Title
SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM CABEZA PRIETA WILDLIFE REFUGE, SOUTHWESTERN ARIZONA

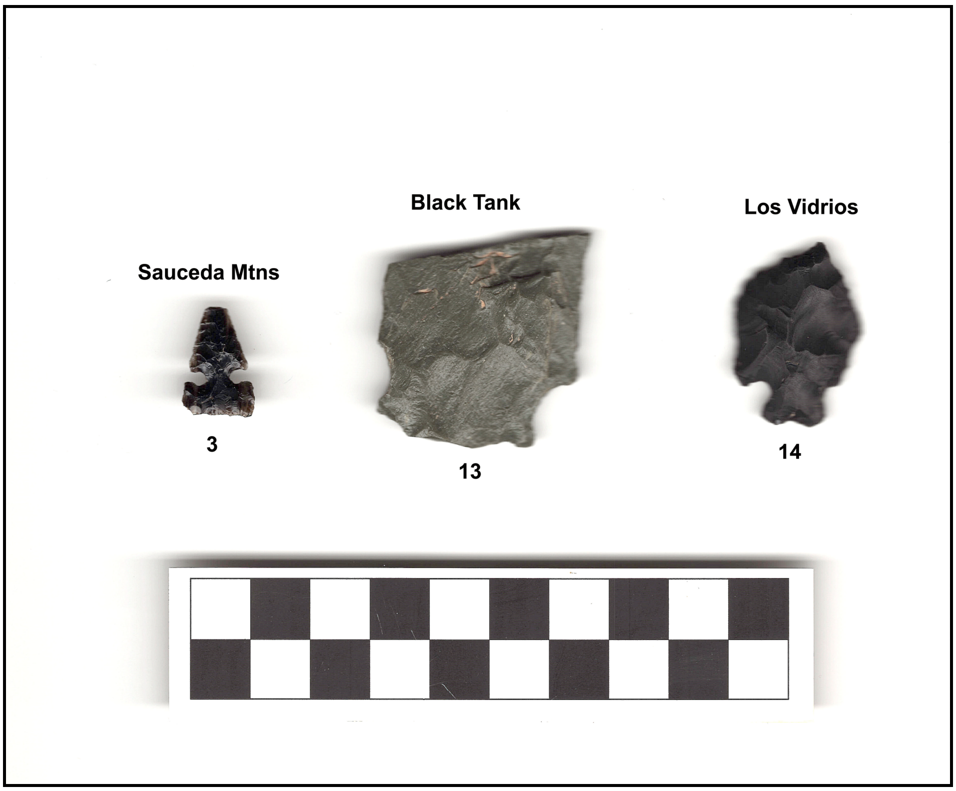
Author
Shackley, M. Steven

Publication Date
2017-12-06

GEOARCHAEOLOGICAL XRF LAB
A GREEN SOLAR FACILITY

GEOARCHAEOLOGICAL X-RAY FLUORESCENCE SPECTROMETRY LABORATORY
8100 WYOMING BLVD., SUITE M4-158 ALBUQUERQUE, NM 87113 USA

SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM CABEZA PRIETA WILDLIFE REFUGE, SOUTHWESTERN ARIZONA



Source provenance of three bifaces from the assemblage

by
M. Steven Shackley Ph.D., Director
Geoarchaeological XRF Laboratory
Albuquerque, New Mexico

Report Prepared for
U.S. Fish and Wildlife Service
Cabeza Prieta National Wildlife Refuge
Ajo, Arizona

6 December 2017

INTRODUCTION

The 20 obsidian artifacts from a number of sites on Cabeza Prieta Wildlife Refuge were produced from three of the sources previously recovered from sites on the refuge, Los Vidrios, Sonora (20%), Los Sitios del Agua (20%), and Sauceda Mountains (55%; see Shackley 2015. 2016; Figure 1 here). As in the previous study, the assemblage suggests that the local environment was important, with connections to the north and south apparent. The large biface recovered from Playa Concha was produced from the Black Tank source in the Mount Floyd Volcanic Field in northern Arizona (Lesko 1989; Shackley 1995, 2005; see cover image here).

