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GEOARCHAEOLOGICAL XRF LAB
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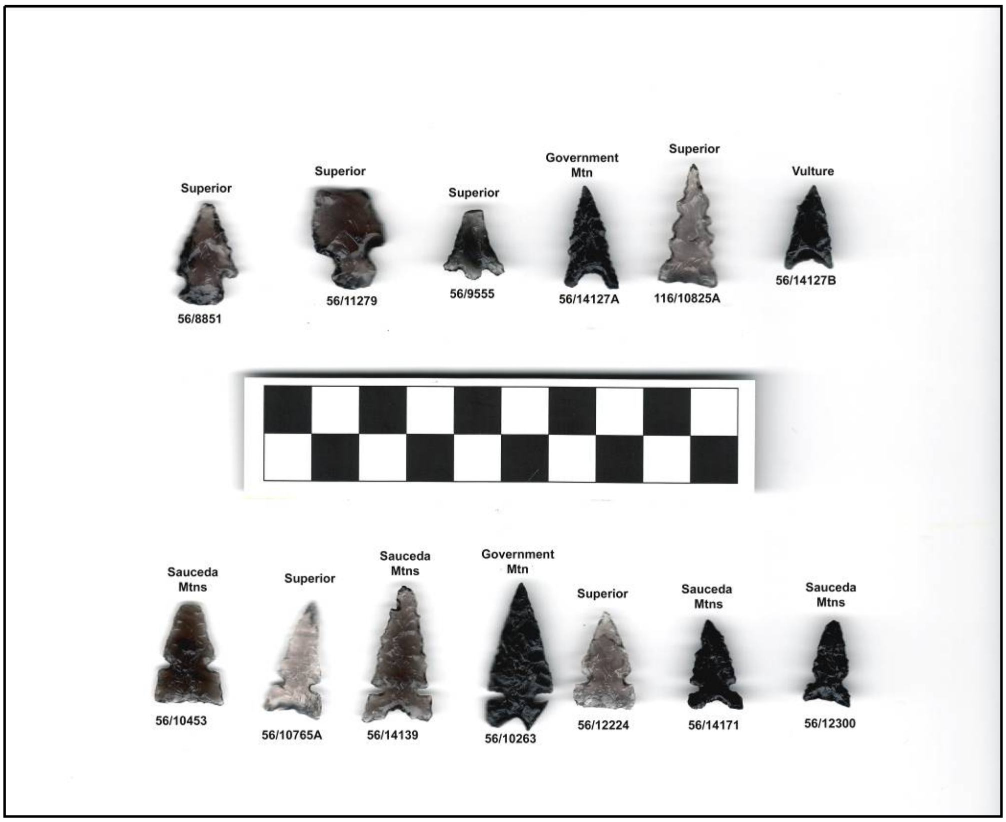

Projectile points from project sites, site/FS# and source provenance

by

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INTRODUCTION

The analysis here of 73 obsidian artifacts is one of the largest in the Superior (Picketpost Mountain) region, and the second assemblage from these sites (Shackley 2005, 2017). While the source provenance of the artifacts is diverse with sources from Government Mountain in northern Arizona, and Sonoran Desert sources (Sauceda Mountains and Vulture), but dominated by the nearby Superior (Picketpost Mountain) source as in the previous analysis (Tables 1 and 2). In this analysis a number of projectile points as well as bipolar cores from Superior and debitage was present. Most striking is that the projectile point assemblage, while diverse, does not reflect the diversity of sources present in the debitage analyzed earlier (Shackley 2017; see cover image here). A direct comparison between the projectile point obsidian provenance and the debitage could prove useful.

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 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 100 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 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. When barium (Ba) is acquired 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 with reference to Shackley (1995, 2005), Shackley et al. (2017) and source standard data at this lab (Tables 1 and 2, and Figure 1).

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Table 1. Elemental concentrations and source provenance of the archaeological samples, and USGS RGM-1 rhyolite standard. All measurements in parts per million (ppm).

