Title

SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM THE CLASSIC PERIOD ROWLEY SITE (AZ U:9:49 ASU), MESA, ARIZONA

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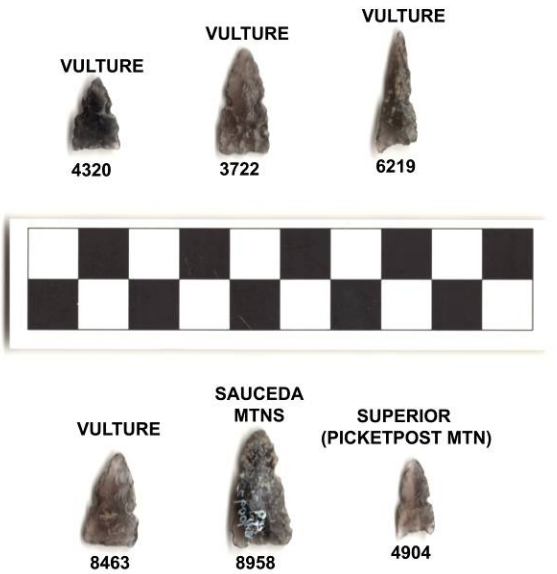

Source provenance of Classic Period mid-blade side notched obsidian projectile points from the Rowley Site

by

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Report Prepared for

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INTRODUCTION

The analysis here of 83 obsidian bifaces (five were not obsidian or too burned/dirty to analyze) indicates an extremely diverse obsidian provenance assemblage with a mix of sources somewhat atypical for Classic contexts in the Middle Salt River Valley (Bayman and Shackley 1999; Loendorf et al. 2018; Peterson et al. 1997; Mills et al. 2013; Shackley 2005, 2019; Table 1 and 2, and Figures 1 through 4 herein). A number or large bifaces, some likely preforms, were produced from the Government Mountain source of the San Francisco volcanic field on the Coconino Plateau of northern Arizona, a source more common in Preclassic Hohokam contexts (Shackley 2005, 2019). While the small projectile point assemblage was produced mainly from the Sonoran Desert sources of Sauceda Mountains (East and West group), Superior (Picketpost Mountain), and Vulture more typical of a Classic assemblage (see cover image), the quantity of Superior is relatively rare in this time period in this area (Shackley 2005, 2019). Three projectile points were produced from the Antelope Creek/Mule Creek source of the Mogollon-Datil Volcanic Province in western New Mexico (Shackley et al. 2018). This source was commonly distributed throughout the Southwest during the Late Classic, an indication of the extensive social networks and the effect of migration in the region and the importance of the Late Classic in the western New Mexico area (Mills et al. 2013).

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 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 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 $K\alpha_1$-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 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, the Centre de Recherches Pétrographiques et Géochimiques in France, and the Japan Geological Survey (Govindaraju 1994). Line fitting is linear (XML) for all elements. When barium (Ba) and cerium (Ce) 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 (1995, 2005, 2011; also Mahood and Stimac 1990; and Hughes and Smith 1993). Nineteen specific pressed powder standards are used for the best fit regression calibration for elements Ti-Nb, Pb, Th, Ba, and Ce 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^{TM} software were translated directly into Excel for Windows software for manipulation and on into SPSS for Windows (ver. 27) or JMP 12.0.1 as appropriate 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 ≤19 for obsidian artifacts to check machine calibration (Table 1).

Source assignments were made by reference to a number of published and unpublished references as cited below, and the Skinner-Shackley database for North American obsidian sources. The choice of elements for North American obsidian compositional analysis is discussed in Shackley (1989, 2005, 2011; Shackley et al. 2016, 2018). Further information on the laboratory instrumentation can be found at: http://www.swxrflab.net/. Trace element data exhibited in Table 1 and Figure 4 are reported in parts per million (ppm), a quantitative measure by weight.