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

All archaeological and source 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).

Trace Element Analyses

All analyses for this study were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer, located in 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 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 quadratic 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 quadratic (XML) for all elements. 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 and SPSS (ver. 21) and JMP 12.0.1 software for statistical manipulation. 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 was analyzed during each sample run for plutonic rock samples to check machine calibration (Table 1 and Figure 2).

DISCUSSION

As noted above, the vast majority of obsidian artifacts were produced from sources in the local area. The direction of the sources, Los Sitios del Agua and Los Vidrios, Sonora to the south, and Sauceda Mountains to the north, indicates a concentration of local source procurement (Tables 1 and 2 and Figure 1; see cover image). All of the Sonoran Desert obsidian sources are generally equal media for tool production in quality and nodule size, although Los Vidrios can be very brittle in hard hammer percussion, but equal to the others for pressure work (Martynec et al. 2011; Shackley 2005). However, the large biface produced from the Black Tank source on the Coconino Plateau is unique, and none of the artifacts recovered from the refuge have been from sources that far north (Shackley 2015, 2016).

REFERENCES CITED

Davis, K.D., T.L. Jackson, M.S. Shackley, T. Teague, and J.H. Hampel
2011 Factors Affecting the Energy-Dispersive X-Ray Fluorescence (EDXRF) Analysis of Archaeological Obsidian. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M.S. Shackley, pp. 45-64. Springer, New York.

Govindaraju, K.
1994 1994 Compilation of Working Values and Sample Description for 383 Geostandards. *Geostandards Newsletter* 18 (special issue).

Hampel, Joachim H.
1984 Technical Considerations in X-ray Fluorescence Analysis of Obsidian. In *Obsidian Studies in the Great Basin*, edited by R.E. Hughes, pp. 21-25. Contributions of the University of California Archaeological Research Facility 45. Berkeley.

Hildreth, W.
1981 Gradients in Silicic Magma Chambers: Implications for Lithospheric Magmatism. *Journal of Geophysical Research* 86:10153-10192.

Hughes, Richard E., and Robert L. Smith
1993 Archaeology, Geology, and Geochemistry in Obsidian Provenance Studies. *In Scale on Archaeological and Geoscientific Perspectives*, edited by J.K. Stein and A.R. Linse, pp. 79-91. Geological Society of America Special Paper 283.

Lesko, Larry
1989 A Reexamination of Northern Arizona Obsidians. *Kiva* 54:385-399.

Mahood, Gail A., and James A. Stimac
1990 Trace-Element Partitioning in Pantellerites and Trachytes. *Geochemica et Cosmochimica Acta* 54:2257- 2276.

Martynec, R.J., R. Davis, and M.S. Shackley
2011 The Los Sitios del Agua Obsidian Source (Formerly AZ Unknown A) and Recent Archaeological Investigations along the Rio Sonoyta, Northern Sonora. *Kiva* 76:413-430.

McCarthy, J.J., and F.H. Schamber
1981 Least-Squares Fit with Digital Filter: A Status Report. In *Energy Dispersive X-ray Spectrometry*, edited by K.F.J. Heinrich, D.E. Newbury, R.L. Myklebust, and C.E. Fiori, pp. 273-296. National Bureau of Standards Special Publication 604, Washington, D.C.

Schamber, F.H.
1977 A Modification of the Linear Least-Squares Fitting Method which Provides Continuum Suppression. In *X-ray Fluorescence Analysis of Environmental Samples*, edited by T.G. Dzubay, pp. 241-257. Ann Arbor Science Publishers.

Shackley, M. Steven
1988 Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study. *American Antiquity* 53(4):752-772.

1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60(3):531-551.

2005 *Obsidian: Geology and Archaeology in the North American Southwest*. University of Arizona Press, Tucson.

