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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM ARCHAIC SITES AND PUEBLO BONITO EAST, MIDDLE AND WEST TRENCH LATE PERIODS, CHACO CULTURE NATIONAL HISTORIC PARK, NEW MEXICO

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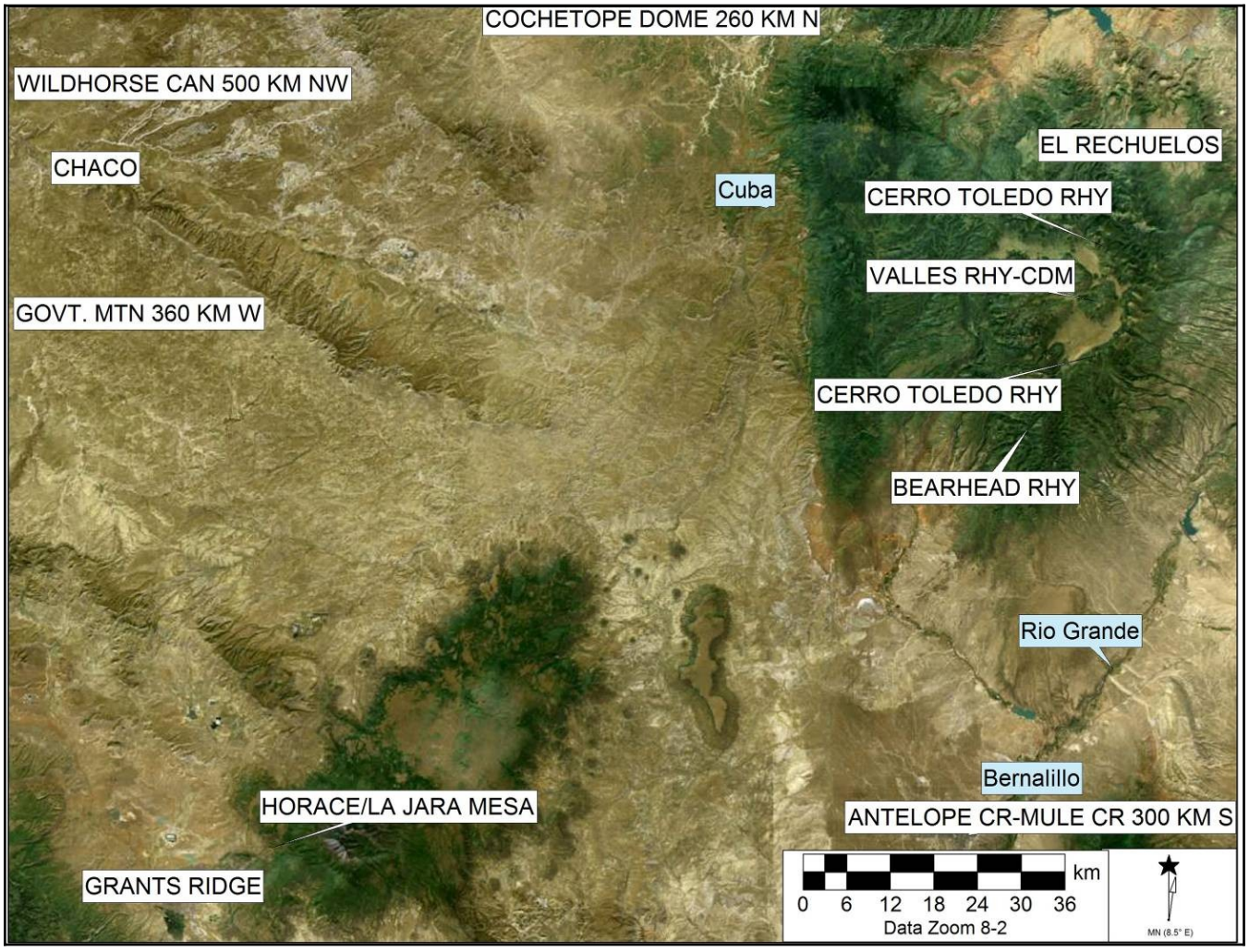
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USA

SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM ARCHAIC SITES AND PUEBLO BONITO EAST, MIDDLE AND WEST TRENCH LATE PERIODS, CHACO CULTURE NATIONAL HISTORIC PARK, NEW MEXICO



Digital elevation model of obsidian source provenance and prominent features from the Archaic sites and late period trench recovery at Pueblo Bonito. Sources in capitals, map features in lower case.

SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM PUEBLO BONITO WEST TRENCH, CHACO CULTURE NATIONAL HISTORICAL PARK, NEW MEXICO

Many projectile points are made of materials that are poorly represented in the debitage, which suggests that projectile points are not the end product of most reduction sequences in the canyon and may have been imported in a finished state. (Cameron 2001:97).

DRAFT

by

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INTRODUCTION

The analysis here of 526 artifacts (524 obsidian) from the Archaic sites (n=69 and East, Middle, and West Trench recovery (n=455) by the University of New Mexico at Pueblo Bonito in Chaco Canyon is similar to the provenance assemblage from previous studies with some important exceptions (see Shackley 2016; Tables 1 through 4 and Figures 1 through 4). While the assemblage is expectably dominated by debitage and utilized flakes produced from Jemez Mountains sources, a number of projectile points, and some debitage, were produced from sources throughout the U.S. West, west, north northwest, and south, of Chaco Canyon, including one piece of debitage from the Wild Horse Canyon source in west Utah over 500 linear km northwest. The obsidian source assemblage from the late sites is derived from a very different mix of sources than the earlier sites from the large study done for Tom Windes over 15 years ago (Shackley and Dillian 2000; see also Duff et al. 2012; Shackley 2016). The Archaic artifacts are mainly produced from Jemez Mountains or Mount Taylor sources.

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 scandium

(Sc). 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.

For the analysis of 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 generally using an 8.8 mm tube collimator 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 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. 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, and http://swxrflab.net/swobsrcs.htm). 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 for manipulation and on into SPSS for Windows (Release 21) and JMP 12.0.1 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 or G-2 USGS granite standard is analyzed during each sample run of ≤ 19 for obsidian artifacts to check machine calibration (Table 5).

Source assignments were made by reference to the laboratory data base (see Shackley 1995, 2005; Shackley et al. 2016, 2018; and online at http://swxrflab.net/swobsrcs.htm). Further information on the laboratory instrumentation can be found at: http://www.swxrflab.net/. Trace element data exhibited in Tables 1 and 3 are reported in parts per million (ppm), a quantitative measure by weight.

With this large sample, a stepped analytical trajectory was used by plotting incompatible elements that have been found to provide the greatest discrimination (Shackley 2005; Shackley et al. 2018; Figures 1 through 3 here). While the sources present in these sites generally do not present the kind of discrimination issues as required for sources in the Mogollon-Datil Volcanic Province in western New Mexico (only Antelope Creek-Mule Creek here is from that province), the sheer number of sources requires a stepped approach. In this approach, all artifacts are first plotted, in this case using Y and Nb, two elements useful for discriminating Jemez Lineaments sources (Jemez and Mount Taylor), then selecting additional mid-Z elements until discrimination of all the sources present is apparent (Figures 1 through 3).

DISCUSSION

Inferences of Production

It would be foolhardy to attempt to explain the organization of lithic production at Chaco with the late period sample of only one raw material. See Cameron (2002), Lekson (1997), and Toll (2006) for discussions of the lithic assemblage overall and their inferences for the

organization of production (also Duff et al. 2012; Shackley 2016). However, between this study and the previous study of earlier period obsidian provenance, some inferences are possible (Duff et al. 2012; Shackley and Dillian 2000; Shackley 2016). Between these various studies, nearly 1300 samples have been assigned to source, considerably greater than the Cameron and Sappington (1984) original obsidian provenance study (Tables 2 and 4, and Figure 1).

Analytical Results

As noted above, the vast majority of obsidian artifacts from the late period sites were produced (actually mostly debitage, a few cores, and utilized flakes) from Valles Rhyolite (Cerro del Medio; 63.7%) and Cerro Toledo Rhyolite (30.5%), and when the other Jemez Mountains sources are included (El Rechuelos 2.0%); they comprise over 96% of the assemblage, nearly identical to the 2016 study (Tables 3 and 4). Additionally, one piece of debitage was produced from the Wild Horse Canyon source in the Mineral Mountains of western Utah, over 500 km northwest, not seen in all the previous Chaco analyses. Government Mountain comprised 1.8% of the assemblage including two projectile points discussed below. Finally two points were produced from the Antelope Creek locality at Mule Creek in southwestern New Mexico, and as discussed below the points are typical of styles recovered from Classic Mimbres contexts in the Middle Gila River and Mimbres Valleys.

The Archaic obsidian assemblage is entirely produced from Jemez Mountains and Mount Taylor sources, except for one produced from Cochetope (Cochetopa) Dome in southern Colorado. Jemez sources accounted for 92.7% of the assemblage, the Mount Taylor sources 5.7% of the assemblage (Tables 1 and 2 and Figure 5).