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

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba[2]	Pb	Th	Source
1187	614	390	11663	252	26	42	114	21		33	40	Antelope Cr/Mule Cr
1291	773	513	10613	124	24	24	99	31		25	19	Superior (Picketpost Mtn)
1762	893	376	10937	141	50	24	132	17		27	20	Vulture
2220	795	376	10867	138	44	18	135	20		29	23	Vulture
2574	961	350	10999	145	48	19	139	24		19	18	Vulture
2875	912	404	11023	143	45	22	141	20		23	12	Vulture
3612	940	359	10887	140	44	19	123	24		25	15	Vulture
3722	977	372	11070	144	54	16	134	21		18	13	Vulture
3775	754	484	10414	118	26	25	92	30		25	20	Superior (Picketpost Mtn)
3780	986	400	11114	148	47	18	131	27		24	25	Vulture
3836	1212	406	11345	150	51	18	135	20		30	14	Vulture
3884	664	479	10431	122	22	26	96	36		24	28	Superior (Picketpost Mtn)
3891	802	508	10568	123	28	26	95	27		21	23	Superior (Picketpost Mtn)
4229	719	355	10798	135	50	20	129	24		19	14	Vulture
4273	1005	402	11074	134	47	23	128	23		22	5	Vulture
4288	1052	385	11035	139	45	18	131	26		25	23	Vulture
4320	911	420	11047	148	46	25	136	23		24	19	Vulture
4439	831	509	10607	127	28	28	96	35		26	18	Superior (Picketpost Mtn)
4582	903	355	10783	133	44	18	127	24		22	21	Vulture
4609	732	461	10380	124	23	26	101	34		19	12	Superior (Picketpost Mtn)
4630	821	527	10611	127	27	26	103	29		20	18	Superior (Picketpost Mtn)
4715	891	347	10661	130	43	19	131	20		18	15	Vulture
4904	860	524	10787	128	29	24	96	25		23	10	Superior (Picketpost Mtn)
4981	955	406	11143	143	48	26	137	19		24	13	Vulture
4999	1106	424	11435	151	49	18	142	25		28	18	Vulture
5253A	1272	389	12269	111	52	41	157	21		43	9	unknown
5256	824	310	10422	121	35	17	122	12		22	21	Vulture
5404	1328	379	11868	148	72	33	194	24		21	21	Sauceda Mtns
5406	637	371	11463	243	22	40	110	28		26	30	Antelope Cr/Mule Cr
5499	1032	375	11000	138	46	21	136	17		22	17	Vulture
5545	524	511	10737	106	58	28	78	6		24	11	Government Mtn[3]
5552	1408	388	12288	107	81	29	115	8		15	14	Government Mtn?
5569	820	507	10630	126	22	26	93	33		22	12	Superior (Picketpost Mtn)
5603	520	489	10661	109	56	26	77	8		18	14	Government Mtn

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba^2	Pb	Th	Source
5661	614	468	10836	110	55	27	80	4		25	5	Government Mtn
5715	1065	400	11216	136	46	21	128	21		22	17	Vulture
5753B	421	472	10558	105	52	23	79	8		23	14	Government Mtn
5768	498	454	10434	107	52	22	73	14		23	7	Government Mtn
5770	429	368	9964	92	49	24	74	10		20	20	Government Mtn
5878A	522	451	10294	101	55	28	78	9	313	24	12	Government Mtn
5878B	1386	752	15359	219	12	87	585	29	365	34	23	unknown
5878C	868	424	8264	103	57	18	78	7	331	21	22	Government Mtn
5969A	782	445	7890	102	53	21	73	11	309	21	14	Government Mtn
5969B	971	442	8632	102	68	23	77	13	365	18	19	Government Mtn
5969C	1605	734	16808	226	12	91	596	33	19	33	23	unknown
6033A	913	472	8427	106	54	27	78	16	392	23	16	Government Mtn
6033B	845	417	8036	101	53	25	74	13	349	22	10	Government Mtn
6057	868	454	8434	106	56	28	79	9	374	24	15	Government Mtn
6112	832	503	10586	126	28	24	97	34		26	13	Superior (Picketpost Mtn)
6133	1155	478	10359	112	27	29	88	26		20	17	Superior (Picketpost Mtn)
6219	1022	390	11164	148	46	16	134	24		21	23	Vulture
6326	1561	342	12567	156	104	29	182	16		21	29	Sauceda Mtns
6517	1497	371	11770	132	166	20	162	13	1115	15	8	Sauceda Mtns?
6698	653	361	11428	240	25	41	111	23		30	48	Antelope Cr/Mule Cr
6724	1505	332	13065	146	74	29	189	11		25	22	Sauceda Mtns
6754	882	390	10923	138	43	20	128	22		26	18	Vulture
7252	783	488	10493	127	29	21	90	27		21	15	Superior (Picketpost Mtn)
7559	1086	386	11416	133	51	26	132	24		23	18	Vulture
7749	941	405	11245	140	47	18	127	19		23	15	Vulture
8022	920	383	10923	134	53	23	131	18		21	13	Vulture
8463	923	384	11101	146	44	23	136	20		28	23	Vulture
8558	1421	416	12384	154	89	34	190	28		35	32	Sauceda Mtns
8645	911	517	10807	120	30	25	96	24		24	13	Superior (Picketpost Mtn)
8958	1770	358	11856	150	84	30	197	24		25	27	Sauceda Mtns
8980	8557	454	10431	113	44	21	92	31		17	10	too burned/dirty
10042	997	383	11114	141	46	21	132	25		23	5	Vulture
10045	810	484	10438	123	33	22	98	32		21	17	Superior (Picketpost Mtn)
10046	745	483	10499	124	31	24	99	28		28	17	Superior (Picketpost Mtn)
10047	1006	384	11178	144	45	17	132	20		20	19	Vulture
10048	889	408	11124	146	48	21	134	21		25	17	Vulture
10049	1079	379	11227	135	47	20	137	16		20	19	Vulture
10051	1080	351	11020	134	52	12	131	20		22	12	Vulture