2011 An Introduction to X-Ray Fluorescence (XRF) Analysis in Archaeology. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M.S. Shackley, pp. 7-44. Springer, New York.

2015 Source Provenance of Obsidian Artifacts from the Cabeza Prieta National Wildlife Refuge, Southwestern Arizona. Report prepared for the Bureau of Land Mangement, Ajo, Arizona.

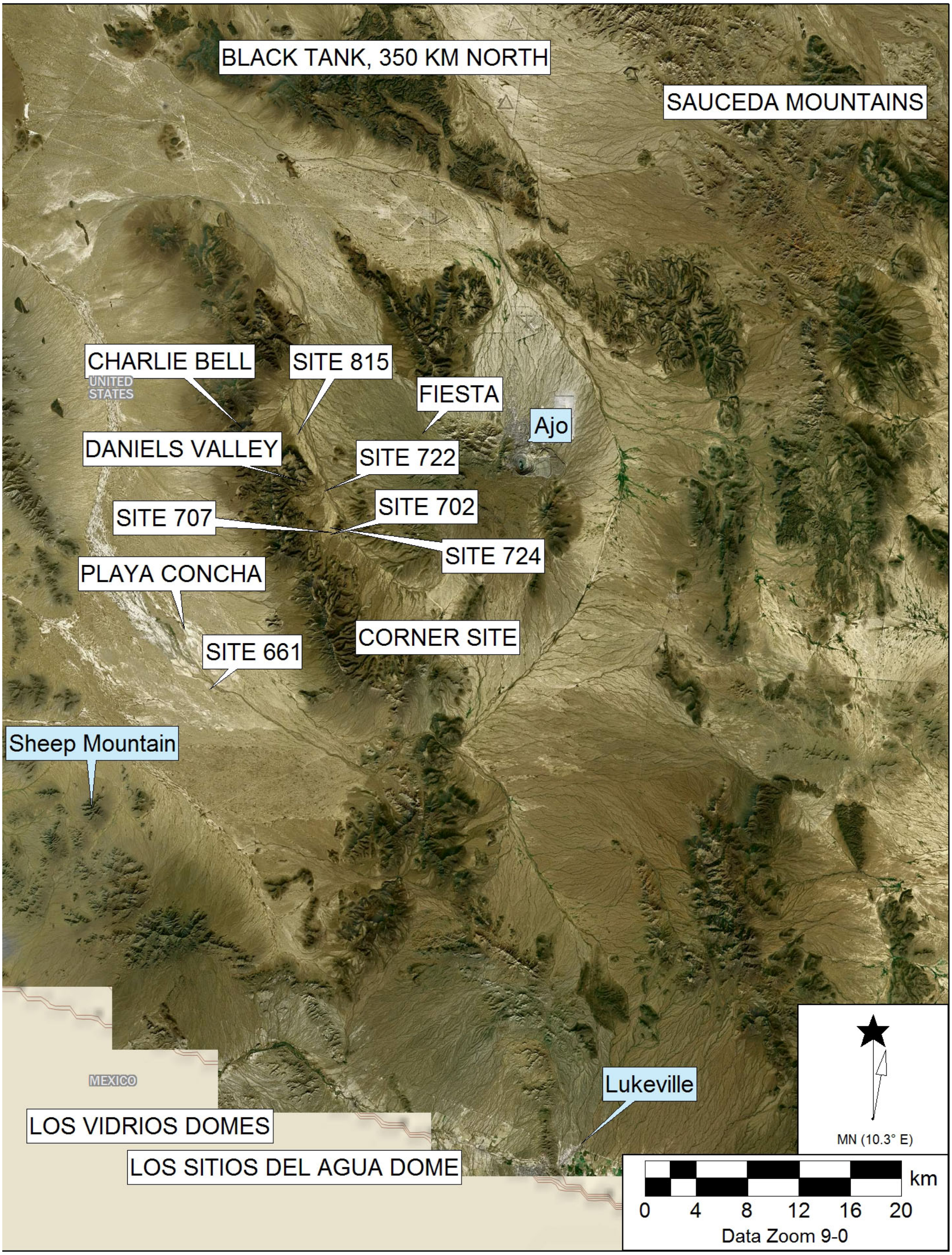
2016 Source Provenance of Obsidian Artifacts from Southwestern Arizona. Report prepared for Cabeza Prieta Wildlife Refuge, U.S. Fish and Wildlife, Ajo, Arizona.

