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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM PREHISTORIC SITES ALONG THE SAN PEDRO RIVER, SOUTHERN ARIZONA

by

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INTRODUCTION

The analysis here of 400 obsidian artifacts from mainly Classic Period sites along the San Pedro River between the Gila River in the north and Tres Alamos in the south is the largest single obsidian study in the region. The source provenance is very diverse, but the distribution of sources is somewhat expected and patterned given the cultural and social dimensions inferred in the project area. The discussion begins with an outline of the analytical methods and instrumentation, followed by a concluding section that is followed by tabulated and graphic data.

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 trace element analyses were performed in the Department of Geology and Geophysics, University of California, Berkeley, using a Philips PW 2400 wavelength x-ray fluorescence spectrometer using a LiF 200 crystal for all measurements. This crystal spectrometer uses specific software written by Philips (SuperQ/quantitative) and modifies the instrument settings between elements of interest. Practical detection limits have not been calculated for this new instrument, but but the variance from established standards is shown in Table 1. Sample selection is automated and controlled by the Philips software. X-ray intensity Kα-line data with the scintillation counter were measured for elements rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). X-ray intensities for barium (Ba) were measured with the flow counter from the Lα-line. 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). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGV-1 (andesite), GSP-1 and SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLM-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).

The data from the SuperQ 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. An analysis of USGS obsidian standard RGM-1 is included in Table 1. Source nomenclature follows Shackley (1995, 1992, 1998a). Further information on the laboratory instrumentation can be found at: http://obsidian.pahma.berkeley.edu/ and Shackley (1998b). Trace element data exhibited in Tables 1 and 2 are reported in parts per million (ppm), a quantitative measure by weight (see also Figures 1 and 2). Source discrimination was best achieved by using the elements Rb, Sr, Zr, and Ba. A single three-dimensional or biplot is not sufficient to separate sources in this large sample, but overlapping source signatures are separated in at least one plot. The high iron and zirconium peralkaline obsidian from Antelope Wells is not plotted here in order to provide more precision in the discrimination. As can be seen in the data tables (Table 2), this obsidian exhibits a highly unique elemental composition quite different from the other more peraluminous glasses north of the international border (see also Shackley 1995, 2002).

GEOCHEMICAL RESULTS AND SUMMARY

The results of the geochemical analysis will be discussed mainly at the assemblage wide level, with a few comments about inter-site differences in source provenance (Table 3).

A simple explanation for the procurement of obsidian in prehistory in southeastern Arizona is, unfortunately, impossible as noted in the earlier smaller study from the US 70 project. (Shackley 1998a, 2002). The two major Tertiary Period sources of archaeological obsidian that dominate the assemblage, Cow Canyon and the Mule Creek source group, as well as the secondary deposit source of "Blue/SF Rivers," have been eroding into the Blue, San Francisco, and Gila River systems for over 10 million years (Houser et al. 1985; Shackley 1992, 1995, 1998a). Sometime during the Plio-Pleistocene, a dam was created in the San Carlos Valley, flooding the area now known as the San Simon and Safford Valleys, creating what is now called the 111 Ranch Formation (Houser et al. 1985; see Figure 3 here). The rivers noted above at that time issued a discharge up to 100 times the modern flood rate, depositing sediments from the Mogollon Highlands, the Mule Creek, and southern Blue Mountain areas into the Gila River system. Marekanites from Cow Canyon have been recovered in the Quaternary alluvium over 100 stream kilometers from the source as far as Geronimo west of Safford (Shackley 1992, 1998a; Figure 3 here). Marekanites of Cow Canyon and Mule Creek glass can be found in the 111 Ranch Formation as large as at the primary sources due to this high velocity discharge. So, using nodule size to infer the point of procurement is essentially impossible. This means, of course, that it is impossible in most cases to determine whether the obsidian artifacts recovered from archaeological contexts in the region were procured from primary or secondary sources.

Additionally, the elemental composition of the Mule Creek localities, are variant, a result of fractionation and other processes, and producing a complex compositional regime (see Shackley 1998a). The three major sources at Mule Creek – Antelope Creek, Mule Mountains, and North Sawmill Creek, while exhibiting elemental variability are mixed together in the alluvium, although Antelope Creek which is on the north side of the Mule Creek caldera, empties almost directly into the San Francisco River and therefore is generally numerically superior to the other Mule Creek groups in secondary deposits. The Cow Canyon/111 Ranch chemical group, however, appears to be most common everywhere, and is generally, but not always, numerically superior in assemblages in the region, including the 300+ recently analyzed objects from McEuen Cave in the Gila Mountains to the north (Shackley, not published). While it is possible that the dominance of Mule Creek obsidian in this late period assemblage is the result of procurement from the primary sources or exchange with groups (Mimbres Mogollon?) at the source, I cannot determine that with the data at hand. Various stream flooding events appear to deposit a load from one area more than another (i.e Cow Canyon versus Mule Creek), and so prehistoric knappers could easily procure all the nodules during one episode and it would appear that they were selecting from one source while all they were doing was collecting from one area of secondary deposits. Other data sets would have to be used to deal with this issue.

The great diversity of obsidian sources within the San Pedro River assemblage, and even at site BB:2:7, the largest site sample, calls for some comment (Table 3 and Figure 4). Assuming that the artifacts recovered from BB:2:7 are contemporaneous, obsidian raw material or finished artifacts were derived from the west as far as Yuma County (Tank Mountains), north to the Coconino Plateau (Government Mountain), south to southwestern New Mexico and northwestern Chihuahua (Antelope Wells/El Berrendo), east to the San Simon and possibly Mogollon Highlands (Cow Canyon and the Mule Creek sources), and even to northern New

Mexico, or the Rio Grande River alluvium (Cerro Toledo Rhyolite), as well as “local” sources such as Superior, Sauceda Mountains, and Los Vidrios. This obviously suggests an extremely diverse interaction network that includes the Colorado Plateau and northern New Mexico, as well as the regional procurement area.

At site BB:2:19, the next largest site sample, the assemblage is much more local, in that all the artifacts were produced from obsidian that was likely procured in the central Arizona region, with one sample from the Coconino Plateau (Government Mountain). Sites BB:1:22, and BB:2:3 exhibited a similar range of sources as BB:2:19 with a more local focus, but the sample sizes are a bit smaller. These sites exploited sources typical of Classic Period Hohokam, as those assemblages recovered from Marana and Pueblo Grande (see Bayman and Shackley 1999; Peterson et al. 1997).

Finally, Site BB:11:26 with 45 samples exhibits a source distribution certainly pointing to the San Simon and Blue River area, a procurement area discussed above (Table 3). The Blue/SF River source group is defined by secondary deposits collected below the Blue River in the San Francisco River alluvium, and while the primary locality has not been discovered, it must be in the Mule Creek area, both because of the location secondary deposits and the similar chemistry (see Shackley 1998a, 2002).

The tremendous diversity of obsidian source provenance from throughout the greater U.S. Southwest, and probable differences in inter-site distributions in San Pedro River sites, suggests quite varying exchange networks and possibly differing kin networks, similar to that proposed for the Tonto Basin during the Late Classic (Shackley 2002). Inhabitants of all the sites seem to have relied on obsidian procured locally, particularly from the 111 Ranch Formation in the Safford and San Simon Valleys, but still maintained contact with home ranges or kin in other regions. Exchange between the sites along the San Pedro River area is probably also represented here, with minority numbers of obsidian artifacts produced from sources outside the majority (i.e. the one piece of Sauceda Mountains assigned artifact from BB:2:7). None of these inferences could be generated without the large sample analyzed here. Further inferences concerning inter-site exchange along the San Pedro River await more intensive scrutiny.

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Table 1. X-ray fluorescence concentrations for selected trace elements RGM-1 (n=5 runs, May 2000). ± values represent first standard deviation computations for the group of measurements. All values are in parts per million (ppm) as reported in Govindaraju (1994) and this study. RGM-1 is a U.S. Geological Survey rhyolite standard.

