Title
Source Provenance of Obsidian Artifacts from Garden Canyon Village, Fort Huachuca, Southern Arizona

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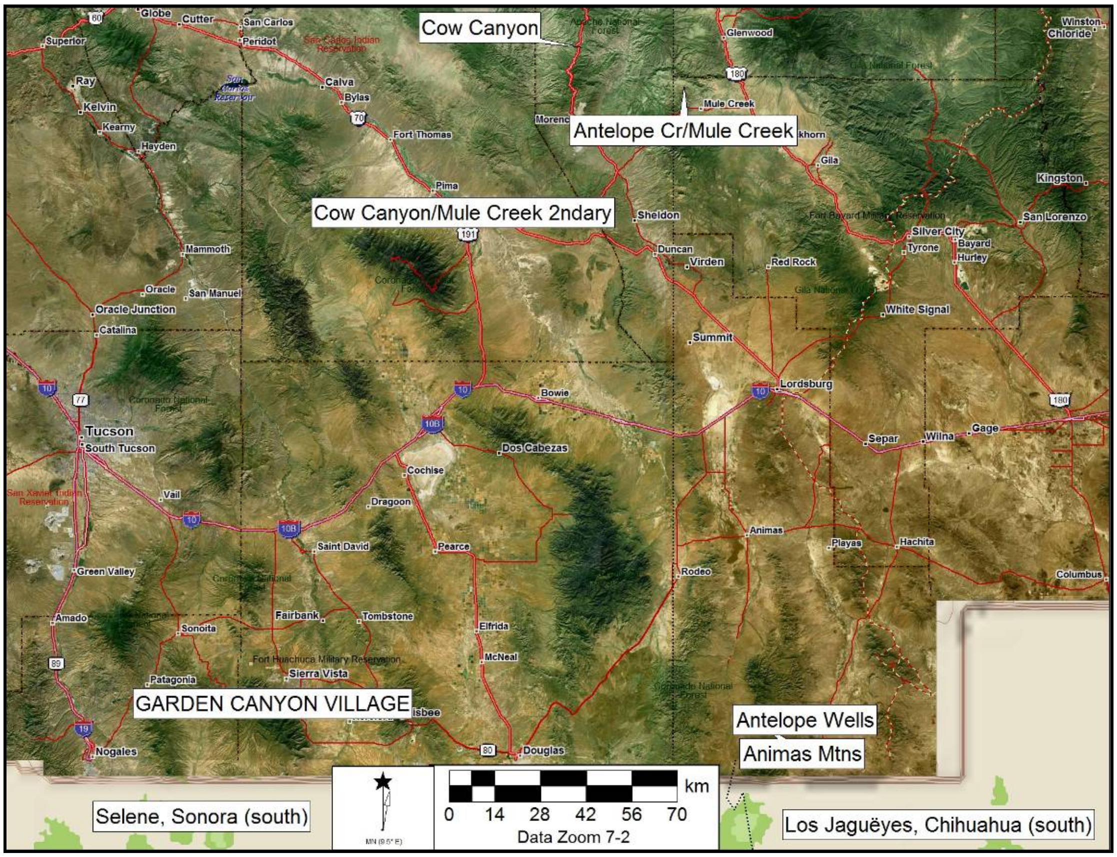

Site locations and known sources present in the project site.

by

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INTRODUCTION

The analysis here of 27 mostly obsidian artifacts from the Garden Canyon Village site in southern Arizona exhibits a very diverse obsidian provenance assemblage with artifacts produced from sources in Sonora, Chihuahua, western New Mexico, and eastern Arizona (see cover image).

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 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 200 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 but Fe where a derivative fitting is used to improve the fit for iron and thus for all the other 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 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 (ver. 21) 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 by reference to Hinojosa-Prieto et al. (2015) and Shackley (1995, 2005 and updated at http://swxrflab.net/swobsrcs.htm; see Tables 1 and 2 and Figures 1 and 2.