Projectile Points in Late Period Sites

There has been considerable discussion about the role of projectile points at Chaco sites with respect to procurement and ritual (see especially Cameron 2001; Lekson 1997). As seen in the Cameron and Sappington analysis, and verified here, many of the projectile points were produced from sources that are absent or rare in the debitage assemblage (see cover image and Figures 2 through 4).

Unlike the 2016 study a number of points exhibit impact fracturing that would be typical in an active assemblage (Figure 5). I have argued that during the preclassic Hohokam (Sedentary Period overlapping the Great House period at Chaco), projectile points were produced in stylistically different forms in the three major Hohokam Core areas and were produced from different obsidian sources (Shackley 2005, 2019). Additionally looking at the role of ceramics in Sedentary Hohokam society, these projectile points (actually arrows) were circulating as part of what we have called the "small m" market economy tied intimately to the ballgames (Abbott 2008; Fertelmes et al. 2012; Lack et al. 2012; Shackley 2005, 2019). In this case, point forms and obsidian provenance signaled the social identity of the weapon makers, possibly a reflection of canal irrigation and/or warrior sodalities (Hoffman 1997; Shackley 2005, 2019). Indeed, in all the sites analyzed in the Lower Salt River basin area, ties to or even actual people present from the Coconino Plateau suggested a multi-ethnic Hohokam - over 1/2 of the point forms and provenance was distinctively Coconino Plateau types (Shackley 2005, 2019). The obsidian sources included Government Mountain and RS Hill/Sitgreaves Peak present in the late period assemblage at Chaco, and Government Mountain in the current study (Tables 2 and 3).

Double Side-notched (Cosgrove) Points

There is an unusual projectile point form represented by two specimens, both produced from the Antelope Creek locality at the Mule Creek Obsidian Complex in southwestern New Mexico 300 km distant (Shackley et al. 2018; cover image and Figure 6 here, top row, two left specimens). This style with double notches along one margin while not unheard of in the Southwest (see Shackley 2019), is relatively common in Late Pithouse to Classic Mimbres contexts in southwestern New Mexico including sites such as Fornholt (LA 164471) in the Mule Creek valley (Ryan 2019). The points are regularly recovered in Mimbres Classic contexts including Nan Ranch Ruin and others in the Mimbres Valley (Dockall 1991:Figure 24c-e; in Ryan 2019:14). According to Ryan they have also occurred in Late Pit House/Classic period deposits in the Mogollon Highlands (from Moore 1999:Figure 3.13j-u, again in Ryan 2019:14).

I agree with Ryan that the extra notches would have no technological (hafting) function and likely represent a social/stylistic design (2019:14). Additionally, Ryan notes that this point style does not occur in later Salado contexts in the Upper Gila region, so can be considered a Late Pithouse to Classic Mimbres form. Further supporting the possibility of a Mimbres presence at Pueblo Bonito is that these two specimens are produced from Antelope Creek-Mule Creek obsidian located within Mimbres territory (Figures 2 through 4).

Debitage and projectile points produced from Government Mountain in the San Francisco Volcanic Field in northern Arizona in Western Pueblo territory likely also signals the presence of knappers/hunters from Arizona (see Figure 6). In the Government Mountain case with two side-notched points and six pieces of debitage it is possible that the points were produced at Pueblo Bonito or another site in the canyon.

CONCLUSION

The later period artifacts produced from obsidian in Chaco Canyon sites, we now know, were created from sources differing somewhat from the original Cameron and Sappington study, mainly since there are many more known sources now and the instrumental technology (i.e. laboratory XRF) is much advanced, still the general pattern is similar (see Shackley 2005, 2016). After the Archaic, and during the earlier periods (i.e. Pueblo I), obsidian raw material was procured dominantly from Mount Taylor sources and very little from Jemez Mountains sources, while during the later periods Jemez sources comprised over 94-95% of the assemblage. Striking is the "outlier" sources that were used to produce many of the projectile points, certainly due to transporting arrows produced in home territories to Chaco. As noted in the 2016 study the projectile point produced from Cow Canyon obsidian of eastern Arizona (Sample 30528-1 from 29SJ633), a source often found in Sedentary Period Hohokam contexts is likely what Hoffman would call a Sacaton Serrated point, common in sites such as Snaketown and Grewe along the Middle Gila River in central Arizona (Hoffman 1997; Shackley 2005, 2016, 2019). Further, the double side-notched points that are similar to a Classic Mimbres style, and produced

from Antelope Creek obsidian further supports the notion of people from all directions in the Southwest, and extra-regionally, traveled to Chaco Canyon.

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Table 1. Elemental concentrations and probable source assignments for the Archaic context archaeological samples.

CHCU #	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Pb	Th	Source
4003-1	725	332	11018	67	133	15	38	155	48	19	26	Valles Rhy (Cerro del Medio)
4029-1	433	782	11258	166	570	13	78	123	196	61	29	Grants Ridge-Mt Taylor
4040-1	654	419	11758	83	158	14	44	164	58	25	16	Valles Rhy (Cerro del Medio)
4060-1	662	390	10278	47	151	15	22	77	47	27	24	El Rechuelos
4072-1	667	382	10306	42	142	14	23	73	47	25	22	El Rechuelos
4087-1	1301	621	13183	76	155	15	40	167	52	25	16	Valles Rhy (Cerro del Medio)
4089-1	742	693	10651	41	139	16	22	75	50	37	23	El Rechuelos
4376-1	802	450	10515	46	160	15	26	76	49	26	18	El Rechuelos
5381-1	1409	409	11941	126	162	12	42	169	51	25	20	Valles Rhy (Cerro del Medio)
5488	770	404	11948	71	155	17	42	167	54	24	20	Valles Rhy (Cerro del Medio)
5505-1	2474	521	12024	70	144	17	38	166	56	25	26	Valles Rhy (Cerro del Medio)
5543-1	621	392	10176	56	147	12	24	73	41	27	25	El Rechuelos
5741-1	826	514	11979	71	160	16	41	167	54	27	16	Valles Rhy (Cerro del Medio)
6224-1	1633	471	10890	57	164	11	23	78	48	30	25	El Rechuelos
8961-1	786	404	12009	70	159	14	45	168	56	23	11	Valles Rhy (Cerro del Medio)
13760-1	618	390	11809	69	161	14	46	174	55	24	17	Valles Rhy (Cerro del Medio)
16405-1	838	482	12932	132	178	12	45	175	52	32	24	Valles Rhy (Cerro del Medio)
17002	805	414	10721	42	144	14	23	71	45	25	16	El Rechuelos

-1			9									
17002			1242									
-2	620	533	1	143	218	10	64	178	97	34	23	Cerro Toledo Rhy
17002			1239									
-3	805	550	6	139	214	11	63	174	93	36	25	Cerro Toledo Rhy
17002			1029									
-4	670	550	8	61	151	13	22	77	49	29	18	El Rechuelos
17008			1252									Valles Rhy (Cerro del
-1	799	475	7	86	167	10	44	171	56	24	13	Medio)
17008												
-2	319	149	8657	28	0	14	2	18	1	0	5	not obsidian
17010			1076									
-1	859	433	0	85	160	11	21	76	45	30	14	El Rechuelos
17010			1231									Valles Rhy (Cerro del
-2	675	411	2	128	170	12	43	167	56	29	19	Medio)
17010			1072									
-3	806	453	7	70	165	19	19	80	45	27	23	El Rechuelos
17012			1185									Valles Rhy (Cerro del
-1	839	403	8	73	157	15	41	161	58	20	20	Medio)
17012			1227									Valles Rhy (Cerro del
-2	802	409	9	108	166	13	52	168	56	30	23	Medio)
17012			1225									Valles Rhy (Cerro del
-3	873	419	5	116	160	14	43	163	58	29	20	Medio)
17012			1235									Valles Rhy (Cerro del
-4	912	449	6	118	165	13	43	167	46	27	18	Medio)
17012			1070									
-5	993	468	0	132	170	11	24	77	44	31	24	El Rechuelos
17218			1145									Valles Rhy (Cerro del
-1	592	360	8	67	152	11	38	160	53	20	17	Medio)
17218			1023									
-2	676	399	7	38	149	17	27	72	44	26	29	El Rechuelos
17254			1222									Valles Rhy (Cerro del
-1	794	418	1	76	163	14	42	167	55	23	22	Medio)
17443			1070									
-1	610	611	3	69	210	12	25	119	29	29	24	Cochetope Dome, CO
17443			1178									Valles Rhy (Cerro del
-2	737	396	6	67	158	12	43	175	48	23	19	Medio)
17443			1141									
-3	382	754	6	184	569	13	80	117	187	66	37	Grants Ridge-Mt Taylor