SAMPLE	Rb	Sr	Y	Zr	Nb	Ba
RGM-1 (Govindaraju 1994)	149	108	25	219	8.9	807
RGM-1 (Glascock and Anderson 1993)	145±3	120±10	n.r.[a]	150±7	n.r.	826±31
RGM-1 (this study)	144.6±0.55	102.2±0.45	24±0	216.4±0.55	8.8±0.45	806.4±5

[a] n.r. = no report; n.m.=not measured

Table 2. Elemental concentrations for the archaeological samples. All measurements in parts per million (ppm).

Site/Sample	Rb	Sr	Y	Zr	Nb	Ba	Source
BB:1:22-3624-1	111	79	20	82	51	295	Government Mtn
BB:1:22-3625-1	158	73	32	194	23	842	Cow Canyon/111 Ranch
BB:1:22-3626-1	161	75	34	197	24	846	Cow Canyon/111 Ranch
BB:1:22-3626-2	121	19	25	97	30	170	Superior
BB:1:22-3626-3	234	19	42	114	27	55	Mule Cr/AC-MM
BB:1:22-3639-1	158	73	33	196	23	727	Cow Canyon/111 Ranch
BB:1:22-3670-1	118	19	24	96	30	161	Superior
BB:1:22-3672-1	161	103	26	181	19	765	Cow Canyon/111 Ranch
BB:1:22-3677-1	109	78	20	82	52	259	Government Mtn
BB:1:22-3677-2	240	19	42	115	27	64	Mule Cr/AC-MM
BB:1:22-3677-3	240	19	43	115	27	69	Mule Cr/AC-MM
BB:1:22-3677-4	236	19	42	115	26	57	Mule Cr/AC-MM
BB:1:22-3677-5	116	18	26	98	30	167	Superior
BB:1:22-3688-1	238	19	41	113	28	51	Mule Cr/AC-MM
BB:1:22-3692-1	102	75	19	75	45	202	Government Mtn
BB:1:22-3692-2	107	77	19	80	50	261	Government Mtn
BB:1:22-3697-1	113	36	24	92	30	141	unknown
BB:1:22-3697-2	107	79	20	83	52	257	Government Mtn
BB:1:22-3697-3	135	124	20	120	15	879	Cow Canyon/111 Ranch
BB:1:22-3702-1	120	19	25	97	31	175	Superior
BB:1:22-3702-2	117	20	25	97	30	176	Superior
BB:1:22-3702-3	102	76	19	81	50	254	Government Mtn
BB:1:22-3702-4	158	76	33	198	25	795	Sauceda Mts
BB:1:32-402-1	95	16	20	78	24	120	Superior
BB:1:32-419-1	231	20	40	112	26	58	Mule Cr/AC-MM
BB:1:32-421-1	233	19	40	112	27	63	Mule Cr/AC-MM
BB:1:32-421-2	237	19	41	113	27	55	Mule Cr/AC-MM
BB:1:32-424-1	122	19	25	93	29	170	Superior
BB:1:32-424-2	118	92	20	114	15	386	Cow Canyon/111 Ranch
BB:1:32-425-1	107	77	20	82	51	256	Government Mtn
BB:1:32-425-2	111	18	23	90	28	145	Superior
BB:1:32-435-1	118	20	25	96	30	148	Superior
BB:1:32-435-2	151	70	32	192	23	707	Cow Canyon/111 Ranch
BB:1:32-437-1	133	124	20	119	15	1008	Cow Canyon/111 Ranch
BB:1:32-437-2	235	19	41	111	26	58	Mule Cr/AC-MM
BB:1:32-443-1	102	17	21	84	27	87	Superior
BB:1:32-467-1	93	67	17	73	44	207	Government Mtn
BB:1:34-1406-1	214	19	37	103	23	86	Mule Cr/AC-MM
BB:1:34-1412-1	212	17	37	102	25	52	Mule Cr/AC-MM
BB:1:34-1414-1	94	69	18	76	47	224	Government Mtn
BB:1:34-1417-1	219	18	37	106	24	74	Mule Cr/AC-MM
BB:1:55-17-1	135	107	24	131	18	608	Cow Canyon/111 Ranch
BB:1:55-3-1	235	13	64	210	30	58	Los Vidrios
BB:1:55-39-1	199	12	55	178	27	89	unknown
BB:1:55-58-1	142	111	23	131	19	719	Cow Canyon/111 Ranch
BB:1:6-1002-1	114	19	24	95	29	180	Superior
BB:1:6-1002-3	108	18	23	92	28	178	Superior
BB:1:6-1002-4	115	18	24	97	29	182	Superior
BB:1:6-814-1	162	77	33	200	24	829	Cow Canyon/111 Ranch
BB:1:6-821-1	149	70	31	188	23	642	Cow Canyon/111 Ranch
Site/Sample	Rb	Sr	Y	Zr	Nb	Ba	Source

BB:1:6-821-2	121	19	25	97	31	162	Superior
BB:1:6-824-1	227	18	41	112	27	74	Mule Cr/AC-MM
BB:1:6-824-2	224	17	39	106	26	71	Mule Cr/AC-MM
BB:11:2-3802-1	224	19	37	105	24	77	Mule Cr/AC-MM
BB:11:2-3802-2	245	18	39	110	27	39	Mule Cr/AC-MM
BB:11:2-3802-3	226	18	40	111	27	59	Mule Cr/AC-MM
BB:11:2-3815-1	230	20	42	114	27	55	Mule Cr/AC-MM
BB:11:2-3815-2	225	17	41	109	27	61	Mule Cr/AC-MM
BB:11:2-3815-3	251	19	42	115	28	83	Mule Cr/AC-MM
BB:11:2-3815-3	122	117	18	112	14	884	Cow Canyon/111 Ranch
BB:11:2-3817-1	220	20	39	108	26	65	Mule Cr/AC-MM
BB:11:2-3820-1	160	10	43	159	53	30	Valle Grande
BB:11:2-3826-1	125	98	21	120	16	625	Cow Canyon/111 Ranch
BB:11:2-3833-1	130	122	19	114	14	699	Cow Canyon/111 Ranch
BB:11:2-3868-1	231	19	41	113	27	58	Mule Cr/AC-MM
BB:11:26-4406-1	226	16	34	95	22	38	Mule Cr/AC-MM
BB:11:26-4422-1	220	18	35	97	22	91	Mule Cr/AC-MM
BB:11:26-4422-3	197	17	35	96	22	64	Mule Cr/AC-MM
BB:11:26-4427-1	212	17	35	94	22	91	Mule Cr/AC-MM
BB:11:26-4429-1	223	17	39	106	25	64	Mule Cr/AC-MM
BB:11:26-4429-2	232	18	41	112	27	51	Mule Cr/AC-MM
BB:11:26-4429-4	211	17	38	104	25	56	Mule Cr/AC-MM
BB:11:26-4441-1	165	12	23	110	29	34	Mule Cr/AC-MM
BB:11:26-4441-3	230	17	37	107	24	36	Mule Cr/AC-MM
BB:11:26-4442-1	228	17	39	103	25	11	Mule Cr/AC-MM
BB:11:26-4442-2	233	20	40	113	26	60	Mule Cr/AC-MM
BB:11:26-4447-2	189	16	33	98	22	42	Mule Cr/AC-MM
BB:11:26-4447-3	186	17	34	92	22	66	Mule Cr/AC-MM
BB:11:26-4454-1	227	18	40	111	26	70	Mule Cr/AC-MM
BB:11:26-4454-2	208	19	37	104	24	73	Mule Cr/AC-MM
BB:11:26-4457-1	223	18	38	106	24	41	Mule Cr/AC-MM
BB:11:26-4457-2	228	19	38	107	25	85	Mule Cr/AC-MM
BB:11:26-4462-1	211	22	35	97	22	95	Mule Cr/AC-MM
BB:11:26-4462-2	211	17	37	105	24	58	Mule Cr/AC-MM
BB:11:26-4462-3	209	18	38	102	24	18	Mule Cr/AC-MM
BB:11:26-4462-4	155	16	25	74	18	109	Blue/SF River
BB:11:26-4462-5	227	20	38	108	25	57	Mule Cr/AC-MM
BB:11:26-4462-6	228	18	40	108	26	77	Mule Cr/AC-MM
BB:11:26-4462-7	230	20	40	111	25	53	Mule Cr/AC-MM
BB:11:26-4462-8	231	17	41	112	26	62	Mule Cr/AC-MM
BB:11:26-4462-9	211	18	38	107	24	54	Mule Cr/AC-MM
BB:11:26-4464-1	206	15	35	99	24	83	Mule Cr/AC-MM
BB:11:26-4481-1	231	18	41	111	27	60	Mule Cr/AC-MM
BB:11:26-4487-1	217	21	39	107	25	79	Mule Cr/AC-MM
BB:11:26-4487-2	217	20	39	108	25	84	Mule Cr/AC-MM
BB:11:26-4492-2	227	16	40	105	26	56	Mule Cr/AC-MM
BB:11:26-4492-3	213	17	38	105	24	54	Mule Cr/AC-MM
BB:11:26-4497-1	210	18	36	101	24	47	Mule Cr/AC-MM
BB:11:26-4497-2	184	18	32	92	20	0	Blue/SF River
BB:11:26-4497-3	219	17	37	104	25	51	Mule Cr/AC-MM
BB:11:26-4504-1	220	17	39	106	25	45	Mule Cr/AC-MM
BB:11:26-4504-2	221	18	39	107	26	40	Mule Cr/AC-MM
BB:11:26-4514-1	220	17	40	103	26	58	Mule Cr/AC-MM
BB:11:26-4517-1	225	18	40	109	26	46	Mule Cr/AC-MM
BB:11:26-4517-2	223	18	39	108	25	49	Mule Cr/AC-MM
Site/Sample	Rb	Sr	Y	Zr	Nb	Ba	Source