Table 1. Elemental concentrations for the artifacts by site and USGS RGM-1 rhyolite standard.

XRF#	Site	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Source
17	661	1035	293	14238	109	269	21	70	231	35	44	Los Vidrios
14	702	1027	260	12578	90	236	15	67	221	33	42	Los Vidrios
20	707	1405	351	10537	62	166	72	31	201	22	1128	Sauceda Mtns
19	722	1436	367	10490	56	157	80	34	205	20	1186	Sauceda Mtns
16	724	1891	459	12578	160	186	77	27	206	24	947	Sauceda Mtns
10	815	1508	486	24913	165	153	16	87	742	50	84	Los Sitios del Agua
11	815	1463	512	26902	181	160	13	86	759	54	104	Los Sitios del Agua
15	Charlie Bell	966	245	12222	93	241	15	70	228	31	31	Los Vidrios
12	Corner Site	1008	256	12587	96	257	15	71	238	33	51	Los Vidrios
1	Daniels Valley	1571	358	10891	91	167	77	30	206	26	1168	Sauceda Mtns
2	Daniels Valley	1610	347	11499	76	168	112	29	191	24	1057	Sauceda Mtns
3	Daniels Valley	1516	371	10800	75	169	80	32	204	21	1249	Sauceda Mtns
4	Daniels Valley	1386	540	25610	227	148	15	79	719	47	80	Los Sitios del Agua
5	Daniels Valley	1294	438	22484	185	140	16	76	700	46	113	Los Sitios del Agua
6	Daniels Valley	1908	354	12988	53	176	110	30	205	19	1200	Sauceda Mtns
7	Daniels Valley	1449	385	11145	64	165	75	29	193	22	1246	Sauceda Mtns
8	Daniels Valley	1326	298	9675	43	140	95	24	176	23	987	Sauceda Mtns
9	Daniels Valley	1555	363	10898	55	170	78	32	199	24	1187	Sauceda Mtns
18	Fiesta	1403	364	10595	56	159	75	36	199	26	1161	Sauceda Mtns
13	Playa Concha	1759	457	16567	50	115	156	25	98	24	978	Black Tank
RGM1-S4	standard	1558	286	13213	44	148	107	21	222	7	858	standard

Table 2. Crosstabulation of source by site.