17443			1110									
-4	407	726	5	180	563	11	73	118	188	59	21	Grants Ridge-Mt Taylor
17443			1170									Valles Rhy (Cerro del
-5	605	364	1	74	154	13	46	161	51	21	21	Medio)
17443			1195									Valles Rhy (Cerro del
-6	738	398	4	98	165	15	42	161	58	27	21	Medio)
17513			1238									Valles Rhy (Cerro del
-1	731	436	7	114	171	16	47	175	54	29	30	Medio)
17516			1039									
-1	743	434	2	44	152	15	23	77	43	28	20	El Rechuelos
17529			1251									Horace/La Jara Mesa-Mt
-1	665	715	4	203	524	17	92	141	219	55	32	Taylor
17529			1217									Valles Rhy (Cerro del
-2	753	405	2	70	157	15	45	162	52	23	30	Medio)
17529			1062									
-3	825	404	3	52	157	16	25	77	47	27	13	El Rechuelos
17550			1039									
-1	728	406	9	36	156	18	24	74	47	26	21	El Rechuelos
17550			1069									
-2	860	446	7	45	158	17	25	74	43	24	21	El Rechuelos
17550			1218									Valles Rhy (Cerro del
-3	814	411	0	106	162	16	40	164	54	29	14	Medio)
17550			1160									Valles Rhy (Cerro del
-4	645	419	8	89	167	11	45	167	51	25	23	Medio)
17551			1195									Valles Rhy (Cerro del
-1	753	381	3	84	156	15	41	162	55	30	21	Medio)
17551			1263									Valles Rhy (Cerro del
-2	900	457	4	118	177	14	47	160	55	31	23	Medio)
17654			1036									
-1	651	407	1	49	155	18	20	77	50	28	15	El Rechuelos
17564			1034									
-2	625	384	3	47	159	13	22	75	45	29	34	El Rechuelos
17657			1209									Valles Rhy (Cerro del
-1	763	475	1	75	161	17	41	171	50	26	9	Medio)
17657			1184									
-2	658	477	3	127	206	10	64	173	98	37	18	Cerro Toledo Rhy
17731			1243									Valles Rhy (Cerro del
-1	804	449	7	81	166	13	45	167	51	27	21	Medio)
17731	723	382	1035	47	147	13	26	75	44	22	21	El Rechuelos

-2			7									
17731			1040									
-3	734	431	2	59	155	13	27	74	45	30	23	El Rechuelos
17731			1207									Valles Rhy (Cerro del
-4	784	418	7	151	167	11	49	158	53	22	24	Medio)
17747			1102									
-1	1132	493	0	46	106	91	24	124	35	19	24	Bearhead Rhy
17747			1099									
-2	1047	479	9	47	102	86	27	132	32	23	16	Bearhead Rhy
17747			1136									
-3	1236	520	5	67	106	90	22	136	27	19	22	Bearhead Rhy
17750			1206									Valles Rhy (Cerro del
-1	706	424	7	103	169	10	45	167	51	26	18	Medio)
17750			1215									Valles Rhy (Cerro del
-2	658	405	4	98	172	13	44	163	52	24	19	Medio)
17750			1036									
-3	610	407	1	44	155	12	23	76	48	27	20	El Rechuelos
17756			1202									Valles Rhy (Cerro del
-1	845	387	6	122	161	14	42	161	48	24	16	Medio)
18942			1001									
-1	535	366	7	45	140	13	21	70	46	22	18	El Rechuelos
30080			1266									
-1	550	548	8	124	223	12	64	181	98	42	37	Cerro Toledo Rhy
			1186									
36269	562	519	5	126	190	11	67	175	95	40	36	Cerro Toledo Rhy
			1169									Valles Rhy (Cerro del
36280	737	409	9	86	156	15	43	162	51	25	21	Medio)

Table 2. Frequency distribution of Archaic obsidian source provenance. Non obsidian artifacts omitted.

		Frequency	Percent
Source	Valles Rhy (Cerro del Medio)	34	49.3
	El Rechuelos	22	31.9
	Cerro Toledo Rhy	5	7.2
	Bearhead Rhy	3	4.3
	Grants Ridge-Mt Taylor	3	4.3
	Horace/La Jara Mesa-Mt Taylor	1	1.4
	Cochetope Dome, CO	1	1.4
	Total	69	100.0

Table 3. Elemental concentrations and probable source assignments for the Late Period Trench contexts archaeological samples.

CHCU#	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Pb	Th	Source
111370-1	771	448	12193	130	174	14	48	172	58	30	23	Valles Rhy (Cerro del Medio)
111370-2	771	546	12495	195	218	18	59	182	91	36	20	Cerro Toledo Rhy
111370-3	719	423	12281	100	172	14	46	168	55	27	23	Valles Rhy (Cerro del Medio)
111370-4	641	375	11680	80	168	11	42	167	60	27	29	Valles Rhy (Cerro del Medio)
111370-5	667	471	11571	153	189	9	66	161	95	31	22	Cerro Toledo Rhy
111370-6	790	536	13146	173	224	15	68	187	104	42	36	Cerro Toledo Rhy
111370-7	544	512	12037	147	217	10	62	174	95	33	41	Cerro Toledo Rhy
111370-8	758	401	12218	114	164	11	43	165	48	25	23	Valles Rhy (Cerro del Medio)
111370-9	670	400	11900	109	164	14	42	161	56	32	25	Valles Rhy (Cerro del Medio)
111370-10	744	427	12035	111	159	14	40	161	54	30	25	Valles Rhy (Cerro del Medio)
111370-11	594	403	11705	82	164	14	43	169	54	26	16	Valles Rhy (Cerro del Medio)
111370-12	563	364	11398	70	150	16	46	164	59	22	17	Valles Rhy (Cerro del Medio)
111370-13	603	473	11947	125	208	12	62	178	97	32	23	Cerro Toledo Rhy
111371-1	644	412	11919	144	156	13	43	161	45	24	16	Valles Rhy (Cerro del Medio)
111371-2	897	390	11743	106	150	13	37	161	48	23	20	Valles Rhy (Cerro del Medio)

111371-3	730	393	11754	103	160	13	41	164	58	24	23	Valles Rhy (Cerro del Medio)
111371-4	711	440	12167	149	169	12	40	172	57	23	18	Valles Rhy (Cerro del Medio)
111371-5	994	371	11204	119	206	47	19	121	25	29	26	Wild Horse Canyon, UT
111378-1	1062	396	13013	78	160	17	43	163	60	23	17	Valles Rhy (Cerro del Medio)
111378-2	793	483	12325	124	194	13	66	184	87	34	21	Cerro Toledo Rhy
111378-3	660	343	11431	72	143	15	38	152	50	22	15	Valles Rhy (Cerro del Medio)
111379-1	865	353	11721	125	143	15	40	150	45	21	22	Valles Rhy (Cerro del Medio)
111380-1	811	395	12097	72	162	15	43	169	61	25	23	Valles Rhy (Cerro del Medio)
111380-2	805	474	11937	131	195	9	62	168	89	32	23	Cerro Toledo Rhy
111383-1	762	378	11932	87	154	13	42	156	52	26	14	Valles Rhy (Cerro del Medio)
111383-2	663	401	11679	97	152	14	45	165	55	25	23	Valles Rhy (Cerro del Medio)
111384-1	637	400	11979	105	159	12	48	158	53	25	25	Valles Rhy (Cerro del Medio)
111388-1	672	389	11566	91	152	15	45	156	59	24	25	Valles Rhy (Cerro del Medio)
111391-1	808	477	12337	153	188	9	64	170	94	39	25	Cerro Toledo Rhy
111397-1	1515	513	12927	205	177	19	57	169	81	39	20	Cerro Toledo Rhy
111399-1	561	518	11984	126	206	12	61	169	95	31	26	Cerro Toledo Rhy
111401-1	1133	375	12224	121	140	15	42	152	49	28	30	Valles Rhy (Cerro del Medio)
111401-2	1587	365	12771	156	135	15	38	148	43	22	11	Valles Rhy (Cerro del Medio)
111401-3	814	529	13175	166	200	16	48	170	51	35	24	Valles Rhy (Cerro del Medio)

111401-4	816	445	12347	101	165	14	42	168	52	32	26	Valles Rhy (Cerro del Medio)
111402-1	737	365	11921	78	159	12	39	162	57	22	26	Valles Rhy (Cerro del Medio)
111402-2	757	400	12165	117	154	14	44	158	57	24	22	Valles Rhy (Cerro del Medio)
111402-3	557	474	11836	141	208	11	64	169	93	32	29	Cerro Toledo Rhy
111402-4	633	375	11765	113	150	12	43	151	53	25	18	Valles Rhy (Cerro del Medio)
111402-5	829	456	11934	158	192	12	59	170	94	36	27	Cerro Toledo Rhy
111402-6	818	427	12293	129	169	13	42	164	52	32	27	Valles Rhy (Cerro del Medio)
111407-1	758	434	12321	104	173	14	47	166	57	30	26	Valles Rhy (Cerro del Medio)
111407-2	618	469	12450	113	209	12	62	172	95	35	28	Cerro Toledo Rhy
111407-3	612	508	12128	143	212	11	60	174	91	34	30	Cerro Toledo Rhy
111407-4	767	449	12323	144	163	16	45	162	52	24	22	Valles Rhy (Cerro del Medio)
111407-5	634	464	12265	130	171	11	42	166	56	30	23	Valles Rhy (Cerro del Medio)
111407-6	674	535	12404	177	213	9	60	176	91	42	30	Cerro Toledo Rhy
111407-7	702	467	12006	135	202	12	64	174	93	35	32	Cerro Toledo Rhy
111408-1	700	391	11946	85	161	9	43	169	58	22	24	Valles Rhy (Cerro del Medio)
111408-2	672	606	12457	228	520	13	87	138	216	61	30	Horace/La Jara Mesa-Mt Taylor
111408-3	745	391	11682	128	164	13	41	164	51	24	20	Valles Rhy (Cerro del Medio)
111409-1	658	395	11836	81	165	13	41	167	53	24	21	Valles Rhy (Cerro del Medio)
111409-2	841	369	11757	113	166	14	41	153	53	26	17	Valles Rhy (Cerro del Medio)