Site/Sample	Rb	Sr	Y	Zr	Nb	Ba	Source
BB:11:26-4517-3	214	20	39	103	24	27	Mule Cr/AC-MM
BB:11:26-4517-4	158	36	18	94	20	105	unknown
BB:11:26-4523-1	231	17	41	110	27	53	Mule Cr/AC-MM
BB:11:26-4524-1	127	122	20	117	14	869	Cow Canyon/111 Ranch
BB:11:26-4525-1	233	8	37	87	49	0	Mule Cr/AC-MM
BB:11:27-4808-1	244	18	42	114	28	50	Mule Cr/AC-MM
BB:11:27-4810-1	229	18	41	112	27	64	Mule Cr/AC-MM
BB:11:27-4810-2	242	19	42	113	27	62	Mule Cr/AC-MM
BB:11:27-4816-1	227	19	40	111	26	60	Mule Cr/AC-MM
BB:11:27-4816-2	231	18	42	113	26	36	Mule Cr/AC-MM
BB:11:27-4816-3	218	17	39	108	27	29	Mule Cr/AC-MM
BB:11:27-4816-4	198	16	35	96	22	55	Mule Cr/AC-MM
BB:11:27-4826-1	236	18	42	113	27	58	Mule Cr/AC-MM
BB:11:27-4826-3	242	19	41	114	26	79	Mule Cr/AC-MM
BB:11:27-4826-4	135	108	24	131	18	625	Cow Canyon/111 Ranch
BB:11:27-4826-5	222	18	41	109	26	63	Mule Cr/AC-MM
BB:11:27-4826-7	236	18	42	114	27	82	Mule Cr/AC-MM
BB:11:27-4830-1	234	18	41	112	27	63	Mule Cr/AC-MM
BB:11:27-4844-1	221	18	39	108	25	65	Mule Cr/AC-MM
BB:11:27-4868-1	230	18	41	113	26	71	Mule Cr/AC-MM
BB:11:27-4868-2	222	17	40	108	26	64	Mule Cr/AC-MM
BB:11:27-4868-3	217	18	39	107	26	50	Mule Cr/AC-MM
BB:11:27-4870-1	238	18	43	115	28	61	Mule Cr/AC-MM
BB:11:27-4870-2	213	18	38	106	25	48	Mule Cr/AC-MM
BB:11:27-4876-1	225	18	40	110	26	42	Mule Cr/AC-MM
BB:11:27-4881-1	232	18	41	113	27	58	Mule Cr/AC-MM
BB:11:27-4883-1	227	18	40	111	26	57	Mule Cr/AC-MM
BB:11:27-4883-2	223	19	39	108	25	61	Mule Cr/AC-MM
BB:11:27-4883-3	233	20	41	114	27	71	Mule Cr/AC-MM
BB:11:27-4883-5	218	18	38	105	25	48	Mule Cr/AC-MM
BB:11:27-4883-7	229	18	40	109	25	82	Mule Cr/AC-MM
BB:11:27-4883-8	213	18	37	105	24	68	Mule Cr/AC-MM
BB:11:27-4887-1	219	17	38	105	25	43	Mule Cr/AC-MM
BB:11:27-4910-1	232	18	41	111	27	30	Mule Cr/AC-MM
BB:11:27-4910-2	125	99	22	122	16	570	Cow Canyon/111 Ranch
BB:11:27-4910-3	231	21	40	109	25	55	Mule Cr/AC-MM
BB:11:27-4910-5	232	19	41	114	27	56	Mule Cr/AC-MM
BB:11:27-4928-1	227	18	41	111	26	51	Mule Cr/AC-MM
BB:11:27-4928-2	210	16	37	103	25	47	Mule Cr/AC-MM
BB:11:27-4928-3	237	22	42	113	27	85	Mule Cr/AC-MM
BB:11:36-4221-1	240	18	44	115	28	50	Mule Cr/AC-MM
BB:11:36-4221-10	262	19	45	119	30	72	Mule Cr/AC-MM
BB:11:36-4221-11	280	22	45	121	29	76	Mule Cr/AC-MM
BB:11:36-4221-15	259	20	42	116	28	95	Mule Cr/AC-MM
BB:11:36-4221-2	245	20	43	114	27	74	Mule Cr/AC-MM
BB:11:36-4221-4	223	19	39	106	23	100	Mule Cr/AC-MM
BB:11:36-4221-5	254	21	42	118	27	103	Mule Cr/AC-MM
BB:11:36-4221-6	218	16	37	103	24	44	Mule Cr/AC-MM
BB:11:36-4221-7	236	21	42	114	27	73	Mule Cr/AC-MM
BB:11:36-4221-8	135	108	23	129	18	703	Cow Canyon/111 Ranch
BB:11:36-4221-9	211	20	36	101	25	86	Mule Cr/AC-MM
BB:11:36-4227-1	223	19	40	107	26	70	Mule Cr/AC-MM
BB:11:36-4228-1	227	20	40	109	26	89	Mule Cr/AC-MM
BB:11:36-4239-7	232	18	41	112	27	57	Mule Cr/AC-MM
BB:11:36-4241-1	234	18	42	114	27	53	Mule Cr/AC-MM