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba[2]	Pb	Th	Source
10219	983	361	11171	140	47	16	128	22		23	26	Vulture
10267	961	402	10889	138	47	18	124	22		26	10	Vulture
10312	869	485	10642	123	34	28	90	34		21	17	Superior (Picketpost Mtn)
10378	1065	405	11008	135	52	18	131	24		24	15	Vulture
10455	1110	525	10920	121	46	20	102	26		24	9	Vulture
10463	1510	391	12333	172	79	26	195	22		20	22	Sauceda Mtns
10464	1045	376	11044	136	55	16	125	19		26	24	Vulture
10466	1002	382	11015	140	50	22	135	21		26	20	Vulture
10474	1010	370	10969	135	53	19	123	25		23	23	Vulture
10509	988	387	11012	137	54	16	127	17		22	15	Vulture
10578	441	486	11467	104	93	21	81	50		27	12	Government Mtn
10594	955	407	10945	139	43	18	128	19		17	7	Vulture
RGM1-H2	1494	288	13699	147	108	23	218	13		20	13	standard
RGM1-H2	1556	309	13680	139	108	25	212	6		25	26	standard
RGM1-S4	1495	277	13078	147	103	28	222	8	819	23	26	standard
RGM1-S6	1499	300	13557	139	106	20	203	5		25	25	standard
RGM1-S6	1442	303	13631	144	105	28	217	10		22	11	standard
RGM1-S6	1473	324	13570	144	105	24	208	7		22	22	standard

[1] Five samples were not obsidian.
[2] Barium (Ba) acquired when necessary for greater discrimination.
[3] Some of the artifacts assigned to Government Mountain, particularly the large bifaces exhibited Sr concentrations generally lower than source standards, but the analysis of Ba and the other mid-Z elements suggests that they were produced from Government Mountain obsidian, perhaps from a portion of the source no longer accessible.

Table 2. Frequency distribution of obsidian source provenance.

		Frequency	Percent
Source	Vulture	39	47.0
	Superior (Picketpost Mtn)	16	19.3
	Sauceda Mtns	7	8.4
	Government Mtn	15	18.1
	Antelope Cr/Mule Cr	3	3.6
	unknown	3	3.6
	Total	83	100.0