			Source				
			Black Tank	Los Sitios del Agua	Los Vidrios	Sauceda Mtns	Total
Site	661	Count	0	0	1	0	1
		% within Site	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	25.0%	0.0%	5.0%
		% of Total	0.0%	0.0%	5.0%	0.0%	5.0%
	702	Count	0	0	1	0	1
		% within Site	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	25.0%	0.0%	5.0%
		% of Total	0.0%	0.0%	5.0%	0.0%	5.0%
	707	Count	0	0	0	1	1
		% within Site	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Source	0.0%	0.0%	0.0%	9.1%	5.0%
		% of Total	0.0%	0.0%	0.0%	5.0%	5.0%
	722	Count	0	0	0	1	1
		% within Site	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Source	0.0%	0.0%	0.0%	9.1%	5.0%
		% of Total	0.0%	0.0%	0.0%	5.0%	5.0%
	724	Count	0	0	0	1	1
		% within Site	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Source	0.0%	0.0%	0.0%	9.1%	5.0%
		% of Total	0.0%	0.0%	0.0%	5.0%	5.0%
	815	Count	0	2	0	0	2
		% within Site	0.0%	100.0%	0.0%	0.0%	100.0%
		% within Source	0.0%	50.0%	0.0%	0.0%	10.0%
		% of Total	0.0%	10.0%	0.0%	0.0%	10.0%
	Charlie Bell	Count	0	0	1	0	1
		% within Site	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	25.0%	0.0%	5.0%
		% of Total	0.0%	0.0%	5.0%	0.0%	5.0%
	Corner Site	Count	0	0	1	0	1
		% within Site	0.0%	0.0%	100.0%	0.0%	100.0%
		% within Source	0.0%	0.0%	25.0%	0.0%	5.0%
		% of Total	0.0%	0.0%	5.0%	0.0%	5.0%
	Daniels Valley	Count	0	2	0	7	9
		% within Site	0.0%	22.2%	0.0%	77.8%	100.0%
		% within Source	0.0%	50.0%	0.0%	63.6%	45.0%
		% of Total	0.0%	10.0%	0.0%	35.0%	45.0%
	Fiesta	Count	0	0	0	1	1
		% within Site	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Source	0.0%	0.0%	0.0%	9.1%	5.0%
		% of Total	0.0%	0.0%	0.0%	5.0%	5.0%
	Playa Concha	Count	1	0	0	0	1
		% within Site	100.0%	0.0%	0.0%	0.0%	100.0%
		% within Source	100.0%	0.0%	0.0%	0.0%	5.0%
		% of Total	5.0%	0.0%	0.0%	0.0%	5.0%
Total		Count	1	4	4	11	20
		% within Site	5.0%	20.0%	20.0%	55.0%	100.0%
		% within Source	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	5.0%	20.0%	20.0%	55.0%	100.0%



Digital model of the archaeological sites selected modern features, and obsidian sources recovered.

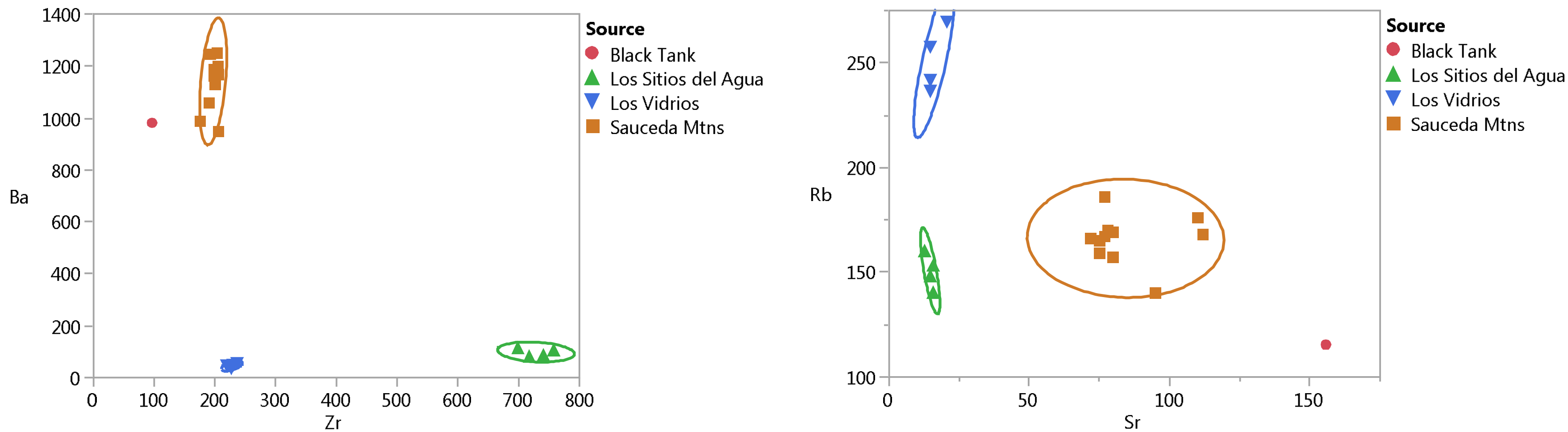


Figure 2. Zr versus Ba and Sr versus Rb bivariate plots of the archaeological samples. Confidence ellipses at 95%.