FS#	Site (AZ)	Mn	Fe (%)	Zn	Rb	Sr	Y	Zr	Nb	Source
8649	U:12:56	494	0.616	85	126	26	25	99	30	Superior (Picketpost Mtn)
8851	U:12:56	490	0.621	76	126	21	24	95	32	Superior (Picketpost Mtn)
9391	U:12:56	521	0.600	80	123	21	22	103	36	Superior (Picketpost Mtn)
9555	U:12:56	501	0.592	73	126	24	28	99	33	Superior (Picketpost Mtn)
10263	U:12:56	523	0.863	81	116	86	20	91	54	Government Mtn
10325	U:12:56	539	0.648	108	123	21	24	92	31	Superior (Picketpost Mtn)
10415	U:12:56	509	0.651	107	126	23	22	101	28	Superior (Picketpost Mtn)
10453	U:12:56	309	1.008	61	167	105	28	199	19	Sauceda Mtns
10755	U:12:56	509	0.639	89	133	23	23	99	31	Superior (Picketpost Mtn)
10765A	U:12:56	559	0.635	65	130	26	25	97	32	Superior (Picketpost Mtn)
10765B	U:12:56	506	0.611	97	123	25	26	100	18	Superior (Picketpost Mtn)
11279	U:12:56	509	0.598	57	126	23	27	99	27	Superior (Picketpost Mtn)
11339	U:12:56	458	0.558	86	119	22	25	89	32	Superior (Picketpost Mtn)
11466	U:12:56	508	0.658	102	131	22	26	100	30	Superior (Picketpost Mtn)
11705	U:12:56	510	0.648	120	126	27	22	98	28	Superior (Picketpost Mtn)
11876	U:12:56	523	0.646	78	135	24	23	103	41	Superior (Picketpost Mtn)
12224	U:12:56	511	0.608	78	126	24	22	102	33	Superior (Picketpost Mtn)
12300	U:12:56	372	1.005	85	168	72	37	205	31	Sauceda Mtns
12497	U:12:56	500	0.661	69	127	23	27	100	31	Superior (Picketpost Mtn)
13109	U:12:56	517	0.642	101	123	25	27	96	28	Superior (Picketpost Mtn)
13915	U:12:56	528	0.660	80	130	24	25	98	30	Superior (Picketpost Mtn)
14127A	U:12:56	511	0.864	99	114	83	17	83	53	Government Mtn
14127B	U:12:56	392	0.700	54	140	45	23	134	21	Vulture
14139	U:12:56	389	1.081	86	172	81	31	206	25	Sauceda Mtns
14171	U:12:56	400	1.082	89	177	80	37	207	25	Sauceda Mtns
277	U:12:116	446	0.556	47	122	24	29	99	34	Superior (Picketpost Mtn)
650A	U:12:116	506	0.587	80	123	23	31	105	33	Superior (Picketpost Mtn)
650B	U:12:116	498	0.591	61	131	25	25	105	26	Superior (Picketpost Mtn)
650C	U:12:116	483	0.622	69	127	24	26	98	35	Superior (Picketpost Mtn)
650D	U:12:116	545	0.605	89	126	24	25	103	31	Superior (Picketpost Mtn)
668	U:12:116	496	0.583	76	125	20	22	93	31	Superior (Picketpost Mtn)

677	U:12:116	479	0.604	90	121	27	27	95	30	Superior (Picketpost Mtn)
780	U:12:116	477	0.573	54	125	27	19	96	36	Superior (Picketpost Mtn)
799	U:12:116	505	0.609	77	124	23	26	94	24	Superior (Picketpost Mtn)
1016	U:12:116	521	0.629	44	125	23	32	104	29	Superior (Picketpost Mtn)
1042	U:12:116	522	0.589	50	123	24	24	92	32	Superior (Picketpost Mtn)
1971	U:12:116	471	0.560	60	118	19	22	98	31	Superior (Picketpost Mtn)
2261	U:12:116	422	0.563	48	99	22	23	89	25	Superior (Picketpost Mtn)
6589	U:12:116	468	0.572	90	120	25	26	101	32	Superior (Picketpost Mtn)
8530	U:12:116	548	0.682	122	132	22	24	95	27	Superior (Picketpost Mtn)
8573A	U:12:116	574	0.742	88	135	21	27	104	27	Superior (Picketpost Mtn)
8573B	U:12:116	549	0.743	120	130	27	30	100	30	Superior (Picketpost Mtn)
8573C	U:12:116	527	0.635	172	126	24	27	97	29	Superior (Picketpost Mtn)
8578	U:12:116	527	0.645	53	133	25	22	99	32	Superior (Picketpost Mtn)
8688	U:12:116	506	0.719	92	128	24	20	98	31	Superior (Picketpost Mtn)
8711	U:12:116	493	0.669	102	126	23	24	98	26	Superior (Picketpost Mtn)
8961	U:12:116	516	0.676	90	129	25	33	102	30	Superior (Picketpost Mtn)
8991	U:12:116	466	0.663	45	116	24	27	101	30	Superior (Picketpost Mtn)
9015	U:12:116	507	0.610	49	128	26	28	99	29	Superior (Picketpost Mtn)
11029	U:12:116	524	0.638	78	126	25	29	98	37	Superior (Picketpost Mtn)
11037	U:12:116	518	0.623	56	128	22	27	101	29	Superior (Picketpost Mtn)
FS#	Site (AZ)	Mn	Fe (%)	Zn	Rb	Sr	Y	Zr	Nb	Source
10825A	U:12:116	529	0.646	61	126	23	22	102	28	Superior (Picketpost Mtn)
10825B	U:12:116	484	0.599	94	122	20	26	98	23	Superior (Picketpost Mtn)
4125	U:12:55	477	0.566	72	126	24	23	95	32	Superior (Picketpost Mtn)
5635	U:12:55	462	0.623	61	118	22	28	98	29	Superior (Picketpost Mtn)
6522	U:12:55	486	0.597	90	119	22	22	101	30	Superior (Picketpost Mtn)
8067	U:12:55	441	0.540	53	117	23	24	96	30	Superior (Picketpost Mtn)
10509	U:12:54	517	0.629	103	126	20	24	95	30	Superior (Picketpost Mtn)
11200	U:12:54	479	0.656	118	123	19	28	96	31	Superior (Picketpost Mtn)
1876	U:12:118	550	0.628	80	130	25	24	93	33	Superior (Picketpost Mtn)
10663	U:12:118	523	0.619	66	132	22	20	104	33	Superior (Picketpost Mtn)