111409-3	683	421	11986	84	164	12	40	166	54	27	25	Valles Rhy (Cerro del Medio)
111410-1	626	493	12216	116	205	15	61	181	96	36	18	Cerro Toledo Rhy
111410-2	726	393	12135	114	173	16	48	171	54	28	12	Valles Rhy (Cerro del Medio)
111410-3	783	385	11796	133	150	12	47	161	50	24	25	Valles Rhy (Cerro del Medio)
111411-1	881	422	12584	135	164	14	43	164	56	35	28	Valles Rhy (Cerro del Medio)
111411-2	839	444	12993	111	179	13	46	175	56	23	16	Valles Rhy (Cerro del Medio)
111414-1	706	356	11627	72	149	9	46	170	56	26	25	Valles Rhy (Cerro del Medio)
111414-2	610	406	11983	97	168	11	43	164	56	29	25	Valles Rhy (Cerro del Medio)
111414-3	801	450	11729	132	203	10	61	171	88	32	20	Cerro Toledo Rhy
111414-4	798	376	11918	120	159	15	48	165	53	23	23	Valles Rhy (Cerro del Medio)
111414-5	723	398	11892	95	167	12	41	168	57	23	16	Valles Rhy (Cerro del Medio)
111414-6	820	407	12262	102	157	12	46	160	59	26	27	Valles Rhy (Cerro del Medio)
111414-7	709	383	12199	149	167	14	47	174	55	21	14	Valles Rhy (Cerro del Medio)
111414-8	784	465	11604	144	192	12	55	174	86	36	28	Cerro Toledo Rhy
111414-9	548	457	11883	115	207	11	64	179	99	34	21	Cerro Toledo Rhy
111414-10	887	416	11765	117	160	13	40	161	53	25	28	Valles Rhy (Cerro del Medio)
111414-11	736	514	12340	147	214	12	65	183	94	38	16	Cerro Toledo Rhy
111414-12	701	475	11910	125	213	12	56	176	95	32	31	Cerro Toledo Rhy
111414-13	658	488	12026	131	210	9	68	176	90	37	30	Cerro Toledo Rhy

111414-14	717	371	11577	138	155	12	39	153	48	24	15	Valles Rhy (Cerro del Medio)
111414-15	646	413	11835	100	176	20	41	168	51	24	17	Valles Rhy (Cerro del Medio)
111414-16	626	472	11879	129	208	13	60	177	94	34	28	Cerro Toledo Rhy
111414-17	650	442	11476	151	195	14	57	161	91	29	26	Cerro Toledo Rhy
111414-18	744	389	11665	127	159	15	46	162	54	20	24	Valles Rhy (Cerro del Medio)
111414-19	850	422	12142	108	170	11	51	163	52	30	14	Valles Rhy (Cerro del Medio)
111414-20	529	511	12189	131	217	12	64	176	94	40	23	Cerro Toledo Rhy
111414-21	721	387	11751	110	151	12	40	160	53	19	17	Valles Rhy (Cerro del Medio)
111417-1	603	395	11820	85	163	17	46	164	54	23	24	Valles Rhy (Cerro del Medio)
111417-2	882	474	12344	110	201	17	62	180	97	34	31	Cerro Toledo Rhy
111417-3	710	361	11229	89	147	14	40	156	46	21	21	Valles Rhy (Cerro del Medio)
111417-4	640	533	12538	151	215	9	68	180	97	36	24	Cerro Toledo Rhy
111417-5	546	347	10963	64	139	9	40	158	57	19	12	Valles Rhy (Cerro del Medio)
111417-6	830	380	11742	93	150	12	43	151	54	22	28	Valles Rhy (Cerro del Medio)
111417-7	520	478	11956	136	214	10	64	171	98	40	25	Cerro Toledo Rhy
111417-8	675	373	11877	113	156	14	40	165	50	28	20	Valles Rhy (Cerro del Medio)
111417-9	781	407	12065	113	168	14	45	172	52	26	22	Valles Rhy (Cerro del Medio)
111417-10	752	511	12022	159	202	12	63	174	86	37	25	Cerro Toledo Rhy
111417-11	876	431	12223	140	163	14	43	161	51	25	23	Valles Rhy (Cerro del Medio)

111418-1	635	525	12264	127	205	9	64	174	95	31	21	Cerro Toledo Rhy
111418-2	1097	393	12010	125	155	12	43	155	53	22	25	Valles Rhy (Cerro del Medio)
111419-1	754	395	12005	88	164	13	43	166	56	28	19	Valles Rhy (Cerro del Medio)
111420-1	563	374	11817	117	159	14	40	155	53	22	19	Valles Rhy (Cerro del Medio)
111420-2	1135	390	12704	119	155	19	42	160	45	23	27	Valles Rhy (Cerro del Medio)
111421-1	652	527	12432	187	213	10	64	179	95	38	15	Cerro Toledo Rhy
111421-2	772	370	11627	119	148	14	38	158	51	23	15	Valles Rhy (Cerro del Medio)
111421-3	487	496	12137	138	219	9	66	175	98	37	26	Cerro Toledo Rhy
111421-4	838	413	12370	123	166	13	41	169	57	22	27	Valles Rhy (Cerro del Medio)
111427-1	566	452	11876	103	201	9	66	176	97	34	22	Cerro Toledo Rhy
111427-2	691	425	11954	91	160	14	46	173	53	29	16	Valles Rhy (Cerro del Medio)
111428-1	802	435	12152	96	167	9	42	168	53	27	24	Valles Rhy (Cerro del Medio)
111428-2	1203	456	13653	101	158	16	44	165	52	28	24	Valles Rhy (Cerro del Medio)
111429-1	810	354	11981	88	151	13	38	157	54	24	26	Valles Rhy (Cerro del Medio)
111429-2	606	491	12153	134	219	12	62	173	90	30	20	Cerro Toledo Rhy
111431-1	604	567	12658	197	223	13	62	188	99	41	46	Cerro Toledo Rhy
111431-2	806	418	12252	173	165	14	45	160	50	26	21	Valles Rhy (Cerro del Medio)
111431-3	1098	395	11764	147	159	18	42	146	46	26	22	Valles Rhy (Cerro del Medio)
111431-4	771	536	12497	169	216	9	70	170	90	40	21	Cerro Toledo Rhy

111431-5	611	394	11718	86	162	14	45	168	53	25	15	Valles Rhy (Cerro del Medio)
111431-6	753	468	12071	157	200	13	63	185	90	29	29	Cerro Toledo Rhy
111431-7	613	341	11143	78	141	15	43	159	51	25	22	Valles Rhy (Cerro del Medio)
111431-8	677	428	12095	119	169	13	45	162	54	23	21	Valles Rhy (Cerro del Medio)
111432-1	677	389	11964	81	156	15	42	167	54	22	24	Valles Rhy (Cerro del Medio)
111432-2	558	477	11949	141	196	11	56	166	91	37	23	Cerro Toledo Rhy
111432-3	735	433	11709	178	173	13	54	152	84	30	18	Cerro Toledo Rhy
111439-1	796	420	11925	122	165	15	42	164	54	27	15	Valles Rhy (Cerro del Medio)
111439-2	659	555	12543	150	226	12	71	177	95	39	30	Cerro Toledo Rhy
111439-3	730	468	12337	156	171	11	41	163	58	26	23	Valles Rhy (Cerro del Medio)
111442-1	1290	397	11911	127	148	15	39	144	47	25	21	Valles Rhy (Cerro del Medio)
111442-2	1131	377	11793	126	142	15	38	144	51	23	26	Valles Rhy (Cerro del Medio)
111442-3	608	448	11654	120	200	11	51	164	95	38	23	Cerro Toledo Rhy
111442-4	1079	437	10200	165	180	14	57	163	87	29	21	Cerro Toledo Rhy
111442-5	552	409	12015	84	160	16	48	174	57	25	18	Valles Rhy (Cerro del Medio)
111443-1	1185	549	12974	232	211	14	64	165	86	41	34	Cerro Toledo Rhy
111443-2	1287	435	11578	226	179	15	53	155	78	29	18	Cerro Toledo Rhy
111443-3	885	439	12265	168	175	16	38	157	51	25	21	Valles Rhy (Cerro del Medio)
111443-4	698	580	12588	166	224	13	65	179	99	43	23	Cerro Toledo Rhy