DISCUSSION

While the obsidian provenance in these sites is relatively diverse, dominated by sources in western New Mexico (Antelope Creek, 34.8%) , Antelope Wells/El Berrendo in southern New Mexico and northern Chihuahua (21.7%), and Animas Mountains (17.4%) in the bootheel of New Mexico, a small proportion of the artifacts were produced from sources in northwest Mexico including Selene, Sonora in the Sierra Madre (4.3%) and Los Jaguëyes south of Nueva Casas Grandes, Chihuahua also at 4.3% (Hinojosa-Prieto et al. 2015; Shackley 2005; Tables 1 and 2, Figure 3). Selene, Sonora is a recently located source in the Sierra El Tigre about 100 km south of Agua Prieta, Sonora. It was originally recorded from archaeological contexts in sites along the border as Sonora Unknown B, and appears to be fairly common in sites north of the border (Hinajosa-Prieto et al. 2015; Shackley 2005). It's location in relatively high elevation in the Sierra Madre is in an environment similar to the Cow Canyon and Mule Creek source areas in eastern Arizona and western New Mexico (see cover image). Keep in mind that the Cow Canyon and Mule Creek sources can be found as secondary deposits in Gila River Quaternary alluvium as far west as Geronimo, Arizona in the Safford Valley (Shackley 1998, 2005; cover image here).

The Animas Mountains source is a newly "discovered" source, formerly known as Sonora Unknown A, and like Selene (formerly Sonora Unknown B), has been recovered in border sites. Recently in a re-analysis of Antelope Wells marekanites, the Animas Mountains source was found as a single marekanite collected with Antelope Wells source samples in the 1980s, and was "discovered" while analyzing the samples I collected then, but not previously evaluated (see http://swxrflab.net/antwells.htm). It is a secondary deposit sample, recovered in the valley between the Animas and Peloncillo Mountains near the border in the bootheel region of southwestern New Mexico. A search for the primary source is underway, but it is likely from somewhere in the vicinity of the Antelope Wells source.

This diverse obsidian provenance assemblage, if all from contemporaneous contexts, indicates not only contact and familiarity with the eastern Arizona/western New Mexico region, but points south well into Sonora and Chihuahua. This pattern was also recently seen in Late Classic sites in southern Arizona (Shackley 2015).

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.

Hinojosa-Prieto, H.R., K.W. Kibler, M.S., and H.J. Hinojosa-García
2015 The Selene Obsidian Source (Formerly Sonora Unknown B) of the Upper Río Bavispe Basin, Sonora, Mexico. *Kiva*, in press.

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.

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

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.

1998 Intrasource Chemical Variability and Secondary Depositional Processes in Sources of Archaeological Obsidian: Lessons from the American Southwest. In *Archaeological Obsidian Studies: Method and Theory*, edited by M.S. Shackley, pp. 83-102. Advances in Archaeological and Museum Studies 3. Springer, New York.

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 Late Classic Contexts in Southeastern Arizona. Report prepared for Archaeology Southwest, Tucson, Arizona.

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

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
1	1424	917	19528	353	10	129	1209	98	Antelope Wells, NM/CHIH
2	1132	430	11273	152	137	19	118	15	Cow Canyon, AZ
3	815	739	12370	372	9	74	204	52	Animas Mtns, NM
4	329	131	8562	0	23	5	12	4	not obsidian[1]
5	1209	696	12101	349	11	68	197	47	Animas Mtns, NM
6	1323	512	11617	143	114	24	131	18	Cow Canyon, AZ
7	358	148	8635	2	22	1	14	0	not obsidian
8	1303	430	11237	141	128	20	115	12	Cow Canyon, AZ
9	1433	765	18398	327	12	121	1150	96	Antelope Wells, NM/CHIH
10	399	141	8900	3	22	1	14	0	not obsidian
11	1507	778	17190	291	12	116	1085	92	Antelope Wells, NM/CHIH
12	294	118	8496	0	16	1	9	0	not obsidian
13	572	395	11965	261	22	43	111	23	Antelope Cr/Mule Cr, NM
14	771	468	12754	272	20	42	112	30	Antelope Cr/Mule Cr, NM
15	657	368	11622	251	20	42	108	22	Antelope Cr/Mule Cr, NM
16	1315	392	11431	178	151	19	124	15	Selene, SON
17	888	428	12581	271	20	44	111	28	Antelope Cr/Mule Cr, NM
18	1507	691	24859	256	12	113	1373	102	Antelope Wells, NM/CHIH
19	1381	406	11944	229	21	38	99	24	Antelope Cr/Mule Cr, NM
20	1102	635	23951	315	14	141	1585	119	Los Jaguëues, CHIH
21	1039	746	12366	342	12	70	205	49	Animas Mtns, NM
22	450	349	11055	246	17	57	99	28	Antelope Cr/Mule Cr, NM
23	1163	742	12494	344	13	68	190	49	Animas Mtns, NM
24	1881	872	18875	316	12	123	1139	100	Antelope Wells, NM/CHIH
25	1281	439	11537	144	139	18	125	18	Cow Canyon, AZ
26	592	367	11729	251	21	39	110	26	Antelope Cr/Mule Cr, NM
27	781	378	11570	246	21	45	119	23	Antelope Cr/Mule Cr, NM
RGM1-S4	1552	295	13776	150	108	22	215	8	standard