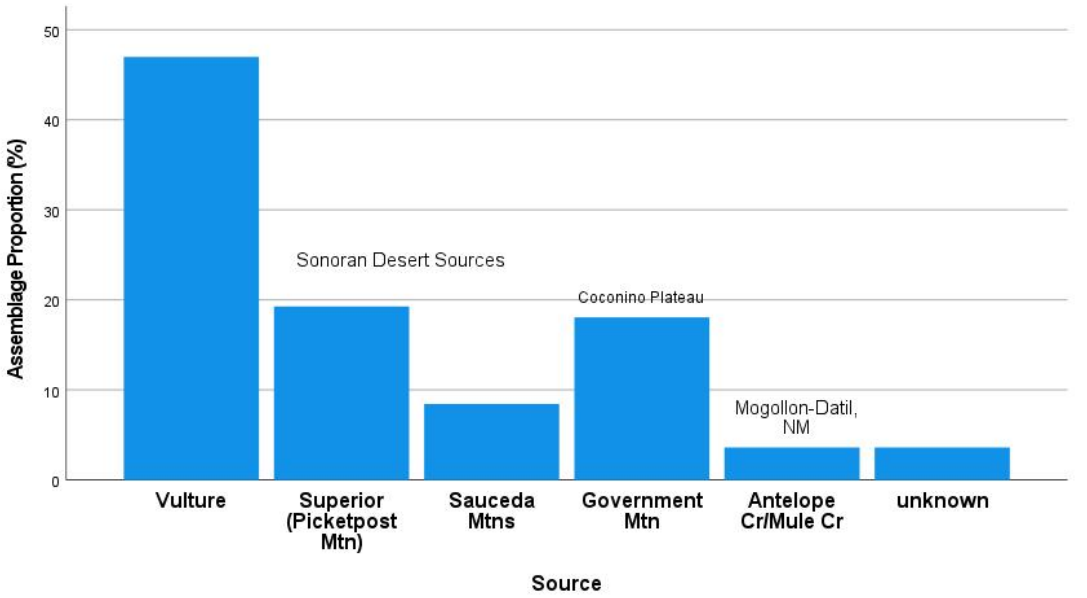

Figure 1. Frequency histogram of obsidian source provenance (see Tables 1 and 2).

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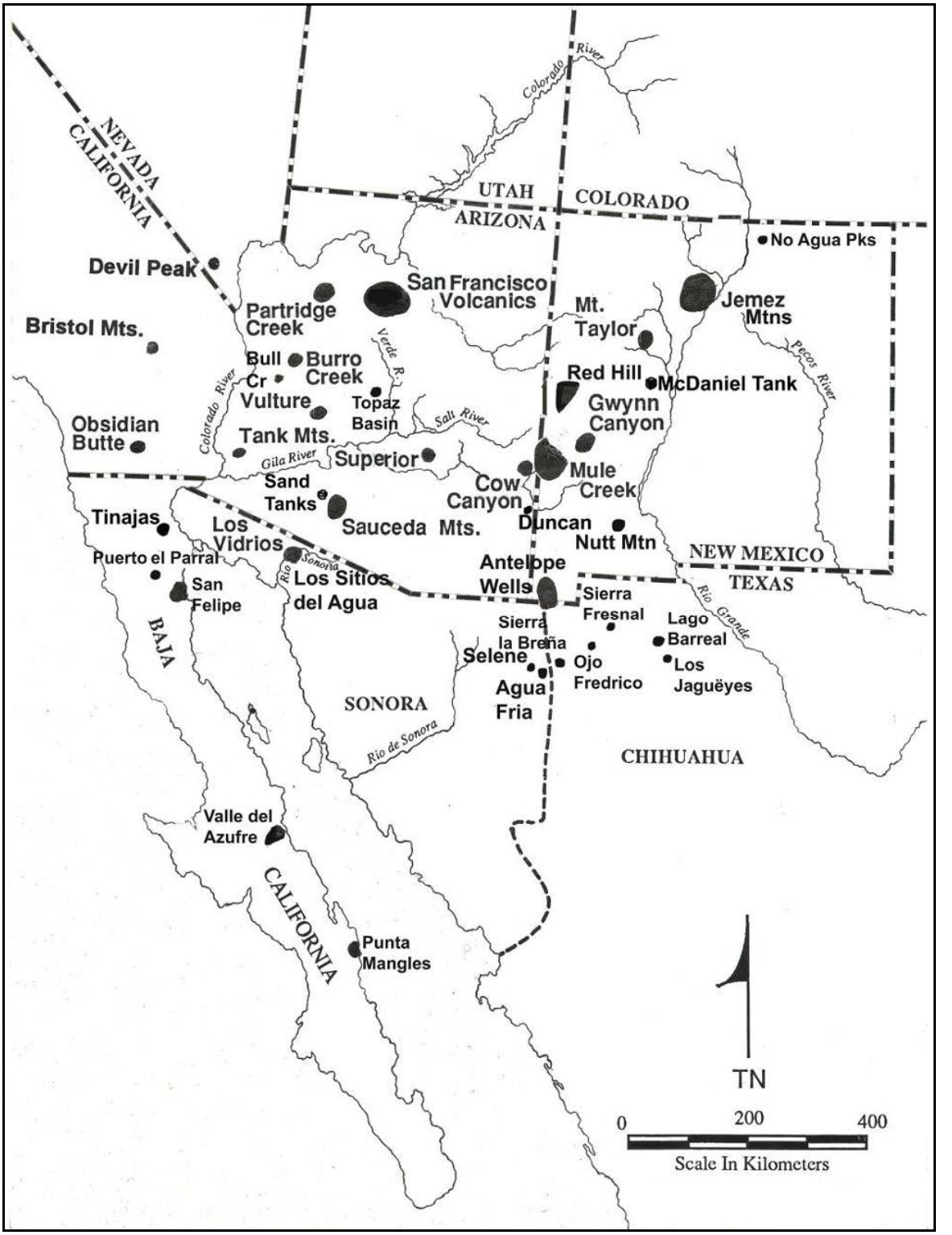