111443-5	669	363	11871	144	160	14	47	157	49	23	22	Valles Rhy (Cerro del Medio)
111443-6	677	391	11887	89	165	12	48	172	55	30	17	Valles Rhy (Cerro del Medio)
111443-7	710	401	11866	120	163	16	44	173	56	28	30	Valles Rhy (Cerro del Medio)
111443-8	686	449	12444	127	176	17	49	170	58	29	27	Valles Rhy (Cerro del Medio)
111443-9	570	432	11705	99	193	11	67	173	91	31	19	Cerro Toledo Rhy
111443-10	747	437	12058	141	164	13	43	167	54	25	24	Valles Rhy (Cerro del Medio)
111445-1	737	416	11898	104	164	12	44	164	58	27	17	Valles Rhy (Cerro del Medio)
111450-1	646	397	11610	65	158	15	45	167	59	25	24	Valles Rhy (Cerro del Medio)
111450-2	644	437	12266	98	163	18	47	178	59	34	27	Valles Rhy (Cerro del Medio)
111452-1	756	447	12237	95	168	14	39	166	54	24	28	Valles Rhy (Cerro del Medio)
111456-1	982	482	12795	116	204	11	60	180	93	37	17	Cerro Toledo Rhy
111456-2	705	373	11855	137	160	15	41	159	53	23	14	Valles Rhy (Cerro del Medio)
111457-1	830	544	12541	162	223	14	69	174	96	37	33	Cerro Toledo Rhy
111457-2	761	443	12585	110	175	12	50	172	57	33	23	Valles Rhy (Cerro del Medio)
111457-3	894	518	12642	172	195	10	64	166	94	38	25	Cerro Toledo Rhy
111458-1	918	458	12555	129	161	20	40	166	57	20	25	Valles Rhy (Cerro del Medio)
111458-2	698	381	11685	104	172	13	42	163	53	30	28	Valles Rhy (Cerro del Medio)
111458-3	605	528	12423	156	220	14	66	180	100	35	21	Cerro Toledo Rhy
111458-4	734	436	12081	128	161	15	45	168	57	26	21	Valles Rhy (Cerro del Medio)

111458-5	782	428	10328	84	153	15	27	70	46	26	31	El Rechuelos
111459-1	713	399	11908	67	160	13	46	170	55	25	11	Valles Rhy (Cerro del Medio)
111459-2	866	479	12632	116	200	19	63	208	87	32	34	Cerro Toledo Rhy
111459-3	651	500	12222	166	204	10	66	180	98	32	26	Cerro Toledo Rhy
111459-4	781	396	12274	127	159	16	44	165	53	29	17	Valles Rhy (Cerro del Medio)
111459-5	693	551	12417	173	222	9	68	177	99	37	23	Cerro Toledo Rhy
111459-6	671	397	11940	121	159	13	40	162	54	26	20	Valles Rhy (Cerro del Medio)
111462-1	678	386	11942	99	164	13	41	165	55	24	19	Valles Rhy (Cerro del Medio)
111462-2	817	375	12178	120	157	18	43	168	50	27	27	Valles Rhy (Cerro del Medio)
111462-3	866	402	12365	111	170	14	39	162	49	21	22	Valles Rhy (Cerro del Medio)
111462-4	1124	379	11688	123	152	14	43	148	55	21	16	Valles Rhy (Cerro del Medio)
111470-1	683	421	11900	79	165	14	47	168	61	25	14	Valles Rhy (Cerro del Medio)
111474-1	544	552	12573	142	210	12	66	187	98	41	31	Cerro Toledo Rhy
111474-2	690	381	11865	129	161	14	43	161	50	26	27	Valles Rhy (Cerro del Medio)
111476-1	614	400	11612	90	161	15	46	169	51	27	9	Valles Rhy (Cerro del Medio)
111476-2	1007	363	11717	135	144	17	36	152	50	19	22	Valles Rhy (Cerro del Medio)
111476-3	810	444	12625	163	176	11	45	162	52	28	20	Valles Rhy (Cerro del Medio)
111476-4	766	374	11535	163	147	13	35	145	47	24	21	Valles Rhy (Cerro del Medio)
111479-1	712	393	11961	77	163	17	43	173	58	21	22	Valles Rhy (Cerro del Medio)

111479-2	753	426	12210	115	169	18	47	164	53	25	22	Valles Rhy (Cerro del Medio)
111479-3	741	376	11920	97	159	15	45	161	55	29	16	Valles Rhy (Cerro del Medio)
111479-4	775	536	12611	169	217	13	63	177	90	38	29	Cerro Toledo Rhy
111480-1	609	425	11997	133	162	11	45	159	47	28	23	Valles Rhy (Cerro del Medio)
111480-2	586	424	12085	125	161	11	48	157	52	22	27	Valles Rhy (Cerro del Medio)
111480-3	611	543	12085	134	210	9	63	172	95	36	28	Cerro Toledo Rhy
111481-1	680	384	11727	77	156	15	43	163	52	23	14	Valles Rhy (Cerro del Medio)
111481-2	784	402	12099	117	159	18	42	164	53	25	21	Valles Rhy (Cerro del Medio)
111481-3	1002	388	10215	105	140	14	23	72	41	22	17	El Rechuelos
111482-1	691	417	12016	120	167	18	43	162	46	24	25	Valles Rhy (Cerro del Medio)
111484-1	599	375	11524	92	154	13	42	168	54	20	9	Valles Rhy (Cerro del Medio)
111484-2	741	466	11878	155	189	13	58	168	87	34	15	Cerro Toledo Rhy
111484-3	687	394	11785	108	158	13	42	163	51	21	14	Valles Rhy (Cerro del Medio)
111484-4	862	398	11901	98	151	13	43	153	52	25	12	Valles Rhy (Cerro del Medio)
111484-5	613	535	12320	125	221	15	69	182	95	40	23	Cerro Toledo Rhy
111484-6	774	478	12840	120	182	15	47	174	56	31	20	Valles Rhy (Cerro del Medio)
111484-7	719	563	12677	241	248	15	64	172	92	40	28	Cerro Toledo Rhy
111488-1	908	389	12159	97	153	14	41	154	53	23	13	Valles Rhy (Cerro del Medio)
111489-1	974	418	12784	121	172	12	44	170	54	20	26	Valles Rhy (Cerro del Medio)

111490-1	674	370	11880	92	165	14	41	170	50	27	14	Valles Rhy (Cerro del Medio)
111490-2	594	444	12233	127	166	17	45	169	51	24	17	Valles Rhy (Cerro del Medio)
111490-3	796	595	12890	196	213	14	64	179	100	43	26	Cerro Toledo Rhy
111490-4	748	438	12241	123	168	15	48	167	56	28	36	Valles Rhy (Cerro del Medio)
111490-5	833	414	11774	145	171	13	38	151	50	22	7	Valles Rhy (Cerro del Medio)
111490-6	571	412	11913	123	163	13	43	161	51	26	24	Valles Rhy (Cerro del Medio)
111491-1	717	436	12281	106	168	12	49	163	57	32	20	Valles Rhy (Cerro del Medio)
111491-2	933	472	11944	148	204	14	58	166	80	33	30	Cerro Toledo Rhy
111492-1	565	364	11694	103	158	15	44	157	58	23	18	Valles Rhy (Cerro del Medio)
111492-2	771	381	11606	72	145	19	40	158	47	20	20	Valles Rhy (Cerro del Medio)
111492-3	1058	425	12468	160	164	13	43	164	53	28	13	Valles Rhy (Cerro del Medio)
111492-4	691	402	12077	145	159	16	49	162	50	25	14	Valles Rhy (Cerro del Medio)
111493-1	625	395	11772	77	158	14	45	163	53	27	19	Valles Rhy (Cerro del Medio)
111499-1	760	410	12271	102	172	12	43	170	57	26	17	Valles Rhy (Cerro del Medio)
111501-1	829	382	12229	106	155	15	42	160	50	29	22	Valles Rhy (Cerro del Medio)
111501-2	762	453	12206	113	168	13	45	172	56	30	18	Valles Rhy (Cerro del Medio)
111503-1	644	411	11883	105	160	11	42	183	55	27	21	Valles Rhy (Cerro del Medio)
111504-1	720	405	11980	89	162	13	42	161	59	24	15	Valles Rhy (Cerro del Medio)
111504-2	685	415	11716	86	156	18	44	171	52	25	14	Valles Rhy (Cerro del Medio)

111504-3	1027	467	11969	165	190	10	61	159	84	35	21	Cerro Toledo Rhy
111504-4	822	488	13069	149	189	13	50	171	53	33	23	Valles Rhy (Cerro del Medio)
111510-1	858	348	11139	90	139	13	43	159	58	16	15	Valles Rhy (Cerro del Medio)
111512-1	1397	365	13423	79	163	18	43	172	54	25	19	Valles Rhy (Cerro del Medio)
111515-1	681	383	11721	64	156	16	44	169	51	22	21	Valles Rhy (Cerro del Medio)
111516-1	711	516	12103	146	203	10	57	179	96	37	27	Cerro Toledo Rhy
111516-2	819	450	12106	161	179	18	55	162	78	33	22	Cerro Toledo Rhy
111517-1	808	391	11976	114	160	15	43	160	59	24	16	Valles Rhy (Cerro del Medio)
111518-1	1159	470	13471	134	199	14	60	168	87	33	33	Cerro Toledo Rhy
111518-2	1505	382	12950	154	142	18	40	148	48	27	17	Valles Rhy (Cerro del Medio)
111520-1	785	449	12317	126	173	15	49	165	59	31	26	Valles Rhy (Cerro del Medio)
111520-2	557	587	11808	83	115	90	22	82	55	30	9	Government Mtn, AZ
111523-1	952	519	12369	169	208	10	64	175	93	33	26	Cerro Toledo Rhy
111529-1	652	439	12029	92	170	14	46	169	54	21	15	Valles Rhy (Cerro del Medio)
111532-1	891	409	11818	149	158	17	39	160	46	24	13	Valles Rhy (Cerro del Medio)
111562-1	767	360	11605	100	154	14	38	157	47	22	19	Valles Rhy (Cerro del Medio)
111562-2	1140	458	13144	150	211	15	46	164	56	36	24	Valles Rhy (Cerro del Medio)
111572-1	782	396	11969	129	157	14	41	167	53	26	21	Valles Rhy (Cerro del Medio)
111576-1	738	570	12863	181	215	14	61	177	92	44	21	Cerro Toledo Rhy