RGM1-S4	1624	289	13775	149	109	25	217	4	standard

[1] These samples labeled "not obsidian" appear to be a smoky colored chert or chalcedony that is common in the region that closely resembles obsidian.

Table 2. Frequency distribution of sources.

		Frequency	Percent
Source	Antelope Cr/Mule Cr, NM	8	34.8
	Antelope Wells, NM/CHIH	5	21.7
	Cow Canyon, AZ	4	17.4
	Animas Mtns	4	17.4
	Los Jaguëues, CHIH	1	4.3
	Selene, SON	1	4.3
	Total	23	100.0

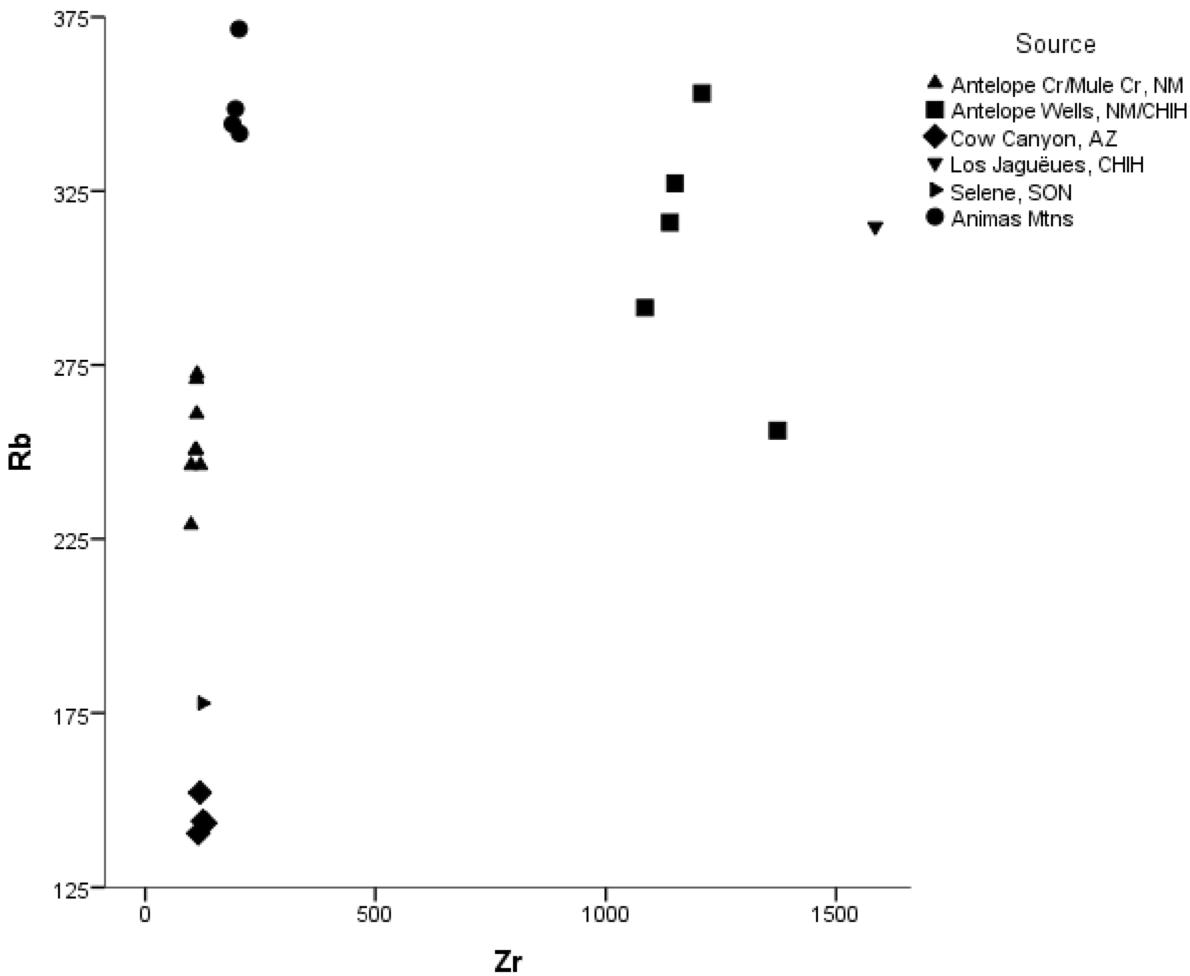

Figure 1. Zr versus Rb bivariate plot of the elemental concentrations for all the archaeological specimens. Bivariate plot below provides clarity for Selene and Cow Canyon samples.

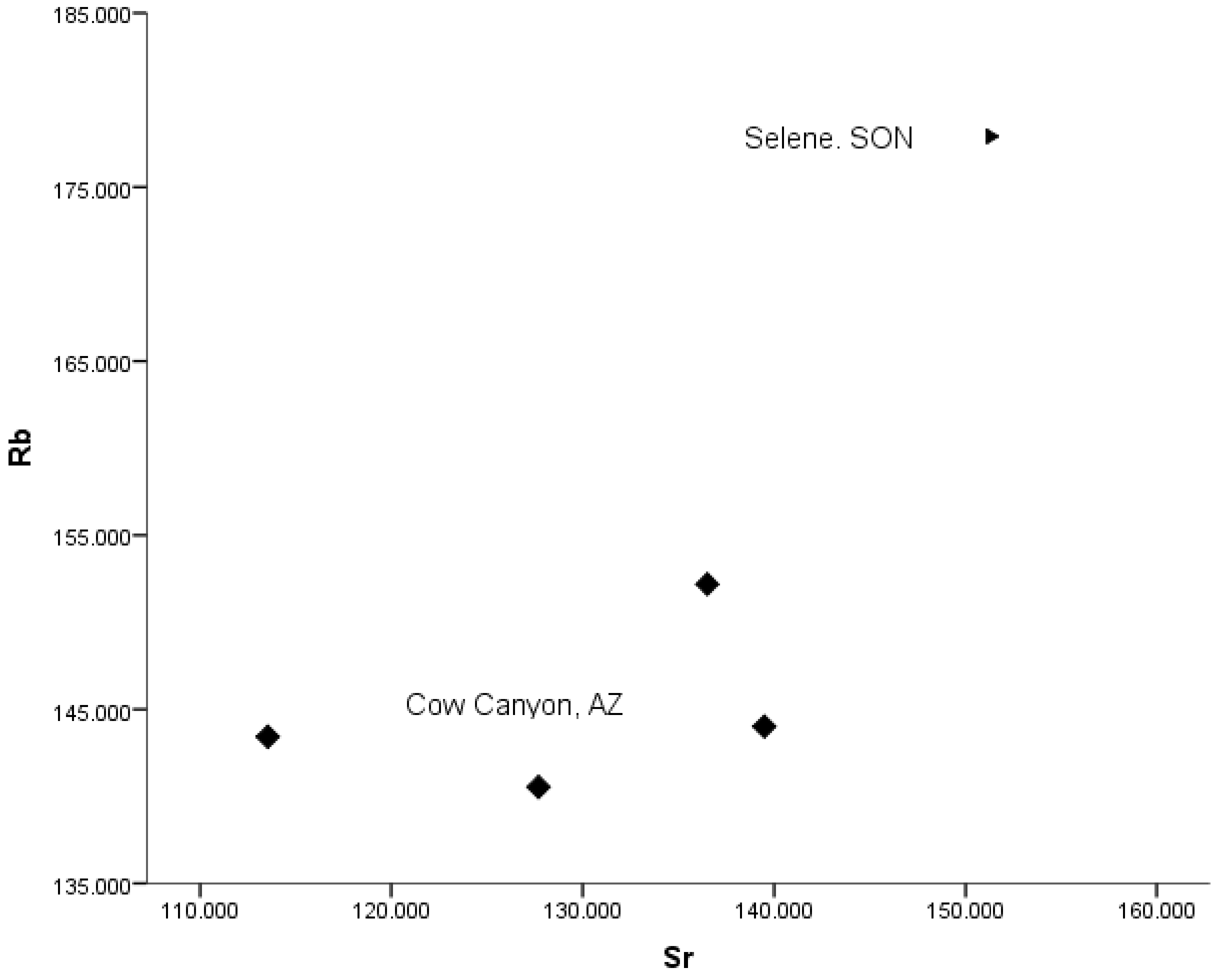

Figure 2. Sr versus Rb bivariate plot of the Selene and Cow Canyon archaeological specimens to provide clarity.