BB:11:36-4241-2	231	18	40	112	27	60 Mule Cr/AC-MM
BB:11:36-4255-7	393	9	68	100	111	12 Mule Cr/N Sawmill Cr
BB:11:36-4256-10	221	22	40	108	26	35 Mule Cr/AC-MM
BB:11:36-4256-11	220	18	36	100	24	54 Mule Cr/AC-MM
BB:11:36-4256-13	237	19	43	114	28	41 Mule Cr/AC-MM
BB:11:36-4256-14	233	20	41	111	27	83 Mule Cr/AC-MM
BB:11:36-4256-15	203	18	36	100	23	18 Mule Cr/AC-MM
BB:11:36-4256-16	241	28	41	116	28	88 Mule Cr/AC-MM
BB:11:36-4256-17	405	9	70	106	117	5 Mule Cr/N Sawmill Cr
BB:11:36-4256-18	216	18	39	106	27	77 Mule Cr/AC-MM
BB:11:36-4256-19	245	23	44	117	30	67 Mule Cr/AC-MM
BB:11:36-4256-8	233	19	42	112	28	53 Mule Cr/AC-MM
BB:11:36-4256-9	240	24	42	114	28	72 Mule Cr/AC-MM
BB:11:36-4262-1	233	20	41	111	26	61 Mule Cr/AC-MM
BB:11:36-4266-3	237	18	42	112	27	53 Mule Cr/AC-MM
BB:11:36-4266-4	236	19	40	112	26	65 Mule Cr/AC-MM
BB:11:36-4266-5	143	84	22	86	16	812 Cow Canyon/111 Ranch
BB:11:36-4266-6	222	18	40	110	25	61 Mule Cr/AC-MM
BB:11:36-4271-1	224	18	39	108	25	90 Mule Cr/AC-MM
BB:11:36-4271-2	228	18	39	108	27	69 Mule Cr/AC-MM
BB:11:36-4271-3	130	78	19	82	16	696 Cow Canyon/111 Ranch?
BB:11:36-4275-1	227	20	40	111	26	60 Mule Cr/AC-MM
BB:11:36-4277-7	233	19	39	106	25	71 Mule Cr/AC-MM
BB:11:36-4278-3	248	20	41	108	27	79 Mule Cr/AC-MM
BB:11:36-4278-4	230	19	39	106	26	62 Mule Cr/AC-MM
BB:11:36-4278-5	217	18	38	102	25	60 Mule Cr/AC-MM
BB:11:36-4278-6	172	17	30	85	20	69 Blue/SF River
BB:11:36-4278-7	234	21	42	113	28	59 Mule Cr/AC-MM
BB:11:36-4278-7	239	22	41	110	26	62 Mule Cr/AC-MM
BB:11:36-4284-1	228	20	41	112	26	77 Mule Cr/AC-MM
BB:11:36-4291-1	221	17	36	100	24	42 Mule Cr/AC-MM
BB:11:36-4302-2	213	23	37	100	24	57 Mule Cr/AC-MM
BB:11:91-5406-1	237	19	42	114	27	53 Mule Cr/AC-MM
BB:11:91-5411-2	231	18	42	113	26	55 Mule Cr/AC-MM
BB:11:91-5411-3	242	18	42	114	27	57 Mule Cr/AC-MM
BB:11:91-5411-4	254	18	42	113	26	44 Mule Cr/AC-MM
BB:11:91-5420-1	189	14	30	83	20	118 Blue/SF River
BB:11:91-5423-1	202	161	19	131	14	1181 Tank Mts
BB:11:91-5454-1	242	19	43	114	27	58 Mule Cr/AC-MM
BB:11:91-5489-1	230	20	40	112	26	60 Mule Cr/AC-MM
BB:11:91-5489-2	251	20	41	117	27	108 Mule Cr/AC-MM
BB:11:91-5509-1	230	19	41	113	26	58 Mule Cr/AC-MM
BB:11:91-5531-1	235	20	41	114	27	78 Mule Cr/AC-MM
BB:11:91-5555-1	237	19	40	111	26	60 Mule Cr/AC-MM
BB:15:1-5273-1	8	38	5	23	0	52 not obsidian
BB:2:19-601-1	202	16	37	98	22	62 Mule Cr/AC-MM
BB:2:19-606-2	162	132	16	115	12	844 Cow Canyon/111 Ranch
BB:2:19-606-3	129	64	28	163	20	637 unknown
BB:2:19-606-4	206	17	35	101	24	54 Mule Cr/AC-MM
BB:2:19-616-1	231	17	41	109	26	29 Mule Cr/AC-MM
BB:2:19-625-1	228	18	39	109	26	53 Mule Cr/AC-MM
BB:2:19-625-10	204	16	37	99	24	44 Mule Cr/AC-MM
BB:2:19-625-2	140	110	24	132	19	683 Cow Canyon/111 Ranch
BB:2:19-625-3	228	18	40	109	27	51 Mule Cr/AC-MM
BB:2:19-625-5	238	18	40	112	27	56 Mule Cr/AC-MM
Site/Sample	Rb	Sr	Y	Zr	Nb	Ba Source

BB:2:19-625-7	231	18	41	111	27	57	Mule Cr/AC-MM
BB:2:19-625-9	372	8	65	98	109	39	Mule Cr/N Sawmill Cr
BB:2:19-626-13	210	17	35	98	23	33	Mule Cr/AC-MM
BB:2:19-626-2	238	19	39	110	25	124	Mule Cr/AC-MM
BB:2:19-626-4	200	16	34	96	23	58	Mule Cr/AC-MM
BB:2:19-626-5	240	31	40	219	29	265	unknown
BB:2:19-626-8	186	16	33	93	22	100	Mule Cr/AC-MM
BB:2:19-626-9	235	78	39	220	28	367	unknown
BB:2:19-654-1	226	19	39	108	27	55	Mule Cr/AC-MM
BB:2:19-654-2	129	123	18	115	14	1061	Cow Canyon/111 Ranch
BB:2:19-662-1	226	20	41	114	27	65	Mule Cr/AC-MM
BB:2:19-662-2	236	19	40	112	27	73	Mule Cr/AC-MM
BB:2:19-666-1	114	21	25	93	30	144	Superior
BB:2:19-666-2	250	19	41	113	26	83	Mule Cr/AC-MM
BB:2:19-674-1	138	107	23	128	19	697	Cow Canyon/111 Ranch
BB:2:19-674-2	132	103	22	124	18	591	Cow Canyon/111 Ranch
BB:2:19-674-3	203	16	34	97	23	52	Mule Cr/AC-MM
BB:2:19-674-4	198	17	34	94	23	57	Mule Cr/AC-MM
BB:2:19-674-5	187	15	32	91	22	59	Mule Cr/AC-MM
BB:2:19-675-11	219	17	36	101	25	64	Mule Cr/AC-MM
BB:2:19-675-12	167	75	33	200	24	803	Sauceda Mts
BB:2:19-675-2	221	17	39	110	26	56	Mule Cr/AC-MM
BB:2:19-675-3	395	15	68	100	106	79	Mule Cr/N Sawmill Cr
BB:2:19-675-5	223	19	39	110	26	69	Mule Cr/AC-MM
BB:2:19-675-6	232	18	40	110	26	75	Mule Cr/AC-MM
BB:2:19-683-1	233	17	41	111	27	51	Mule Cr/AC-MM
BB:2:19-683-2	118	19	24	93	30	156	Superior
BB:2:19-683-3	130	126	19	115	13	810	Cow Canyon/111 Ranch
BB:2:19-692-1	236	17	40	110	27	74	Mule Cr/AC-MM
BB:2:19-692-2	223	17	38	107	25	63	Mule Cr/AC-MM
BB:2:19-692-3	217	18	39	107	25	49	Mule Cr/AC-MM
BB:2:19-692-4	108	98	15	95	12	671	Government Mtn
BB:2:3-5802-1	217	19	37	105	25	56	Mule Cr/AC-MM
BB:2:3-5834-2	241	20	43	117	28	49	Mule Cr/AC-MM
BB:2:3-5834-3	220	20	39	105	25	33	Mule Cr/AC-MM
BB:2:3-5834-4	231	20	40	112	26	43	Mule Cr/AC-MM
BB:2:3-5852-3	210	22	37	105	25	63	Mule Cr/AC-MM
BB:2:3-5856-1	254	28	39	111	25	80	Mule Cr/AC-MM
BB:2:3-5856-2	101	79	18	79	48	224	Government Mtn
BB:2:3-5867-1	141	131	19	118	15	1005	Cow Canyon/111 Ranch
BB:2:3-5867-10	219	21	38	109	25	49	Mule Cr/AC-MM
BB:2:3-5867-12	239	25	42	114	27	65	Mule Cr/AC-MM
BB:2:3-5867-13	226	20	39	108	26	52	Mule Cr/AC-MM
BB:2:3-5867-2	136	137	19	121	15	867	Cow Canyon/111 Ranch
BB:2:3-5867-3	120	36	17	117	20	227	Vulture
BB:2:3-5867-4	221	18	39	109	26	69	Mule Cr/AC-MM
BB:2:3-5867-8	233	18	40	109	27	49	Mule Cr/AC-MM
BB:2:3-5891-1	139	131	21	123	15	1022	Cow Canyon/111 Ranch
BB:2:3-5903-1	129	124	20	117	14	878	Cow Canyon/111 Ranch
BB:2:3-5903-2	126	102	22	123	17	579	Cow Canyon/111 Ranch
BB:2:3-5904-1	235	22	42	110	27	77	Mule Cr/AC-MM
BB:2:3-5925-1	105	76	20	80	49	257	Government Mtn
BB:2:3-5927-1	132	130	20	119	14	999	Cow Canyon/111 Ranch
BB:2:3-5927-2	229	24	41	111	27	34	Mule Cr/AC-MM
BB:2:3-5927-3	138	110	23	134	19	641	Cow Canyon/111 Ranch
Site/Sample	Rb	Sr	Y	Zr	Nb	Ba	Source