10665	U:12:118	513	0.603	87	126	25	26	100	27	Superior (Picketpost Mtn)
10935B	U:12:118	424	0.514	43	114	23	23	95	24	Superior (Picketpost Mtn)
14228	U:12:118	495	0.600	62	122	24	31	98	38	Superior (Picketpost Mtn)
8442B	U:12:142	534	0.668	139	125	22	24	94	33	Superior (Picketpost Mtn)
8442A	U:12:142	488	0.631	88	132	21	27	101	28	Superior (Picketpost Mtn)
11415	U:12:142	519	0.593	66	125	23	25	98	30	Superior (Picketpost Mtn)
12041	U:12:2	511	0.668	70	128	22	22	106	31	Superior (Picketpost Mtn)
8377	U:12:233	498	0.607	56	121	25	27	99	29	Superior (Picketpost Mtn)
612	U:12:122	440	0.649	87	109	22	22	93	33	Superior (Picketpost Mtn)
5577	U:12:135	503	0.618	48	128	26	28	105	29	Superior (Picketpost Mtn)
8900	U:12:111	464	0.609	60	127	22	21	98	31	Superior (Picketpost Mtn)
6974	V:2:101	512	0.617	55	121	23	25	98	27	Superior (Picketpost Mtn)
RGM1-S5		300	1.308	42	145	108	23	216	1	standard
RGM1-S5		297	1.326	42	146	108	24	226	15	standard
RGM1-S5		299	1.321	40	148	106	20	216	15	standard
RGM1-S5		301	1.308	41	146	107	23	218	5	standard
RGM1-S5		309	1.312	41	152	107	31	214	10	standard

Table 2. Crosstabulation of site by source (see Table 1).

			Source				
			Government Mtn	Sauceda Mtns	Superior (Picketpost Mtn)	Vulture	Total
Site (AZ)	U:12:2	Count	0	0	1	0	1
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	1.5%	0.0%	1.4%
		% of Total	0.0%	0.0%	1.4%	0.0%	1.4%
	U:12:54	Count	0	0	2	0	2
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	3.0%	0.0%	2.7%
		% of Total	0.0%	0.0%	2.7%	0.0%	2.7%
	U:12:55	Count	0	0	4	0	4
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	6.1%	0.0%	5.5%
		% of Total	0.0%	0.0%	5.5%	0.0%	5.5%
	U:12:56	Count	2	4	18	1	25
		% within Site (AZ)	8.0%	16.0%	72.0%	4.0%	100.0%
		% within Source	100.0%	100.0%	27.3%	100.0%	34.2%
		% of Total	2.7%	5.5%	24.7%	1.4%	34.2%
	U:12:111	Count	0	0	1	0	1
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	1.5%	0.0%	1.4%
		% of Total	0.0%	0.0%	1.4%	0.0%	1.4%
	U:12:116	Count	0	0	28	0	28
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	42.4%	0.0%	38.4%
		% of Total	0.0%	0.0%	38.4%	0.0%	38.4%
	U:12:118	Count	0	0	5	0	5
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	7.6%	0.0%	6.8%
		% of Total	0.0%	0.0%	6.8%	0.0%	6.8%
	U:12:122	Count	0	0	1	0	1
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	1.5%	0.0%	1.4%
		% of Total	0.0%	0.0%	1.4%	0.0%	1.4%
	U:12:135	Count	0	0	1	0	1
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	1.5%	0.0%	1.4%
		% of Total	0.0%	0.0%	1.4%	0.0%	1.4%
	U:12:142	Count	0	0	3	0	3
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	4.5%	0.0%	4.1%
		% of Total	0.0%	0.0%	4.1%	0.0%	4.1%
	U:12:233	Count	0	0	1	0	1
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	1.5%	0.0%	1.4%
		% of Total	0.0%	0.0%	1.4%	0.0%	1.4%
	V:2:101	Count	0	0	1	0	1
		% within Site (AZ)	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	1.5%	0.0%	1.4%
		% of Total	0.0%	0.0%	1.4%	0.0%	1.4%
Total		Count	2	4	66	1	73
		% within Site (AZ)	2.7%	5.5%	90.4%	1.4%	100.0%
		% within Source	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	2.7%	5.5%	90.4%	1.4%	100.0%