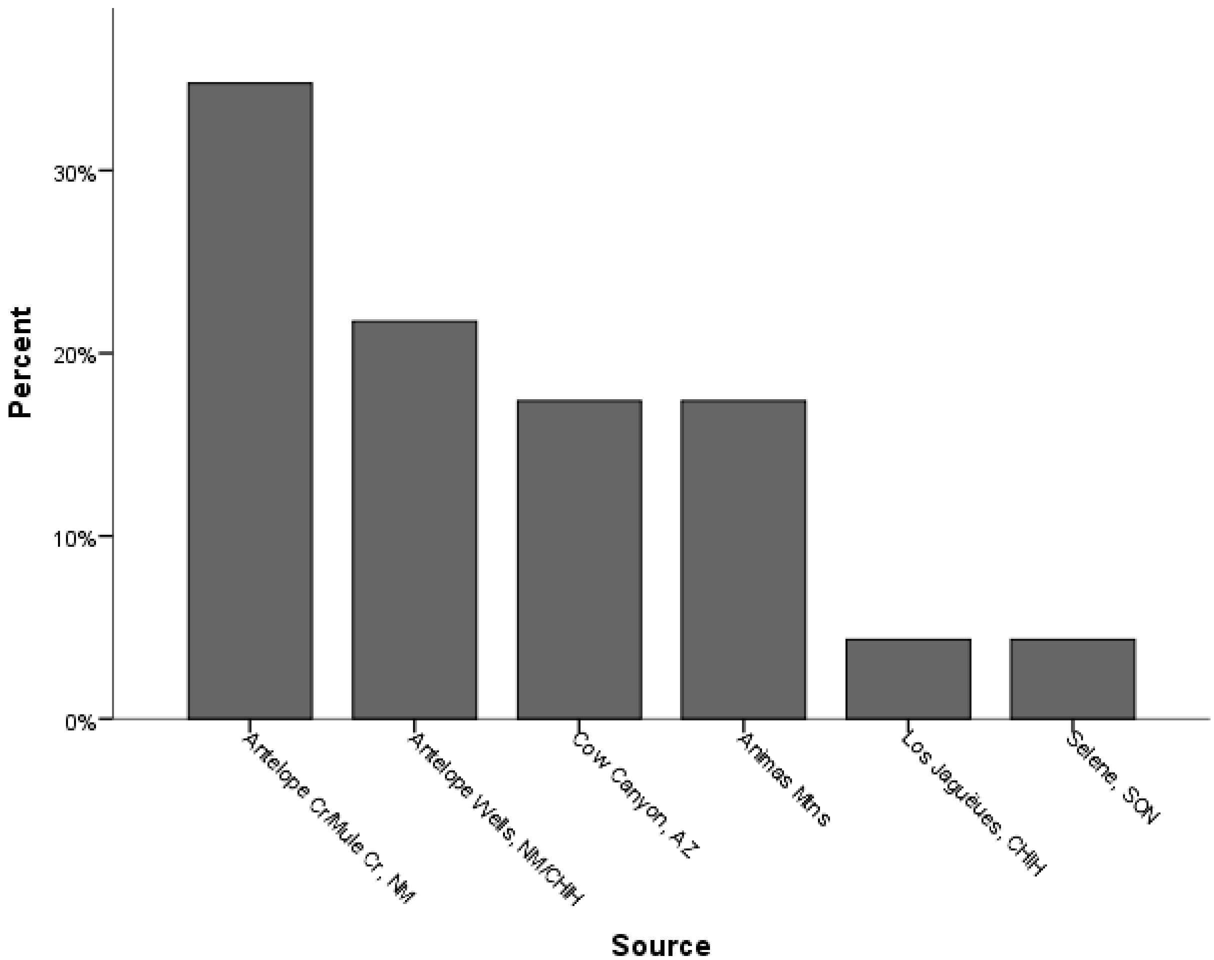

Figure 3. Proportional distribution of obsidian source provenance.