	Sauceda Moutains
7926	1,605	367	9,790	149	70	31	186	26	Sauceda Moutains
195	816	543	7,467	128	21	28	99	33	Superior
RGM1-S4	1,533	303	12,863	148	104	23	211	7	Standard
RGM1-S5	1,604	289	12,905	150	106	25	212	10	Standard

Table 2. Cross-tabulation of source by site.

		Site		
Source		Honey Bee	Sleeping Snake	Total
Cow Canyon	Count	1.0	0.0	1.0
	Percent within source	100.0	0.0	100.0
	Percent within sample	4.0	0.0	3.3
	Percent of total	3.3	0.0	3.3
Government Mountain	Count	1.0	0.0	1.0
	Percent within source	100.0	0.0	100.0
	Percent within sample	4.0	0.0	3.3
	Percent of total	3.3	0.0	3.3
Mule Creek/AC-MM	Count	1.0	1.0	2.0
	Percent within source	50.0	50.0	100.0
	Percent within sample	4.0	S0.0	6.7
	Percent of total	3.3	3.3	6.7
Sauceda Mountains	Count	17.0	1.0	18.0
	Percent within source	94.4	5.6	100.0
	Percent within sample	68.0	20.0	60.0
	Percent of total	56.7	3.3	60.0
Superior	Count	25.0	5.0	30.0
	Percent within source	50.0	50.0	100.0
	Percent within sample	12.0	60.0	20.0
	Percent of Total	10.0	10.0	20.0
Tank Mountains	Count	2.0	0.0	2.0
	Percent within source	100.0	0.0	100.0
	Percent within sample	8.0	0.0	6.7
	Percent of total	6.7	0.0	6.7
Total	Count	25.0	5.0	30.0
	Percent within source	83.3	16.7	100.0
	Percent within sample	100.0	100.0	100.0
	Percent of total	83.3	16.7	100.0

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