Title
Source Provenance of Obsidian Artifacts from a Number of Sites and Isolated Finds in Southern New Mexico

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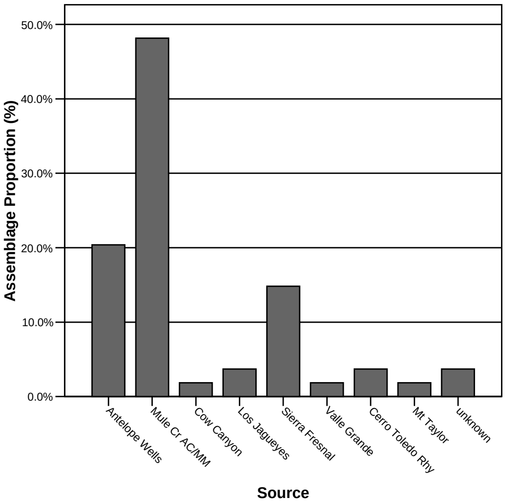
SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM A NUMBER OF SITES AND ISOLATED FINDS IN SOUTHERN NEW MEXICO



by

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Report Prepared for
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INTRODUCTION

The analysis here of 67 artifacts and geological samples from a number of temporal contexts in southeastern New Mexico exhibits a very diverse obsidian source provenance including sources from northern Chihuahua, western New Mexico, and the Rio Grande Quaternary alluvium, as well as one sample that had to be originally procured from Valles Caldera in northern New Mexico. The mix of sources in the assemblage is quite similar to that reported for a Late Pithouse period site in the area (Shackley 2004a).

ANALYSIS AND INSTRUMENTATION

All samples were analyzed whole with little or no formal preparation. 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).

The EDXRF trace element analyses were performed in the Archaeological XRF Laboratory, Department of Earth and Planetary Sciences, University of California, Berkeley, using a Spectrace/ThermoNoran™ QuanX energy dispersive x-ray fluorescence spectrometer. All samples were analyzed whole with little or no formal preparation. 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). The spectrometer is equipped with an air cooled Cu x-ray target with a 125 micron Be window, an x-ray generator that operates from 4-50 kV/0.02-2.0 mA at 0.02 increments, using an IBM PC based microprocessor and WinTrace™ software. The x-ray tube is operated at 30 kV, 0.14 mA, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (as Fe^T), rubidium zinc (Zn), (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), and thorium (Th). Weight percent iron ($Fe_2O_3^T$) can be derived by multiplying ppm estimates by 1.4297(10-4). Trace element intensities were converted to concentration estimates by employing a least-squares calibration line 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). Further details concerning the petrological choice of these elements in Southwest obsidian is available in Shackley (1992, 1995, 2004; also Mahood and Stimac 1991; and Hughes and Smith 1993). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGV-1 (andesite), GSP-1, SY-2 (syenite), BHVO-1 (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), all US Geological Survey standards, and BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). In addition to the reported values here, Ni, Cu, and Ga were measured, but these are rarely useful in discriminating glass sources and are not generally reported.

The data 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. An analysis of the repeated runs of source standard RGM-1 is included in Table 1. Source nomenclature follows Baugh and Nelson (1987), Glascock et al. (1999), and Shackley (1988, 1995, 1998a, 1998b, 2004b). Further information on the laboratory instrumentation and source nomenclature can be found at: http://www.swxrflab.net/ and Shackley (1998a). Trace element data exhibited in Table 1 and Figures 1 and 2 are reported in parts per million (ppm), a quantitative measure by weight.

SUMMARY AND CONCLUSION

As with the earlier study, the vast majority of obsidian sources present in the assemblage suggests considerable contact or procurement to the south in northwestern Chihuahua (Sierra Fresnal and Los Jaguëyes), and western New Mexico/eastern Arizona (Mule Creek and Antelope Wells, Cow Canyon; Tables 1 and 2 and Figures 1 through 3 here). The Chihuahuan sources, particularly Sierra Fresnal have been found in alluvium considerably north of the primary domes almost to the international border, so the obsidian used to produce these artifacts could actually be nearly "local" in origin. Similarly, the artifacts produced from Mount Taylor and Cerro Toledo Rhyolite glass, could have been procured in the Rio Grande alluvium just to the east of Florida Mountains toward Las Cruces (see Church 2000). The Antelope Wells obsidian is not distributed in secondary deposits, so had to be originally procured from the area near the source at El Berrendo, Chihuahua or immediately north of the border. More interestingly, the one artifact produced from Valle Grande obsidian must have been originally procured from the Valles Caldera proper since it does not erode outside the rim of the caldera (Shackley 2004b).