111576-2	586	467	11608	141	195	12	57	164	89	28	24	Cerro Toledo Rhy
111576-3	589	484	12009	146	199	10	60	175	86	35	39	Cerro Toledo Rhy
111576-4	1156	376	11598	169	142	17	36	149	57	22	19	Valles Rhy (Cerro del Medio)
111576-5	569	458	11829	118	201	12	62	180	99	35	28	Cerro Toledo Rhy
111576-6	759	377	11921	90	161	12	43	166	56	29	18	Valles Rhy (Cerro del Medio)
111576-7	667	500	12145	118	207	13	66	181	101	40	28	Cerro Toledo Rhy
111576-8	650	502	12242	150	216	11	62	175	99	41	30	Cerro Toledo Rhy
111576-9	697	412	12072	102	167	11	49	171	51	25	21	Valles Rhy (Cerro del Medio)
111576-10	828	393	11706	172	149	13	39	152	51	18	13	Valles Rhy (Cerro del Medio)
111576-11	700	488	11816	140	196	9	58	178	97	35	16	Cerro Toledo Rhy
111576-12	702	412	11863	106	161	14	39	165	51	27	19	Valles Rhy (Cerro del Medio)
111576-13	785	400	11894	92	156	15	45	164	51	22	22	Valles Rhy (Cerro del Medio)
111576-14	951	552	13104	217	207	12	67	167	91	42	22	Cerro Toledo Rhy
111576-15	1079	519	12246	185	206	16	58	166	82	35	26	Cerro Toledo Rhy
111576-16	1088	504	12436	220	204	9	57	168	84	31	26	Cerro Toledo Rhy
111576-17	717	509	12152	170	213	10	61	178	95	35	28	Cerro Toledo Rhy
111576-18	955	388	12149	118	165	15	39	170	51	25	25	Valles Rhy (Cerro del Medio)
111577-1	789	366	11854	117	150	12	41	158	55	26	26	Valles Rhy (Cerro del Medio)
111577-2	714	486	11908	187	197	11	59	174	86	33	23	Valles Rhy (Cerro del Medio)

111577-3	671	554	12444	175	219	12	63	174	92	38	31	Cerro Toledo Rhy
111577-4	577	508	11918	126	208	9	62	178	94	36	31	Cerro Toledo Rhy
111577-5	1110	363	11845	192	141	16	39	149	42	22	21	Valles Rhy (Cerro del Medio)
111577-6	638	425	12031	101	161	15	42	159	50	26	13	Valles Rhy (Cerro del Medio)
111577-7	886	578	12846	199	207	13	57	176	88	36	21	Cerro Toledo Rhy
111577-8	552	522	12361	150	220	10	66	172	99	39	29	Cerro Toledo Rhy
111577-9	601	540	12491	138	227	11	68	181	99	42	33	Cerro Toledo Rhy
111577-10	717	353	11878	131	155	15	42	155	48	22	8	Valles Rhy (Cerro del Medio)
111577-11	805	525	12188	187	214	12	62	180	81	35	12	Cerro Toledo Rhy
111577-12	804	412	12076	118	163	14	46	163	54	25	14	Valles Rhy (Cerro del Medio)
111577-13	805	535	12271	186	219	14	61	176	91	37	25	Cerro Toledo Rhy
111577-14	701	378	11687	157	155	12	43	162	49	24	20	Valles Rhy (Cerro del Medio)
111577-15	619	424	12182	102	182	13	46	166	57	29	26	Valles Rhy (Cerro del Medio)
111577-16	705	413	11981	115	210	18	43	163	52	22	18	Valles Rhy (Cerro del Medio)
111577-17	711	610	12860	192	228	16	68	183	96	32	29	Cerro Toledo Rhy
111577-18	639	484	11984	140	203	12	63	177	92	32	25	Cerro Toledo Rhy
111587-1	930	499	12988	139	198	16	46	185	51	32	23	Valles Rhy (Cerro del Medio)
111587-2	880	418	12581	157	161	14	45	160	55	28	26	Valles Rhy (Cerro del Medio)
111587-3	929	479	12989	151	200	11	63	174	89	37	24	Cerro Toledo Rhy

111587-4	836	472	12160	146	186	10	61	170	90	36	23	Cerro Toledo Rhy
111587-5	1237	389	13194	126	160	18	43	155	47	28	16	Valles Rhy (Cerro del Medio)
111588-1	673	411	11995	137	169	16	43	164	54	29	25	Valles Rhy (Cerro del Medio)
111588-2	936	398	12141	128	149	23	43	158	43	21	26	Valles Rhy (Cerro del Medio)
111588-3	927	370	11892	161	141	17	35	159	47	20	19	Valles Rhy (Cerro del Medio)
111588-4	687	410	12056	87	170	12	46	162	45	30	28	Valles Rhy (Cerro del Medio)
111608-1	645	403	12113	101	162	11	46	169	57	30	22	Valles Rhy (Cerro del Medio)
111622-1	907	503	12071	158	198	9	67	168	90	31	20	Cerro Toledo Rhy
111631-1	649	412	12163	83	169	13	44	170	47	28	27	Valles Rhy (Cerro del Medio)
111631-2	697	498	12172	125	210	10	68	183	104	32	26	Cerro Toledo Rhy
111638-1	875	407	12267	110	155	12	43	165	51	30	29	Valles Rhy (Cerro del Medio)
111645-1	558	471	11636	114	198	11	66	173	94	34	26	Cerro Toledo Rhy
111645-2	685	548	12389	151	230	11	71	186	93	46	27	Cerro Toledo Rhy
111648-1	873	528	12317	175	204	10	61	184	90	35	24	Cerro Toledo Rhy
111648-2	632	392	11756	85	155	15	46	169	52	25	19	Valles Rhy (Cerro del Medio)
111648-3	871	362	11709	119	149	14	41	162	53	18	24	Valles Rhy (Cerro del Medio)
111650-1	1125	426	12842	88	156	16	40	166	53	25	25	Valles Rhy (Cerro del Medio)
111683-1	765	411	12054	103	170	20	47	166	61	22	22	Valles Rhy (Cerro del Medio)
111688-1	817	396	12041	81	164	19	44	172	55	27	23	Valles Rhy (Cerro del Medio)

111689-1	610	380	11736	83	156	16	41	167	56	23	22	Valles Rhy (Cerro del Medio)
111689-2	666	396	11813	134	155	11	43	160	53	26	19	Valles Rhy (Cerro del Medio)
111689-3	1212	411	12097	163	151	15	43	159	57	20	22	Valles Rhy (Cerro del Medio)
111689-4	733	369	11862	105	157	13	49	161	51	23	21	Valles Rhy (Cerro del Medio)
111689-5	914	506	12658	151	197	20	47	167	50	28	24	Valles Rhy (Cerro del Medio)
111696-1	876	475	12939	159	183	19	44	170	56	28	23	Valles Rhy (Cerro del Medio)
111702-1	706	376	11662	92	157	13	43	161	53	25	15	Valles Rhy (Cerro del Medio)
111706-1	881	500	13319	122	187	17	50	182	59	29	15	Valles Rhy (Cerro del Medio)
111707-1	936	439	12088	120	164	14	46	169	60	31	31	Valles Rhy (Cerro del Medio)
111709-1	722	399	11932	115	161	14	44	171	52	26	12	Valles Rhy (Cerro del Medio)
111709-2	660	368	11611	114	155	13	41	160	51	21	28	Valles Rhy (Cerro del Medio)
111709-3	343	586	11586	197	523	10	91	135	233	54	36	Horace/La Jara Mesa-Mt Taylor
111711-1	746	392	11974	89	168	15	44	167	55	20	15	Valles Rhy (Cerro del Medio)
111711-2	844	431	12356	135	170	17	39	166	57	24	26	Valles Rhy (Cerro del Medio)
111711-3	619	404	12054	100	169	17	51	167	54	24	30	Valles Rhy (Cerro del Medio)
111713-1	599	402	11896	135	165	15	43	163	53	26	27	Valles Rhy (Cerro del Medio)
111713-2	649	442	11812	109	203	9	58	179	95	34	19	Cerro Toledo Rhy
111713-3	412	523	11725	89	120	88	17	86	49	36	10	Government Mtn, AZ
111713-4	549	474	11769	111	199	11	64	173	103	37	27	Cerro Toledo Rhy