BB:2:3-5927-4	133	127	20	120	14	863	Cow Canyon/111 Ranch
BB:2:3-5927-5	255	21	42	117	28	50	Mule Cr/AC-MM
BB:2:3-5943-1	134	128	20	122	15	832	Cow Canyon/111 Ranch
BB:2:3-5943-2	138	110	24	132	18	628	Cow Canyon/111 Ranch
BB:2:3-5943-4	228	25	40	111	26	71	Mule Cr/AC-MM
BB:2:3-5943-5	122	143	18	118	14	604	Cow Canyon/111 Ranch
BB:2:3-5943-6	249	17	39	106	26	101	Mule Cr/AC-MM
BB:2:3-5943-7	203	17	35	100	24	101	Mule Cr/AC-MM
BB:2:3-5946-1	214	20	39	109	25	44	Mule Cr/AC-MM
BB:2:3-5955-1	135	127	19	124	15	975	Cow Canyon/111 Ranch
BB:2:51-3034-2	196	25	34	97	23	45	Mule Cr/AC-MM
BB:2:51-3034-3	179	15	32	88	22	34	Blue/SF River
BB:2:51-3037-1	211	18	37	101	25	22	Mule Cr/AC-MM
BB:2:51-3041-1	126	102	22	119	17	469	Cow Canyon/111 Ranch
BB:2:51-3041-2	238	45	41	113	28	91	Mule Cr/AC-MM
BB:2:51-3043-1	105	75	19	78	49	217	Government Mtn
BB:2:51-3054-1	129	101	20	122	17	585	Cow Canyon/111 Ranch
BB:2:51-3054-2	129	104	22	126	18	575	Cow Canyon/111 Ranch
BB:2:51-3054-3	233	20	40	110	27	56	Mule Cr/AC-MM
BB:2:51-3054-4	127	99	22	119	18	563	Cow Canyon/111 Ranch
BB:2:51-3054-5	133	106	23	129	19	602	Cow Canyon/111 Ranch
BB:2:51-3063-1	134	107	22	129	19	539	Cow Canyon/111 Ranch
BB:2:51-3063-2	249	20	42	115	28	88	Mule Cr/AC-MM
BB:2:51-3063-3	235	21	41	112	27	91	Mule Cr/AC-MM
BB:2:7-1603-1	215	18	39	112	25	91	Mule Cr/AC-MM
BB:2:7-1603-2	245	19	44	117	28	77	Mule Cr/AC-MM
BB:2:7-1603-3	215	16	37	104	24	89	Mule Cr/AC-MM
BB:2:7-1606-1	227	19	39	108	26	87	Mule Cr/AC-MM
BB:2:7-1613-1	238	18	43	115	28	50	Mule Cr/AC-MM
BB:2:7-1613-2	236	27	39	106	25	114	Mule Cr/AC-MM
BB:2:7-1613-3	231	18	41	113	27	50	Mule Cr/AC-MM
BB:2:7-1617-1	234	18	40	111	26	60	Mule Cr/AC-MM
BB:2:7-1617-2	247	19	41	112	26	76	Mule Cr/AC-MM
BB:2:7-1617-3	135	105	22	126	18	727	Cow Canyon/111 Ranch
BB:2:7-1617-4	222	17	42	109	25	42	Mule Cr/AC-MM
BB:2:7-1617-5	230	19	40	111	27	61	Mule Cr/AC-MM
BB:2:7-1621-10	234	13	67	216	32	33	Los Vidrios
BB:2:7-1621-2	144	64	31	180	22	726	Sauceda Mts
BB:2:7-1621-3	234	17	40	110	27	67	Mule Cr/AC-MM
BB:2:7-1621-4	341	8	127	1170	97	1	Antelope Wells
BB:2:7-1621-6	120	19	26	100	31	165	Superior
BB:2:7-1621-9	234	18	42	113	28	46	Mule Cr/AC-MM
BB:2:7-1626-1	246	18	42	116	28	68	Mule Cr/AC-MM
BB:2:7-1626-2	169	140	19	122	13	936	Tank Mts
BB:2:7-1633-1	109	77	19	80	51	344	Government Mtn
BB:2:7-1633-2	158	72	32	192	23	837	Cow Canyon/111 Ranch
BB:2:7-1636-1	222	18	38	108	25	10	Mule Cr/AC-MM
BB:2:7-1641-1	201	17	36	102	23	2	Mule Cr/AC-MM
BB:2:7-1646-1	122	108	18	106	14	899	Cow Canyon/111 Ranch
BB:2:7-1646-2	233	21	41	113	27	63	Mule Cr/AC-MM
BB:2:7-1646-3	114	80	20	83	52	242	Government Mtn
BB:2:7-1646-4	215	17	38	105	26	58	Mule Cr/AC-MM
BB:2:7-1646-5	117	19	25	95	31	156	Superior
BB:2:7-1650-1	238	19	42	112	26	55	Mule Cr/AC-MM
BB:2:7-1659-1	212	17	37	106	24	74	Mule Cr/AC-MM
Site/Sample	Rb	Sr	Y	Zr	Nb	Ba	Source