The Florida Mountain vitrophyre (perlitic glass) submitted for analysis exhibits an elemental composition similar to Chihuahuan basin and range obsidian, but displays that quite variable elemental composition typical of crystalline rocks and particularly perlite (Zielinski et al. 1977; Table 3 here). Perlite or vitrophyre is commonly attributed to the Little Florida Mountains by local rockhounds, and this study does suggest that there is no artifact quality obsidian derived from that rhyolite. Again, there is a possibility that the Sierra Fresnal obsidian has been transported into alluvial context not far south of these sites. Further work on the Chihuahuan basin and range sources is certainly necessary.

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Table 1. Elemental concentrations and source assignments for archaeological samples. All measurements in parts per million.

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source	Geological ?
DAP 3										
14	1210	353	9704	283	43	55	155	31	Sierra Fresnal	
22	1888	1253	24282	332	22	120	1124	92	Antelope Wells	
22L5	1183	315	9337	277	40	57	157	30	Sierra Fresnal	
29	950	414	8141	221	16	40	103	23	Mule Cr AC/MM	
136	1150	1020	18412	290	22	110	1035	91	Antelope Wells	
138	1423	912	19460	308	19	124	1121	92	Antelope Wells	
139	1628	730	18006	179	20	122	1007	100	Antelope Wells?	
DAP 7										
40	1243	338	9095	270	41	63	151	38	Sierra Fresnal	
LA 73369?										
55	786	11985	3593	3	124	10	11	13	chert?	
DAP 8										
59	1376	1015	19510	291	31	114	1068	115	Antelope Wells	
DAP 9										
61	1518	528	11720	276	34	53	156	44	vitrophyre	x
DAP 11										
67	987	427	8649	148	12	38	154	49	Valle Grande	
68	707	271	2780	3	11	-3	9	1	chert?	
69	895	884	7848	494	8	77	103	189	Mt Taylor	x
70	1216	412	6650	80	74	13	102	35	unknown	
DAP 12										
74	1996	1460	39012	349	32	238	2185	170	Los Jagueyes	
LA 45416										
72	928	642	9500	190	9	57	172	101	Cerro Toledo Rhy	
78	1546	1128	27919	258	30	158	1437	124	Los Jagueyes	
79	1102	508	7857	147	128	20	97	22	Cow Canyon	
DAP 13										
90	1101	564	6871	173	27	12	105	18	Mule Cr AC/MM	
116	1078	527	7110	191	24	23	112	17	Mule Cr AC/MM	x
DAP 14										
92-1	1081	513	6950	177	21	20	99	27	Mule Cr AC/MM	
92-2	950	449	6394	17	20	17	101	22	Mule Cr AC/MM	

				1						
94	1020	429	8589	231	19	34	98	32	Mule Cr AC/MM	
95	1015	514	7013	178	24	30	110	25	Mule Cr AC/MM	x
96	1054	821	8779	312	11	62	192	46	Sierra Fresnal	
97	947	366	7954	215	16	33	102	15	Mule Cr AC/MM	
98	829	464	6518	171	20	15	107	15	Mule Cr AC/MM	
99	911	512	6594	167	27	21	105	29	Mule Cr AC/MM	
99L3	895	422	8098	235	13	39	112	23	Mule Cr AC/MM	
100	1042	550	7452	192	23	20	120	28	Mule Cr AC/MM	x
101	984	484	6947	187	24	27	116	23	Mule Cr AC/MM	
102	961	480	6833	169	21	20	102	24	Mule Cr AC/MM	
103	999	487	6896	183	18	26	109	3	Mule Cr AC/MM	
108	1023	495	7199	179	25	26	111	18	Mule Cr AC/MM	
112	942	480	7396	156	5	47	147	79	unknown	
112L1	1075	560	7270	198	27	24	112	19	Mule Cr AC/MM	
113	1034	498	6864	173	14	20	113	15	Mule Cr AC/MM	
114	943	552	7572	195	22	22	115	20	Mule Cr AC/MM	