111713-5	926	544	12381	179	219	10	62	172	86	36	17	Cerro Toledo Rhy
111713-6	704	425	12328	101	169	16	49	172	59	29	26	Valles Rhy (Cerro del Medio)
111713-7	630	418	11859	104	160	14	43	162	52	22	20	Valles Rhy (Cerro del Medio)
111713-8	893	391	11676	120	174	15	45	162	58	26	17	Valles Rhy (Cerro del Medio)
111732-1	516	457	11848	141	197	11	62	175	94	30	25	Cerro Toledo Rhy
111737-1	744	512	12421	169	214	10	67	166	90	36	23	Cerro Toledo Rhy
111737-2	834	425	12448	128	168	15	43	176	57	27	26	Valles Rhy (Cerro del Medio)
111756-1	601	380	11705	70	159	14	42	159	55	23	23	Valles Rhy (Cerro del Medio)
111767-1	673	379	11929	84	152	15	42	155	53	17	20	Valles Rhy (Cerro del Medio)
111768-1	574	436	11879	147	161	12	43	169	52	25	14	Valles Rhy (Cerro del Medio)
111768-2	796	409	12007	144	165	12	41	155	52	30	19	Valles Rhy (Cerro del Medio)
111768-3	636	535	12168	182	204	9	63	173	90	33	17	Cerro Toledo Rhy
111768-4	738	400	11732	139	147	14	44	162	50	25	15	Valles Rhy (Cerro del Medio)
111769-1	500	544	11727	90	114	82	18	86	52	35	5	Government Mtn, AZ
111769-2	702	504	11829	147	212	9	65	174	90	35	26	Cerro Toledo Rhy
111769-3	797	408	11926	114	164	15	44	163	50	23	24	Valles Rhy (Cerro del Medio)
111769-4	837	434	12672	138	170	11	44	168	52	28	18	Valles Rhy (Cerro del Medio)
111788-1	694	375	11808	85	165	10	47	169	52	26	20	Valles Rhy (Cerro del Medio)
111789-1	410	477	11357	87	111	84	21	84	49	32	11	Government Mtn, AZ

111789-2	681	516	12289	106	204	9	61	175	99	38	26	Cerro Toledo Rhy
111790-1	568	449	11417	142	180	9	63	162	85	27	22	Cerro Toledo Rhy
111790-2	633	521	12189	157	213	10	67	180	95	39	32	Cerro Toledo Rhy
111790-3	705	449	12093	118	168	14	44	163	53	25	19	Valles Rhy (Cerro del Medio)
111794-1	599	385	11946	116	165	14	41	160	56	22	22	Valles Rhy (Cerro del Medio)
111794-2	577	374	11370	75	150	9	47	160	51	24	19	Valles Rhy (Cerro del Medio)
111795-1	727	442	12383	99	169	16	45	165	58	24	26	Valles Rhy (Cerro del Medio)
111796-1	569	472	11736	102	202	14	63	177	95	34	36	Cerro Toledo Rhy
111802-1	946	392	12122	129	159	17	41	160	49	26	25	Valles Rhy (Cerro del Medio)
111803-1	658	518	12278	130	210	9	65	178	101	37	28	Cerro Toledo Rhy
111810-1	655	340	11481	73	159	15	45	162	61	21	13	Valles Rhy (Cerro del Medio)
111819-1	520	468	11721	110	205	10	60	172	98	35	21	Cerro Toledo Rhy
111820-1	682	518	12228	128	225	10	68	185	96	48	28	Cerro Toledo Rhy
111829-1	666	406	11796	66	167	14	46	168	57	20	23	Valles Rhy (Cerro del Medio)
111829-2	670	357	11751	100	159	14	40	162	58	27	19	Valles Rhy (Cerro del Medio)
111833-1	482	524	11904	107	208	11	67	183	93	32	25	Cerro Toledo Rhy
111839-1	660	402	11841	97	159	13	45	171	56	23	19	Valles Rhy (Cerro del Medio)
111839-2	850	467	12496	153	178	10	48	170	55	29	29	Valles Rhy (Cerro del Medio)
111839-3	632	513	12084	110	207	13	63	179	96	32	29	Cerro Toledo Rhy

111842-1	431	507	11507	99	110	82	18	83	48	29	14	Government Mtn, AZ
111842-2	794	453	12473	117	171	14	47	173	57	33	26	Valles Rhy (Cerro del Medio)
111846-1	819	443	12326	119	161	15	44	173	55	26	17	Valles Rhy (Cerro del Medio)
111847-1	581	370	11289	64	145	14	44	156	52	24	24	Valles Rhy (Cerro del Medio)
111855-1	644	366	11454	73	159	13	46	162	49	26	18	Valles Rhy (Cerro del Medio)
111857-1	537	538	12586	153	218	9	68	182	98	36	21	Cerro Toledo Rhy
111857-2	570	490	11867	172	193	12	57	172	89	35	18	Cerro Toledo Rhy
111859-1	668	570	12631	115	223	9	70	182	94	36	25	Cerro Toledo Rhy
111862-1	650	500	12259	145	211	12	63	182	96	42	22	Cerro Toledo Rhy
111868-1	954	410	10923	93	164	14	44	169	55	26	20	Valles Rhy (Cerro del Medio)
111868-2	633	415	12010	83	166	11	48	173	61	25	17	Valles Rhy (Cerro del Medio)
111870-1	510	422	11445	123	182	10	57	158	84	30	31	Cerro Toledo Rhy
111870-2	603	398	11750	109	158	13	42	166	55	24	22	Valles Rhy (Cerro del Medio)
111870-3	628	494	12278	130	224	9	66	190	102	39	24	Cerro Toledo Rhy
111872-1	557	461	11746	107	205	9	63	177	98	35	21	Cerro Toledo Rhy
111875-1	535	522	12142	147	211	10	70	178	100	40	25	Cerro Toledo Rhy
111877-1	594	500	11973	123	206	11	65	177	102	32	29	Cerro Toledo Rhy
111880-1	1048	455	12653	179	175	13	47	181	55	37	33	Valles Rhy (Cerro del Medio)
111881-1	613	431	12112	79	170	14	46	175	58	28	29	Valles Rhy (Cerro del Medio)

111884-1	859	421	12102	106	159	17	43	168	54	26	22	Valles Rhy (Cerro del Medio)
111887-1	579	362	11288	64	150	15	45	159	54	27	17	Valles Rhy (Cerro del Medio)
111890-1	591	373	11459	63	152	13	41	162	57	23	16	Valles Rhy (Cerro del Medio)
111890-2	1107	483	12930	256	194	9	58	170	91	33	28	Cerro Toledo Rhy
111893-1	547	470	11786	109	206	10	64	179	93	41	19	Cerro Toledo Rhy
111893-2	578	394	11577	83	156	12	41	171	51	28	21	Valles Rhy (Cerro del Medio)
111895-1	622	356	11724	75	148	15	42	155	52	20	18	Valles Rhy (Cerro del Medio)
111895-2	624	400	11845	110	168	10	45	169	51	28	21	Valles Rhy (Cerro del Medio)
111901-1	492	374	11353	61	152	11	45	162	52	24	13	Valles Rhy (Cerro del Medio)
111901-2	686	399	12080	87	165	11	43	168	50	23	17	Valles Rhy (Cerro del Medio)
111905-1	633	498	12272	152	201	11	65	169	92	34	39	Cerro Toledo Rhy
111906-1	721	393	11763	72	157	15	43	170	50	21	23	Valles Rhy (Cerro del Medio)
111907-1	772	385	11537	107	149	13	43	150	51	24	19	Valles Rhy (Cerro del Medio)
111908-1	2690	387	11153	86	189	11	55	170	85	31	24	Cerro Toledo Rhy
111909-1	740	425	12127	81	161	16	46	160	55	24	27	Valles Rhy (Cerro del Medio)
111909-2	680	405	11728	82	158	14	46	167	56	22	19	Valles Rhy (Cerro del Medio)
111915-1	831	468	12761	79	175	15	45	178	63	27	26	Valles Rhy (Cerro del Medio)
111922-1	635	534	12216	111	211	11	69	185	96	33	28	Cerro Toledo Rhy
111924-1	762	395	12062	96	164	14	44	172	48	26	22	Valles Rhy (Cerro del Medio)