BB:2:7-1665-1	235	24	41	115	27	79	Mule Cr/AC-MM
BB:2:7-1665-2	232	24	41	114	26	73	Mule Cr/AC-MM
BB:2:7-1672-1	201	8	63	175	95	26	Cerro Toledo Rhy
BB:2:7-1672-11	230	18	40	111	26	52	Mule Cr/AC-MM
BB:2:7-1672-2	249	22	44	117	28	72	Mule Cr/AC-MM
BB:2:7-1672-3	255	20	42	116	27	72	Mule Cr/AC-MM
BB:2:7-1672-7	144	85	21	85	15	724	Government Mtn
BB:2:7-1672-9	104	76	20	80	49	257	Government Mtn
BB:2:7-1680-1	245	22	41	116	27	88	Mule Cr/AC-MM
BB:2:7-1686-1	232	18	40	113	27	66	Mule Cr/AC-MM
BB:2:7-1692-1	336	9	128	1180	99	1	Antelope Wells
BB:2:7-1692-2	121	19	26	98	30	179	Superior
BB:2:7-1696-1	226	19	40	110	27	58	Mule Cr/AC-MM
BB:2:7-1696-10	147	71	33	192	22	649	Cow Canyon/111 Ranch
BB:2:7-1696-3	119	18	24	95	29	175	Superior
BB:2:7-1696-5	165	73	33	198	24	898	Cow Canyon/111 Ranch
BB:2:7-1696-7	235	19	41	115	27	68	Mule Cr/AC-MM
BB:2:7-1696-8	227	20	40	110	26	62	Mule Cr/AC-MM
BB:2:7-1708-1	139	134	22	125	15	1130	Cow Canyon/111 Ranch
BB:2:7-1708-2	214	18	45	113	27	54	Mule Cr/AC-MM
BB:2:7-1723-1	248	20	44	118	28	67	Mule Cr/AC-MM
BB:2:7-1723-2	162	76	33	196	24	865	Cow Canyon/111 Ranch
BB:2:83-3226-1	237	18	43	115	27	62	Mule Cr/AC-MM
BB:2:83-3226-2	147	70	30	184	22	695	Cow Canyon/111 Ranch
BB:2:83-3349-1	226	20	40	110	26	68	Mule Cr/AC-MM
BB:6:11-2400-1	238	18	42	116	27	66	Mule Cr/AC-MM
BB:6:11-2400-2	138	131	20	126	15	1026	Cow Canyon/111 Ranch
BB:6:11-2400-4	108	108	17	106	10	610	Cow Canyon/111 Ranch
BB:6:11-2406-1	235	21	42	114	28	79	Mule Cr/AC-MM
BB:6:11-2406-2	136	130	21	123	15	1006	Cow Canyon/111 Ranch
BB:6:11-2406-3	139	131	20	125	15	1027	Cow Canyon/111 Ranch
BB:6:11-2406-4	245	25	42	113	28	78	Mule Cr/AC-MM
BB:6:11-2415-1	247	20	43	115	29	69	Mule Cr/AC-MM
BB:6:11-2415-2	245	22	42	114	28	75	Mule Cr/AC-MM
BB:6:11-2424-1	122	96	21	120	17	638	Cow Canyon/111 Ranch
BB:6:11-2429-1	140	133	21	124	15	1102	Cow Canyon/111 Ranch
BB:6:11-2432-1	233	18	40	112	28	45	Mule Cr/AC-MM
BB:6:11-2432-2	250	19	42	114	28	59	Mule Cr/AC-MM
BB:6:11-2432-3	229	20	42	114	26	70	Mule Cr/AC-MM
BB:6:11-2432-4	232	19	42	115	27	72	Mule Cr/AC-MM
BB:6:2-2000-1	221	17	40	108	26	50	Mule Cr/AC-MM
BB:6:2-2011-1	239	18	43	112	28	58	Mule Cr/AC-MM
BB:6:2-2031-1	141	136	20	125	16	1083	Cow Canyon/111 Ranch
BB:6:2-2035-1	137	131	20	124	15	1020	Cow Canyon/111 Ranch
BB:6:2-2038-1	135	128	20	122	15	982	Cow Canyon/111 Ranch
BB:6:2-2059-1	159	73	32	197	24	831	Cow Canyon/111 Ranch
BB:6:5-2606-1	138	92	24	160	18	511	Cow Canyon/111 Ranch
BB:6:5-2625-1	125	120	18	113	14	834	Cow Canyon/111 Ranch
BB:6:73-1800-1	134	123	19	118	15	922	Cow Canyon/111 Ranch
BB:6:73-1804-1	350	8	62	95	102	2	Mule Cr/N Sawmill Cr
BB:6:73-1814-1	124	118	18	113	14	722	Cow Canyon/111 Ranch
BB:6:73-1814-2	125	117	19	113	14	832	Cow Canyon/111 Ranch
BB:6:73-1816-1	128	129	19	110	13	804	Cow Canyon/111 Ranch
BB:6:73-1830-1	132	124	19	117	15	976	Cow Canyon/111 Ranch
BB:6:73-1850-1	125	119	18	113	13	851	Cow Canyon/111 Ranch
Site/Sample	Rb	Sr	Y	Zr	Nb	Ba	Source

BB:6:73-1853-1	226	18	37	106	24	89 Mule Cr/AC-MM
BB:6:73-1861-1	130	124	21	117	15	916 Cow Canyon/111 Ranch
BB:6:73-1868-1	128	122	19	113	15	722 Cow Canyon/111 Ranch
BB:6:73-1868-2	131	122	19	116	15	975 Cow Canyon/111 Ranch
BB:6:73-1869-1	128	104	22	123	18	505 Cow Canyon/111 Ranch
BB:6:73-1869-2	129	122	19	115	14	827 Cow Canyon/111 Ranch
BB:6:73-1880-1	125	117	18	111	14	970 Cow Canyon/111 Ranch
BB:6:73-1891-1	119	116	18	109	13	658 Cow Canyon/111 Ranch
BB:6:73-1926-1	132	126	20	119	15	964 Cow Canyon/111 Ranch
BB:7:5:4013-1	205	17	35	100	23	93 Mule Cr/AC-MM
BB:7:5:4014-1	235	22	42	115	28	66 Mule Cr/AC-MM
BB:7:5:4035-1	225	17	38	106	26	50 Mule Cr/AC-MM
BB:7:5:4035-2	183	16	31	86	20	57 Blue/SF River
BB:7:5:4045-1	139	109	24	133	19	693 Cow Canyon/111 Ranch
BB:7:5:4045-2	541	33	33	100	21	34 unknown
BB:7:5:4045-3	428	40	26	80	18	50 unknown
BB:7:5:4082-1	128	133	19	116	14	779 Cow Canyon/111 Ranch
BB:7:5:4085-1	222	17	38	106	25	46 Mule Cr/AC-MM
BB:7:5:4106-1	217	17	39	107	26	60 Mule Cr/AC-MM
BB:7:5:4119-1	129	123	19	117	14	876 Cow Canyon/111 Ranch
BB:7:5:4119-2	204	17	34	97	23	32 Mule Cr/AC-MM

Table 3. Crosstabulation of site by obsidian source provenance.