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source	Geological ?
LA 50180										
117	959	404	7860	224	19	26	101	31	Mule Cr AC/MM	
FT. CUMMINGS										
131	1024	533	7183	182	22	27	109	27	Mule Cr AC/MM	
132	1111	386	7790	216	16	29	96	33	Mule Cr AC/MM	
133	857	364	7465	202	17	36	95	33	Mule Cr AC/MM	
134	929	422	6430	158	21	18	105	17	Mule Cr AC/MM	
135	1049	512	6721	181	25	19	94	15	Mule Cr AC/MM	
ISOLATE										
28	4838	823	46080	53	573	23	267	16	not obsidian?	x
77	1040	575	9625	197	5	62	164	97	Cerro Toledo Rhy	
107	3439	1031	25207	29	350	17	345	17	not obsidian?	
119	1310	876	19451	301	27	124	1124	90	Antelope Wells	
120	1148	374	8972	268	38	60	157	35	Sierra Fresnal	
121	108	341	9307	29	36	74	165	35	Sierra Fresnal	

	2			2						
123	982	356	7668	198	20	44	103	22	Mule Cr AC/MM	
124	1519	976	19682	307	22	112	1108	98	Antelope Wells	
125	1223	829	17725	288	20	128	1055	82	Antelope Wells	
126	1225	358	9738	287	42	67	162	35	Sierra Fresnal	x
127	1099	303	8592	265	42	56	149	24	Sierra Fresnal	
128	1409	1026	20331	313	25	130	1143	91	Antelope Wells	
129	1672	1116	19781	286	21	120	1100	86	Antelope Wells	
130	1426	905	19093	300	21	129	1117	89	Antelope Wells	
STANDARDS										
RGM1-S1	1549	333	12992	141	106	25	207	10	standard	
RGM1-S1	1572	335	13247	151	112	15	222	6	standard	
RGM1-S1	1595	304	13240	146	111	25	217	7	standard	
RGM1-S1	1472	302	13330	151	111	25	214	0	standard	

Table 2. Crosstabulation of site by source provenance. Vitrophyre/perlite not included.