Figure 2. Obsidian sources in southwestern North America (adapted from Shackley 2005). Source configurations not to scale.

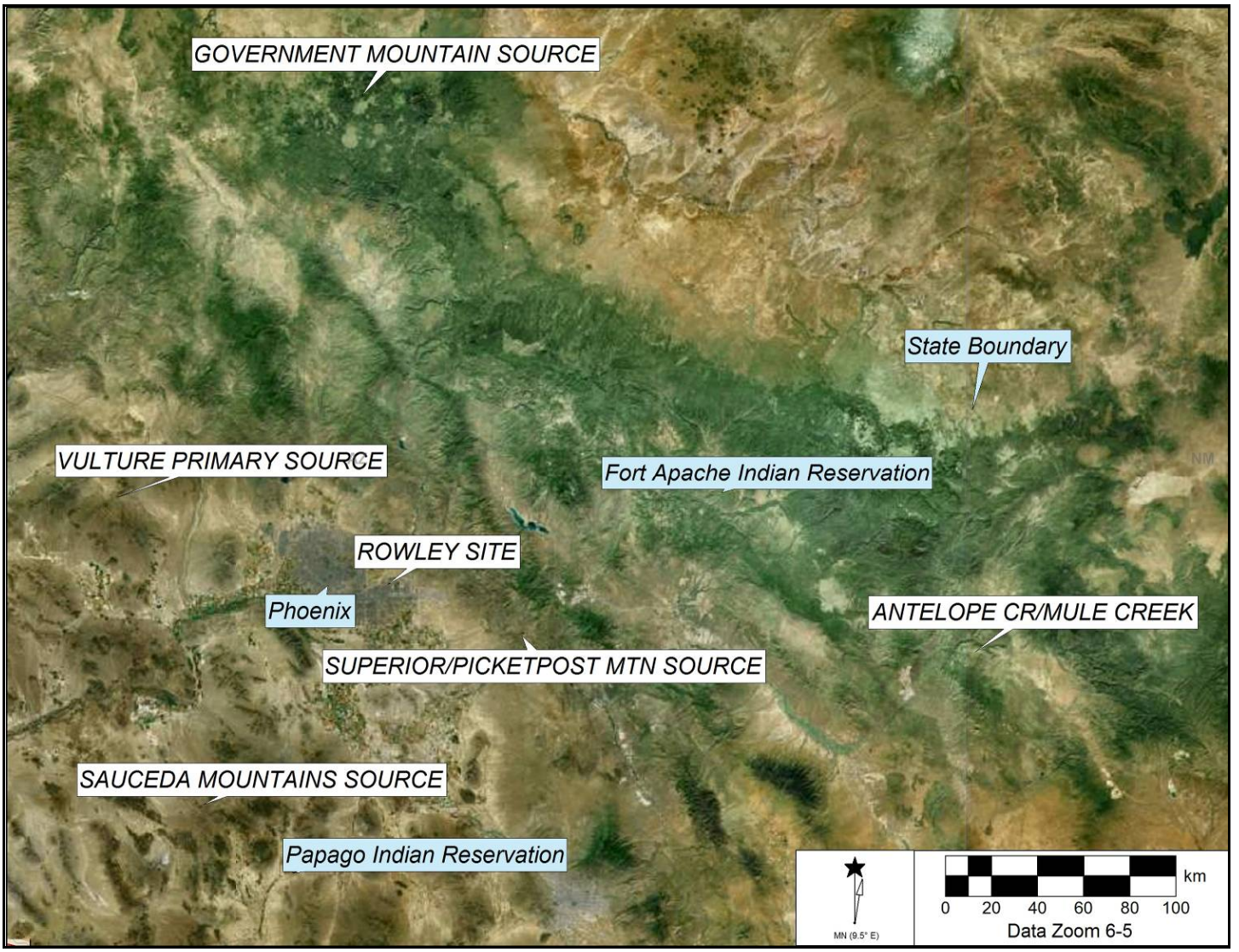

Figure 3. Satellite aerial image of the Rowley Site, obsidian sources (in capitals) recovered at the site, and prominent features.