			SOURCE														
			Antelope Wells	Blue/SF River	Cerro Toledo Rhy	Cow Canyon/111 Ranch	Government Mtn	Los Vidrios	Mule Cr/AC-MM	Mule Cr/N Sawmill Cr	Sauceda Mts	Superior	Tank Mts	Valle Grande	Vulture	unknown	Total
SITE	BB:11:2	Count				3			8					1			12
		% within Site/Sample				25.0%			66.7%					8.3%			100.0%
		% within SOURCE				3.6%			3.2%					100.0%			3.0%
		% of Total				.8%			2.0%					.3%			3.0%
	BB:11:26	Count		2		1			41							1	45
		% within Site/Sample		4.4%		2.2%			91.1%							2.2%	100.0%
		% within SOURCE		33.3%		1.2%			16.4%							12.5%	11.3%
		% of Total		.5%		.3%			10.3%							.3%	11.3%
	BB:11:27	Count				2			33								35
		% within Site/Sample				5.7%			94.3%								100.0%
		% within SOURCE				2.4%			13.2%								8.8%
		% of Total				.5%			8.3%								8.8%
	BB:11:36	Count		1		3			41	2							47
		% within Site/Sample		2.1%		6.4%			87.2%	4.3%							100.0%
		% within SOURCE		16.7%		3.6%			16.4%	40.0%							11.8%
		% of Total		.3%		.8%			10.3%	.5%							11.8%
	BB:11:91	Count		1					10				1				12
		% within Site/Sample		8.3%					83.3%				8.3%				100.0%
		% within SOURCE		16.7%					4.0%				50.0%				3.0%
		% of Total		.3%					2.5%				.3%				3.0%
	BB:1:22	Count				5	6		5		1	5				1	23
		% within Site/Sample				21.7%	26.1%		21.7%		4.3%	21.7%				4.3%	100.0%
		% within SOURCE				6.0%	37.5%		2.0%		33.3%	25.0%				12.5%	5.8%
		% of Total				1.3%	1.5%		1.3%		.3%	1.3%				.3%	5.8%
	BB:1:32	Count				3	2		4			5					14
		% within Site/Sample				21.4%	14.3%		28.6%			35.7%					100.0%
		% within SOURCE				3.6%	12.5%		1.6%			25.0%					3.5%
		% of Total				.8%	.5%		1.0%			1.3%					3.5%
	BB:1:34	Count					1		3								4
		% within Site/Sample					25.0%		75.0%								100.0%
		% within SOURCE					6.3%		1.2%								1.0%
		% of Total					.3%		.8%								1.0%
	BB:1:55	Count				2		1								1	4
		% within Site/Sample				50.0%		25.0%								25.0%	100.0%
		% within SOURCE				2.4%		50.0%								12.5%	1.0%
		% of Total				.5%		.3%								.3%	1.0%
	BB:1:6	Count				2			2			4					8
		% within Site/Sample				25.0%			25.0%			50.0%					100.0%
		% within SOURCE				2.4%			.8%			20.0%					2.0%
		% of Total				.5%			.5%			1.0%					2.0%
	BB:2:19	Count				6	1		27	2	1	2				3	42
		% within Site/Sample				14.3%	2.4%		64.3%	4.8%	2.4%	4.8%				7.1%	100.0%
		% within SOURCE				7.2%	6.3%		10.8%	40.0%	33.3%	10.0%				37.5%	10.5%
		% of Total				1.5%	.3%		6.8%	.5%	.3%	.5%				.8%	10.5%
	BB:2:3	Count				12	2		18						1		33
		% within Site/Sample				36.4%	6.1%		54.5%						3.0%		100.0%
		% within SOURCE				14.5%	12.5%		7.2%						100.0%		8.3%
		% of Total				3.0%	.5%		4.5%						.3%		8.3%
	BB:2:51	Count		1		6	1		6								14
		% within Site/Sample		7.1%		42.9%	7.1%		42.9%								100.0%
		% within SOURCE		16.7%		7.2%	6.3%		2.4%								3.5%
		% of Total		.3%		1.5%	.3%		1.5%								3.5%
	BB:2:7	Count	2		1	8	3	1	32		1	4	1				53
		% within Site/Sample	3.8%		1.9%	15.1%	5.7%	1.9%	60.4%		1.9%	7.5%	1.9%				100.0%
		% within SOURCE	100.0%		100.0%	9.6%	18.8%	50.0%	12.8%		33.3%	20.0%	50.0%				13.3%
		% of Total	.5%		.3%	2.0%	.8%	.3%	8.0%		.3%	1.0%	.3%				13.3%
	BB:2:83	Count				1			2								3
		% within Site/Sample				33.3%			66.7%								100.0%
		% within SOURCE				1.2%			.8%								.8%
		% of Total				.3%			.5%								.8%
	BB:6:11	Count				6			9								15
		% within Site/Sample				40.0%			60.0%								100.0%
		% within SOURCE				7.2%			3.6%								3.8%
		% of Total				1.5%			2.3%								3.8%
	BB:6:2	Count				4			2								6
		% within Site/Sample				66.7%			33.3%								100.0%
		% within SOURCE				4.8%			.8%								1.5%
		% of Total				1.0%			.5%								1.5%
	BB:6:5	Count				2											2
		% within Site/Sample				100.0%											100.0%
		% within SOURCE				2.4%											.5%
		% of Total				.5%											.5%
	BB:6:73	Count				14			1	1							16
		% within Site/Sample				87.5%			6.3%	6.3%							100.0%
		% within SOURCE				16.9%			.4%	20.0%							4.0%
		% of Total				3.5%			.3%	.3%							4.0%
	BB:7:5	Count		1		3			6							2	12
		% within Site/Sample		8.3%		25.0%			50.0%							16.7%	100.0%
		% within SOURCE		16.7%		3.6%			2.4%							25.0%	3.0%
		% of Total		.3%		.8%			1.5%							.5%	3.0%
Total		Count	2	6	1	83	16	2	250	5	3	20	2	1	1	8	400
		% within Site/Sample	.5%	1.5%	.3%	20.8%	4.0%	.5%	62.5%	1.3%	.8%	5.0%	.5%	.3%	.3%	2.0%	100.0%
		% within SOURCE	100.0%	100.0%	100.0%	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%	1.5%	.3%	20.8%	4.0%	.5%	62.5%	1.3%	.8%	5.0%	.5%	.3%	.3%	2.0%	100.0%

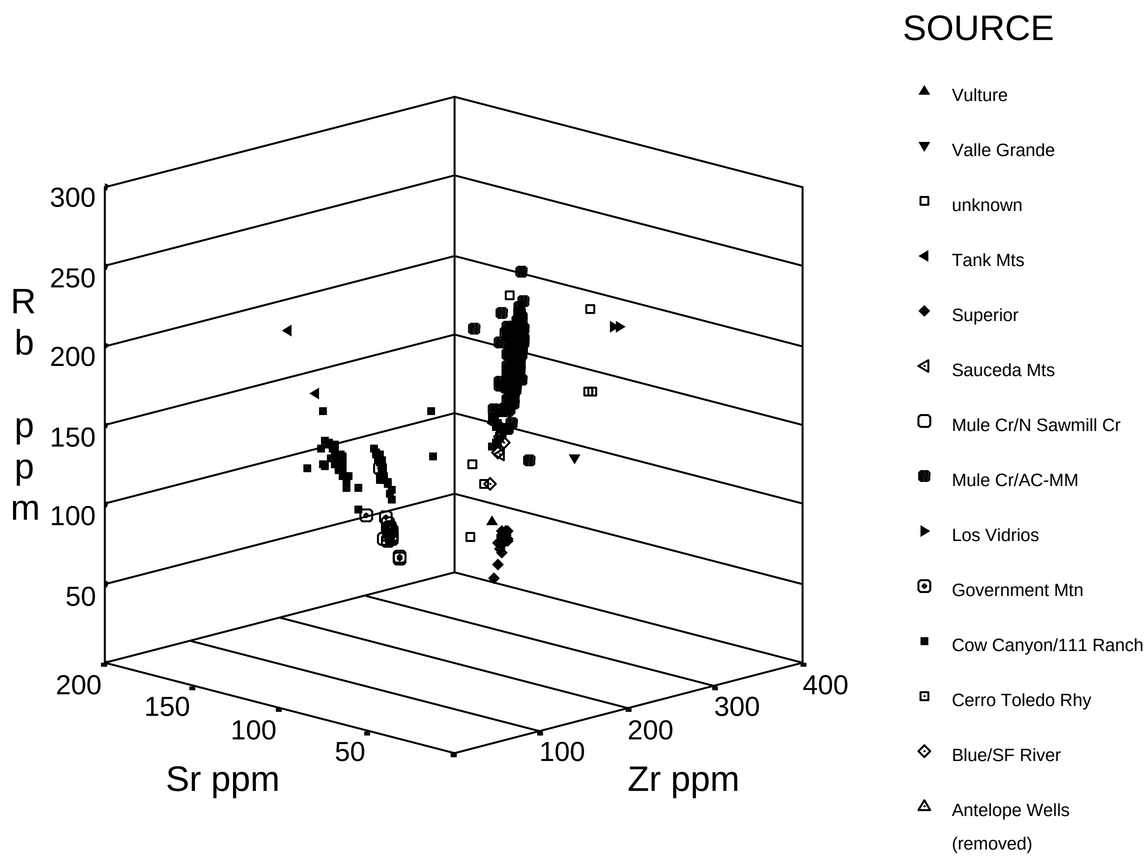

Figure 1. Rb, Sr, Zr three dimensional plot of archaeological data. The very distinctive Antelope Wells data have been removed to provide better separation (see Table 2). See the following biplots for more effective elemental discrimination of the artifact data.

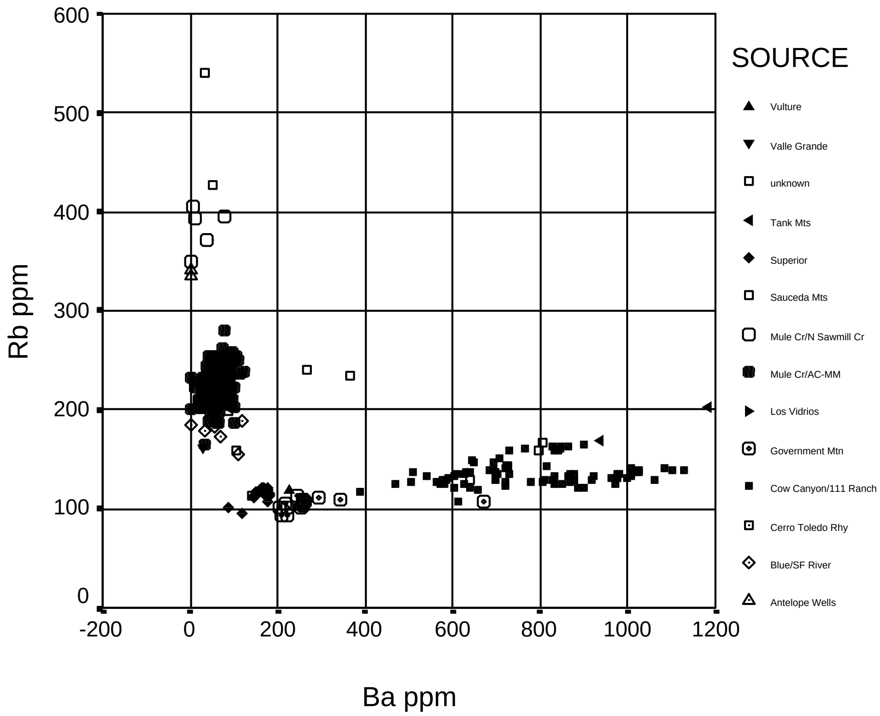

Figure 2. Rb versus Ba biplot of archaeological data. Sr, plotted below more effectively separates the Mule Creek from other sources.