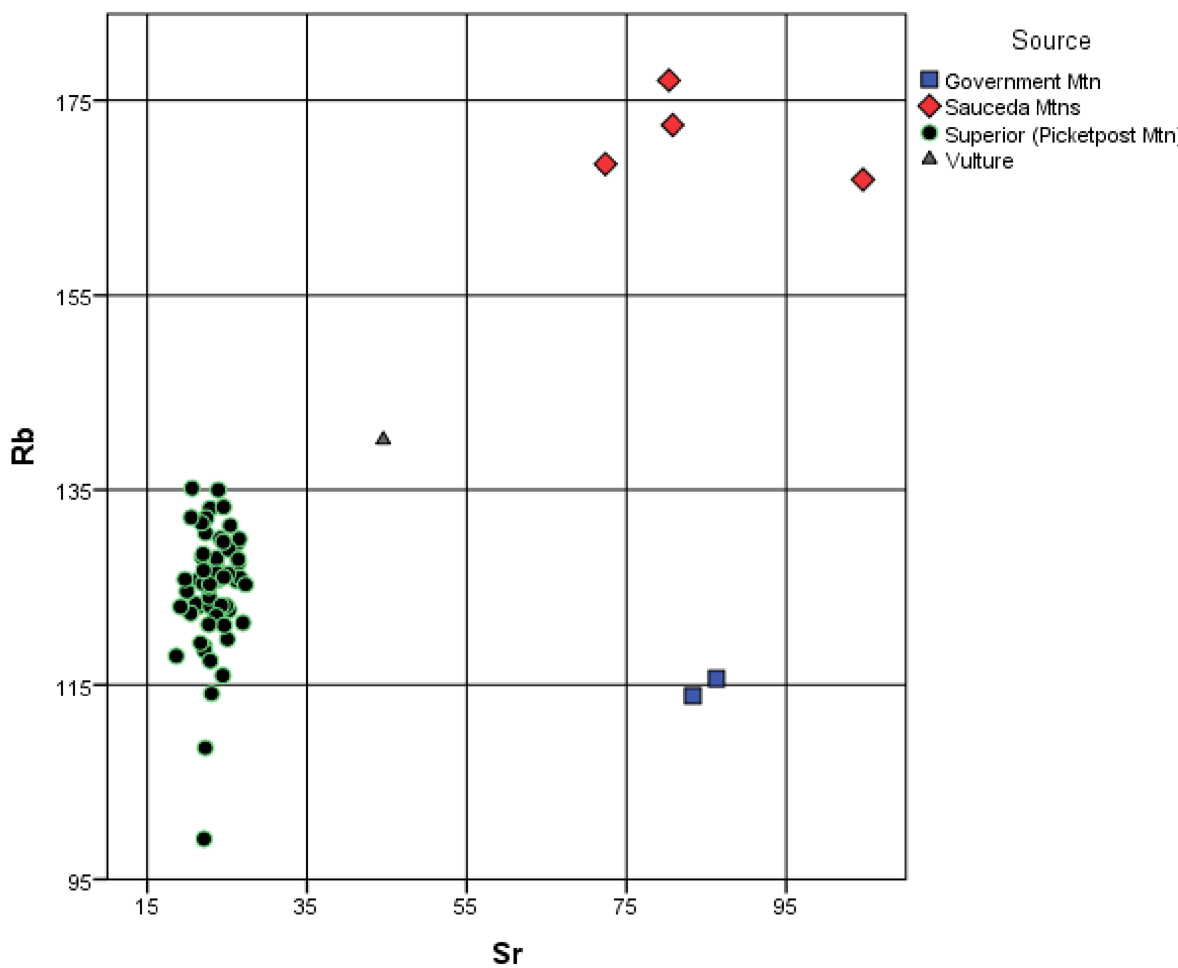

Figure 1. Sr versus Rb bivariate plot of all the archaeological specimens.