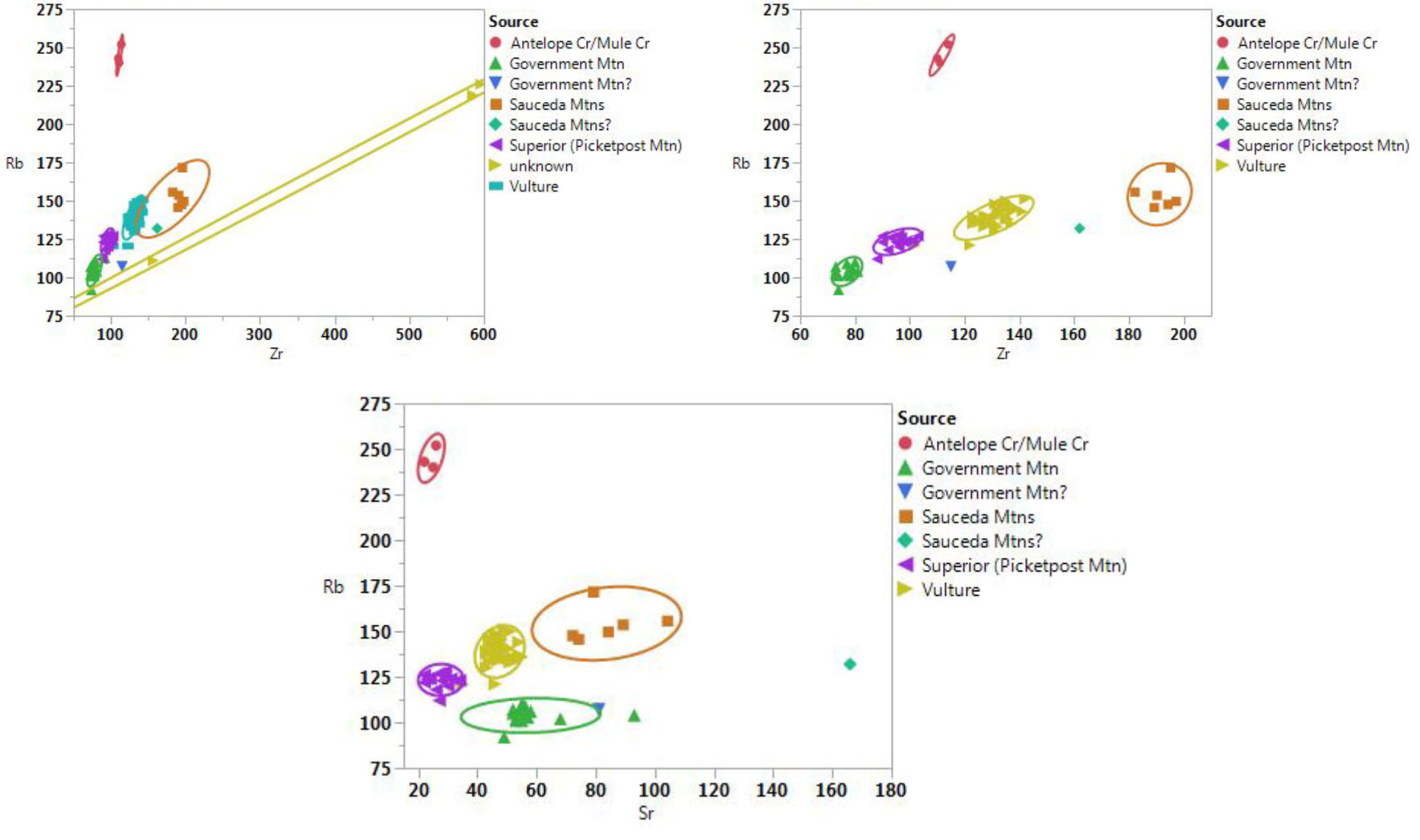

Figure 4. Zr/Rb bivariate plot of all samples (left) and unknowns deleted (right) for increased clarity. Sr/Rb bivariate plot of all sources minus unknowns providing increased discrimination. Confidence ellipses at 90%.