			Site											
			DAP11	DAP12	DAP13	DAP14	DAP3	DAP7	DAP8	FT CUMMINGS	ISO	LA45416	LA50180	Total
Source	Antelope Wells	Count	0	0	0	0	4	0	1	0	6	0	0	11
		% within Source	.0%	.0%	.0%	.0%	36.4%	.0%	9.1%	.0%	54.5%	.0%	.0%	100.0%
		% within Sample	.0%	.0%	.0%	.0%	66.7%	.0%	100.0%	.0%	46.2%	.0%	.0%	20.4%
		% of Total	.0%	.0%	.0%	.0%	7.4%	.0%	1.9%	.0%	11.1%	.0%	.0%	20.4%
	Cerro Toledo Rhy	Count	0	0	0	0	0	0	0	0	1	1	0	2
		% within Source	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	50.0%	50.0%	.0%	100.0%
		% within Sample	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	7.7%	33.3%	.0%	3.7%
		% of Total	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.9%	1.9%	.0%	3.7%
	Cow Canyon	Count	0	0	0	0	0	0	0	0	0	1	0	1
		% within Source	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	100.0%	.0%	100.0%
		% within Sample	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	33.3%	.0%	1.9%
		% of Total	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.9%	.0%	1.9%
	Los Jagueyes	Count	0	1	0	0	0	0	0	0	0	1	0	2
		% within Source	.0%	50.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	50.0%	.0%	100.0%
		% within Sample	.0%	100.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	33.3%	.0%	3.7%
		% of Total	.0%	1.9%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.9%	.0%	3.7%
	Mt Taylor	Count	1	0	0	0	0	0	0	0	0	0	0	1
		% within Source	100.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within Sample	33.3%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.9%
		% of Total	1.9%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.9%
	Mule Cr AC/MM	Count	0	0	2	16	1	0	0	5	1	0	1	26
		% within Source	.0%	.0%	7.7%	61.5%	3.8%	.0%	.0%	19.2%	3.8%	.0%	3.8%	100.0%
		% within Sample	.0%	.0%	100.0%	88.9%	16.7%	.0%	.0%	100.0%	7.7%	.0%	100.0%	48.1%
		% of Total	.0%	.0%	3.7%	29.6%	1.9%	.0%	.0%	9.3%	1.9%	.0%	1.9%	48.1%
	Sierra Fresnal	Count	0	0	0	1	1	1	0	0	5	0	0	8
		% within Source	.0%	.0%	.0%	12.5%	12.5%	12.5%	.0%	.0%	62.5%	.0%	.0%	100.0%
		% within Sample	.0%	.0%	.0%	5.6%	16.7%	100.0%	.0%	.0%	38.5%	.0%	.0%	14.8%
		% of Total	.0%	.0%	.0%	1.9%	1.9%	1.9%	.0%	.0%	9.3%	.0%	.0%	14.8%
	unknown	Count	1	0	0	1	0	0	0	0	0	0	0	2
		% within Source	50.0%	.0%	.0%	50.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within Sample	33.3%	.0%	.0%	5.6%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	3.7%
		% of Total	1.9%	.0%	.0%	1.9%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	3.7%
	Valle Grande	Count	1	0	0	0	0	0	0	0	0	0	0	1
		% within Source	100.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within Sample	33.3%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.9%
		% of Total	1.9%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.9%
Total		Count	3	1	2	18	6	1	1	5	13	3	1	54
		% within Source	5.6%	1.9%	3.7%	33.3%	11.1%	1.9%	1.9%	9.3%	24.1%	5.6%	1.9%	100.0%
		% within Sample	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	5.6%	1.9%	3.7%	33.3%	11.1%	1.9%	1.9%	9.3%	24.1%	5.6%	1.9%	100.0%

Table 3. Elemental concentrations for three vitrophyric glass samples from Florida Mountains.

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
63L10	1111	345	7762	427	137	52	158	29	vitrophyre
63L4	1207	427	8574	302	63	51	157	39	vitrophyre
63L6	1329	468	9404	311	153	57	160	38	vitrophyre
63L7	1016	281	7317	269	419	56	138	35	vitrophyre
63L8	987	380	7257	272	57	50	145	30	vitrophyre
63L9	1250	433	8377	326	81	54	155	39	vitrophyre
63	1249	428	8692	294	75	47	142	32	vitrophyre
64	1229	465	7933	328	35	46	135	28	vitrophyre