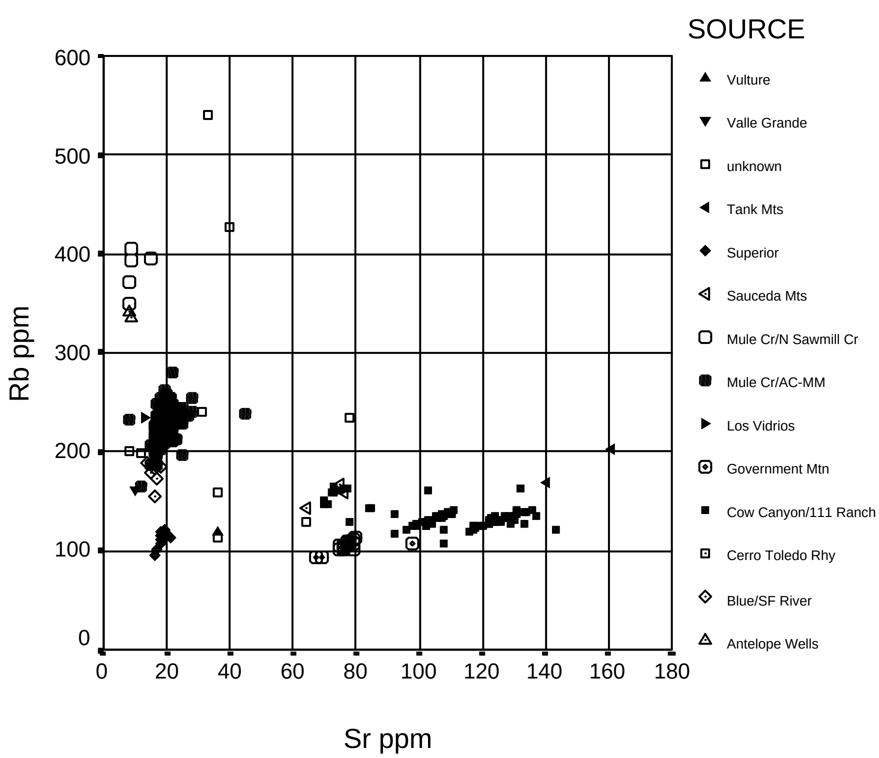

Figure 3. Rb versus Sr biplot of archaeological data.

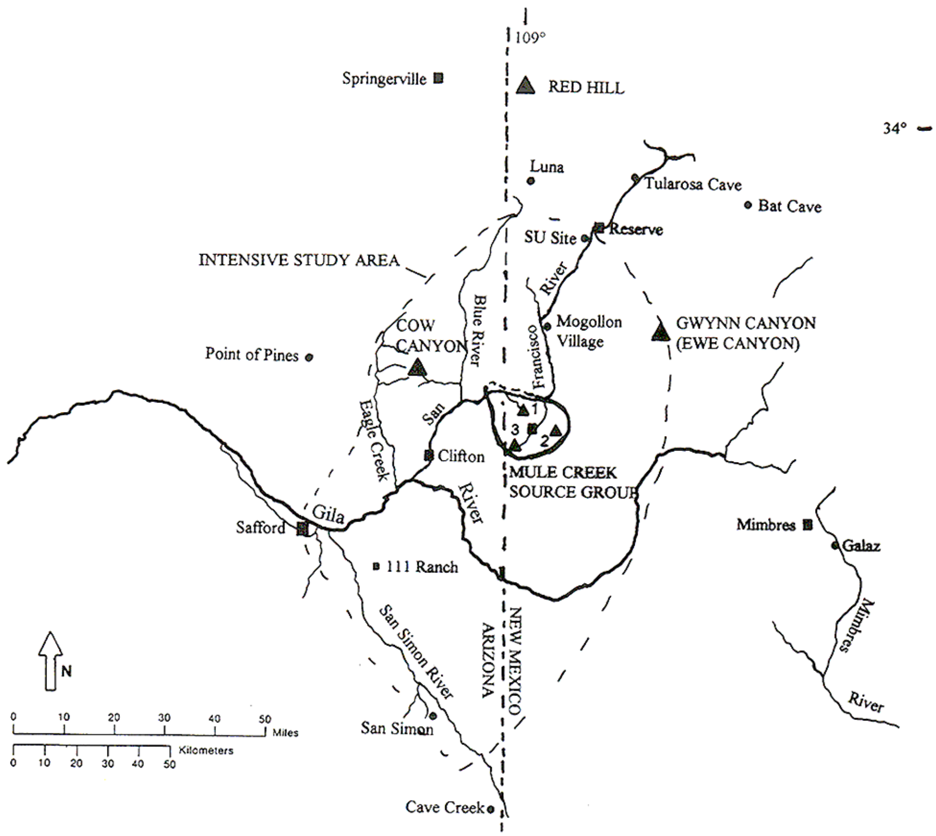

Figure 3. The eastern Arizona/western New Mexico region and sources of archaeological obsidian and the center of the 111 Ranch Formation. Sources = filled triangles; modern towns = filled squares; archaeological sites = filled circles. Mule Creek source localities = 1-Antelope Creek; 2 – Mule Mountains; 3 – North Sawmill Creek.

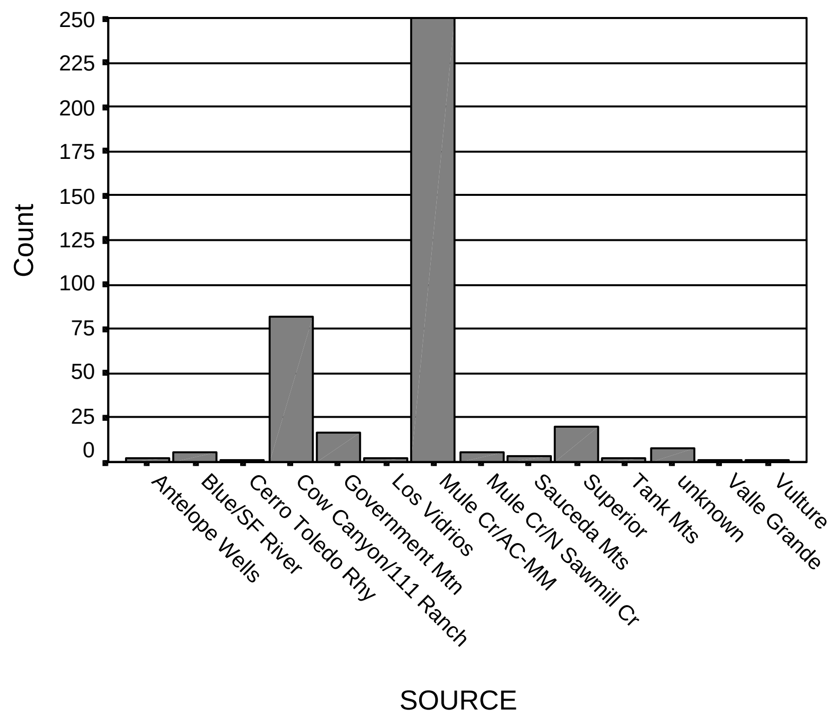

Figure 4. Distribution of obsidian source provenance for all sites.