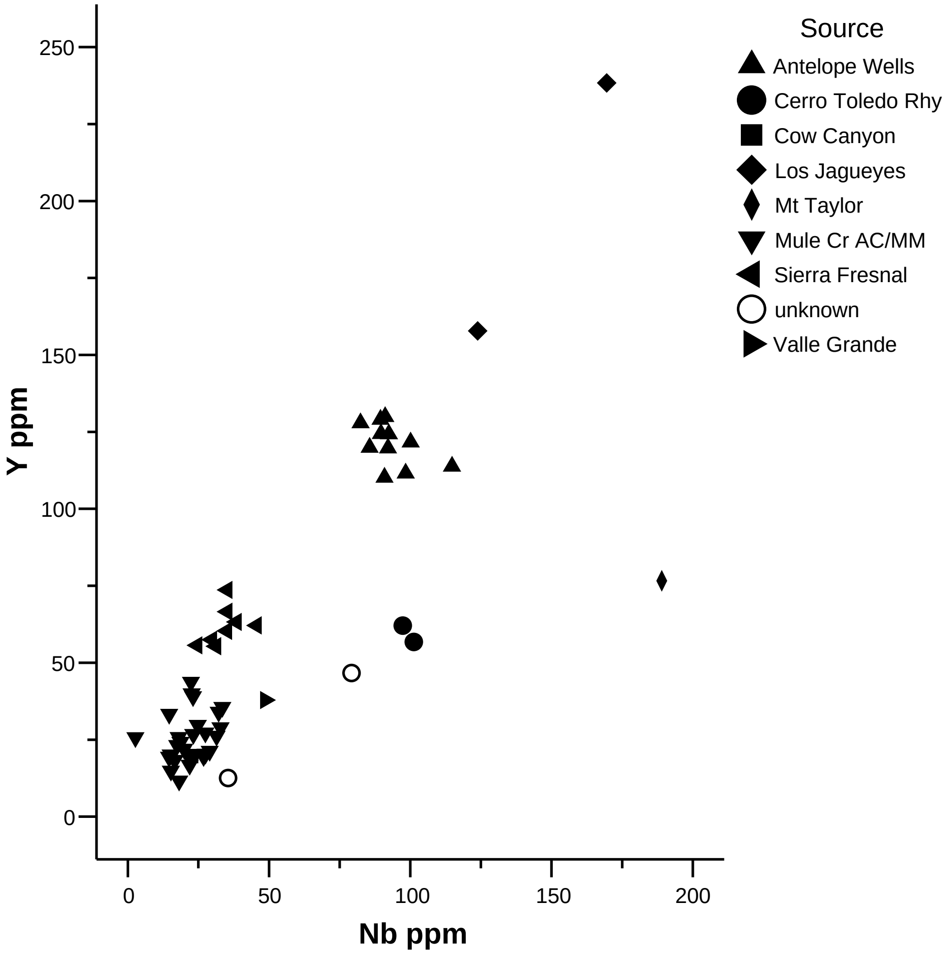

Figure 1. Y versus Nb biplot of archaeological data.

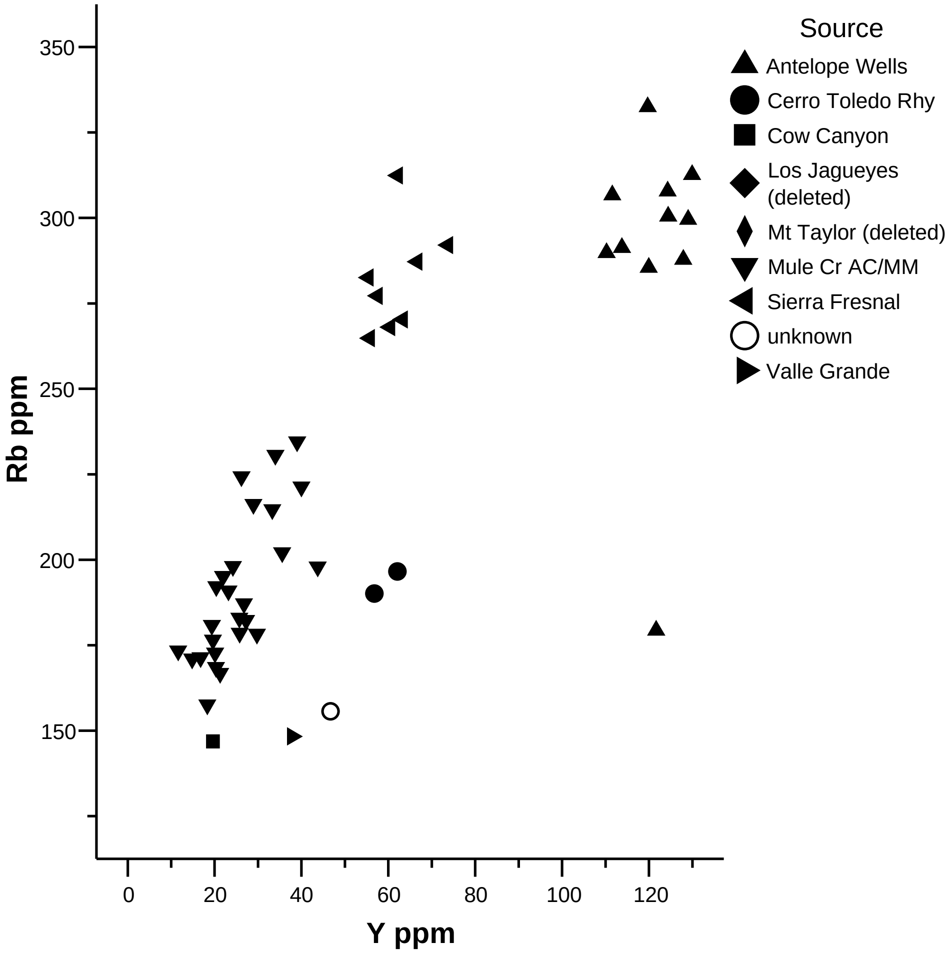

Figure 2. Rb versus Y biplot of archaeological data with outlier sources Los Jaguëyes and Mount Taylor removed for clarity.

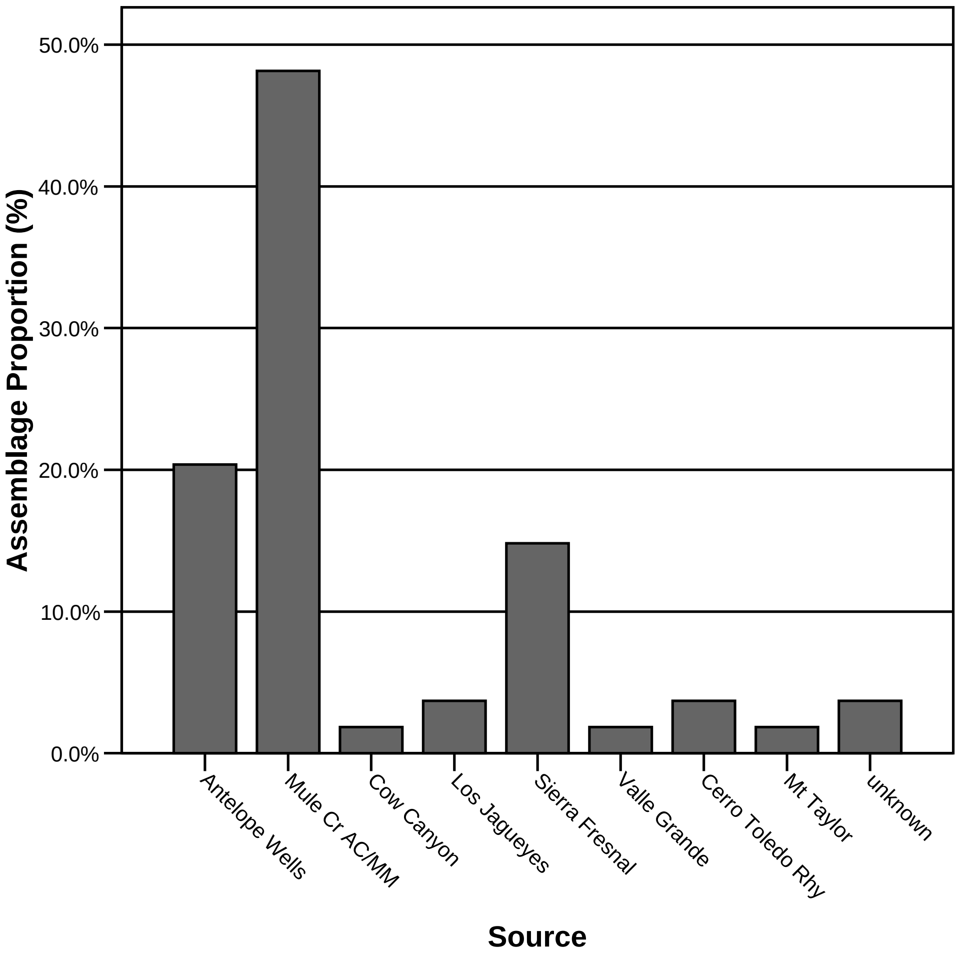

Figure 3. Distribution of obsidian source provenance in the assemblage.