111926-1	676	397	11667	85	160	15	45	167	57	23	14	Valles Rhy (Cerro del Medio)
111935-1	674	361	11754	84	163	15	42	164	59	25	16	Valles Rhy (Cerro del Medio)
111935-2	652	411	12027	90	166	13	47	177	59	27	27	Valles Rhy (Cerro del Medio)
111939-1	642	382	11469	89	155	13	43	161	53	25	23	Valles Rhy (Cerro del Medio)
111939-2	827	498	12676	87	175	14	45	173	57	29	21	Valles Rhy (Cerro del Medio)
111944-1	673	428	12275	92	176	13	50	166	54	34	17	Valles Rhy (Cerro del Medio)
111950-1	694	401	11982	84	151	9	43	160	47	23	15	Valles Rhy (Cerro del Medio)
111952-1	535	448	11556	98	195	10	61	174	94	32	27	Cerro Toledo Rhy
111955-1	1119	359	11767	91	136	11	39	156	50	21	23	Valles Rhy (Cerro del Medio)
111960-1	515	344	11251	69	145	12	40	151	52	18	19	Valles Rhy (Cerro del Medio)
111962-1	543	385	11762	86	160	13	44	176	61	23	15	Valles Rhy (Cerro del Medio)
111963-1	676	382	11791	77	161	12	47	166	51	21	22	Valles Rhy (Cerro del Medio)
111966-1	795	482	11794	136	198	10	63	164	91	36	28	Cerro Toledo Rhy
111967-1	1124	471	13245	71	165	19	40	174	57	20	28	Valles Rhy (Cerro del Medio)
111972-1	659	489	12009	108	205	11	69	178	99	37	30	Cerro Toledo Rhy
111976-1	535	402	11744	83	161	14	46	162	55	32	23	Valles Rhy (Cerro del Medio)
111988-1	726	420	12173	124	172	15	44	162	54	23	26	Valles Rhy (Cerro del Medio)
111989-1	705	388	12134	67	161	17	42	166	61	25	21	Valles Rhy (Cerro del Medio)
111994-1	649	351	11283	59	143	12	40	157	50	22	24	Valles Rhy (Cerro del Medio)

111994-2	615	423	11915	72	161	14	42	173	53	23	18	Valles Rhy (Cerro del Medio)
111997-1	683	489	12063	129	210	13	66	175	96	37	35	Cerro Toledo Rhy
112001-1	773	416	12038	92	162	14	46	174	53	23	20	Valles Rhy (Cerro del Medio)
112007-1	719	370	11478	121	156	13	43	163	46	25	19	Valles Rhy (Cerro del Medio)
112007-2	704	402	11713	71	164	17	41	171	56	20	16	Valles Rhy (Cerro del Medio)
112009-1	592	451	11683	100	197	10	62	174	95	28	26	Cerro Toledo Rhy
112012-1	982	403	11719	119	148	11	41	162	49	22	12	Valles Rhy (Cerro del Medio)
112013-1	794	426	12416	71	163	16	46	168	60	24	26	Valles Rhy (Cerro del Medio)
112016-1	518	461	11549	93	193	9	58	170	98	30	26	Cerro Toledo Rhy
112019-1	608	378	11609	62	157	14	43	169	62	24	32	Valles Rhy (Cerro del Medio)
112021-1	810	443	12202	135	165	17	43	166	58	30	19	Valles Rhy (Cerro del Medio)
112028-1	759	499	12072	147	207	12	62	178	93	32	29	Cerro Toledo Rhy
112029-1	1215	406	12846	98	156	15	42	166	51	23	19	Valles Rhy (Cerro del Medio)
112038-1	652	386	11628	74	151	13	46	163	52	23	14	Valles Rhy (Cerro del Medio)
112047-1	722	399	11638	62	158	13	40	165	52	23	13	Valles Rhy (Cerro del Medio)
112047-2	607	398	11844	71	161	12	48	176	60	24	17	Valles Rhy (Cerro del Medio)
112048-1	730	374	11707	69	155	15	47	163	54	22	25	Valles Rhy (Cerro del Medio)
112054-1	566	526	12348	125	222	10	70	183	98	40	40	Cerro Toledo Rhy
112059-1	737	485	11803	149	193	13	66	169	91	31	32	Cerro Toledo Rhy

112067-1	717	405	12075	111	163	13	43	165	58	23	23	Valles Rhy (Cerro del Medio)
112070-1	884	402	12320	75	162	16	42	160	49	24	14	Valles Rhy (Cerro del Medio)
112073-1	709	401	12140	90	168	14	46	173	55	23	19	Valles Rhy (Cerro del Medio)
112073-2	671	502	12009	105	213	11	63	188	101	35	28	Cerro Toledo Rhy
112079-1	614	511	12022	198	496	15	92	131	225	55	38	Horace/La Jara Mesa-Mt Taylor
112117-1	921	432	12326	127	167	15	47	157	55	29	12	Valles Rhy (Cerro del Medio)
112149-1	829	465	12349	99	194	16	57	170	89	31	29	Cerro Toledo Rhy
112188-1	657	402	11885	69	168	14	45	171	64	26	28	Valles Rhy (Cerro del Medio)
112189-1	650	418	12095	84	169	18	41	170	54	27	32	Valles Rhy (Cerro del Medio)
112193-1	553	337	10983	65	136	16	41	152	52	21	18	Valles Rhy (Cerro del Medio)
112199-1	626	367	11699	70	160	15	40	172	58	25	24	Valles Rhy (Cerro del Medio)
112206-1	576	464	12007	131	210	10	64	179	100	36	28	Cerro Toledo Rhy
112219-1	820	406	12011	92	169	16	41	167	51	28	27	Valles Rhy (Cerro del Medio)
112220-1	714	419	11982	116	158	14	44	168	62	26	23	Valles Rhy (Cerro del Medio)
112225-1	649	387	11417	62	156	12	40	160	52	19	20	Valles Rhy (Cerro del Medio)
112251-1	678	402	11702	74	155	15	43	161	55	24	27	Valles Rhy (Cerro del Medio)
112251-2	614	415	11884	75	169	13	49	173	59	23	18	Valles Rhy (Cerro del Medio)
112252-1	647	435	12126	78	167	14	47	174	59	27	22	Valles Rhy (Cerro del Medio)
113197-1	649	365	11791	85	160	15	45	165	49	25	25	Valles Rhy (Cerro del Medio)

113228-1	841	375	12185	108	162	17	47	164	55	27	15	Valles Rhy (Cerro del Medio)
113249-1	722	374	11448	76	250	23	43	111	31	33	34	Antelope Cr-Mule Creek
113252-1	1239	384	13142	100	162	22	41	165	51	26	27	Valles Rhy (Cerro del Medio)
113255-1	473	561	11894	210	521	11	91	141	220	60	32	Horace/La Jara Mesa-Mt Taylor
113264-1	812	402	11775	93	243	22	44	115	24	27	28	Antelope Cr-Mule Creek
113265-1	592	372	10149	41	152	15	22	71	47	22	28	El Rechuelos
113268-1	625	493	12027	136	200	12	68	170	92	33	19	Cerro Toledo Rhy
113274-1	794	481	12255	149	205	10	60	174	92	39	23	Cerro Toledo Rhy
113276-1	447	642	11896	232	562	12	100	140	229	66	29	Horace/La Jara Mesa-Mt Taylor
113279-1	510	526	11374	100	104	81	20	81	52	29	10	Government Mtn, AZ
113282-1	635	414	10166	47	145	13	24	77	40	24	14	El Rechuelos
113286-1	544	394	10220	53	157	16	26	80	44	21	19	El Rechuelos
113299	640	444	11887	109	208	9	69	183	98	34	24	Cerro Toledo Rhy
113302-1	494	609	11815	244	529	11	91	141	225	62	28	Horace/La Jara Mesa-Mt Taylor
113305-1	826	401	12009	102	163	15	41	166	53	27	28	Valles Rhy (Cerro del Medio)
113322-1	1272	384	11793	224	145	12	39	140	48	25	21	Valles Rhy (Cerro del Medio)
113323-1	706	395	10552	88	162	14	22	74	45	25	28	El Rechuelos
113329-1	644	398	10158	49	154	17	22	72	47	26	24	El Rechuelos
113330-1	711	567	10686	86	176	17	37	70	41	35	23	El Rechuelos

113332-1	33730	411	11553	73	102	82	18	80	52	30	18	Government Mtn, AZ
113333-1	794	549	11833	84	114	84	18	84	48	34	5	Government Mtn, AZ
131443-1	614	870	8730	40	0	32	1	19	1	1	5	not obsidian

Table 4. Frequency distribution of obsidian source provenance in the East, Middle, and West Trench assemblage. Non-obsidian artifacts omitted.

		Frequency	Percent
Source	Valles Rhy (Cerro del Medio)	290	63.9
	Cerro Toledo Rhy	139	30.6
	El Rechuelos	8	1.8
	Horace/La Jara Mesa-Mt Taylor	6	1.3
	Antelope Cr-Mule Creek	2	.4
	Government Mtn, AZ	8	1.8
	Wild Horse Canyon, UT	1	.2
	Total	454	100.0

Table 5. Recommended values for USGS RGM-1 obsidian and G-2 granite pressed powder standards and mean and central tendency from this study of those standards. ± = 1st standard deviation.

SAMPLE	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
RGM-1 (USGS recommended)[1]	279±50	13010±210	32[2]	150±8	110±10	25[2]	220±20	8.9±0.6	810±46	24±3	15±1.3
RGM-1, pressed powder standard (this study, n=19)	304±16	13668±55	16±4	144±2	105±2	23±2	214±3	8.8±2.5	nm	22±1.8	14±3.4
G-2 (USGS recommended)	232±77	18605±1189	86±8	170±3	478±2	11±2	309±35	12[2]	1880	30±4	25±2
G-2, pressed powder standard (this study, n=10)	288±13	16128±73	90±4	168±3	465±6	12±3	284±5	12±3	nm	23±2	26±3

[1] Mn, Fe calculated to ppm from wt. percent from USGS data.
[2] information value
nm = not measured in this study

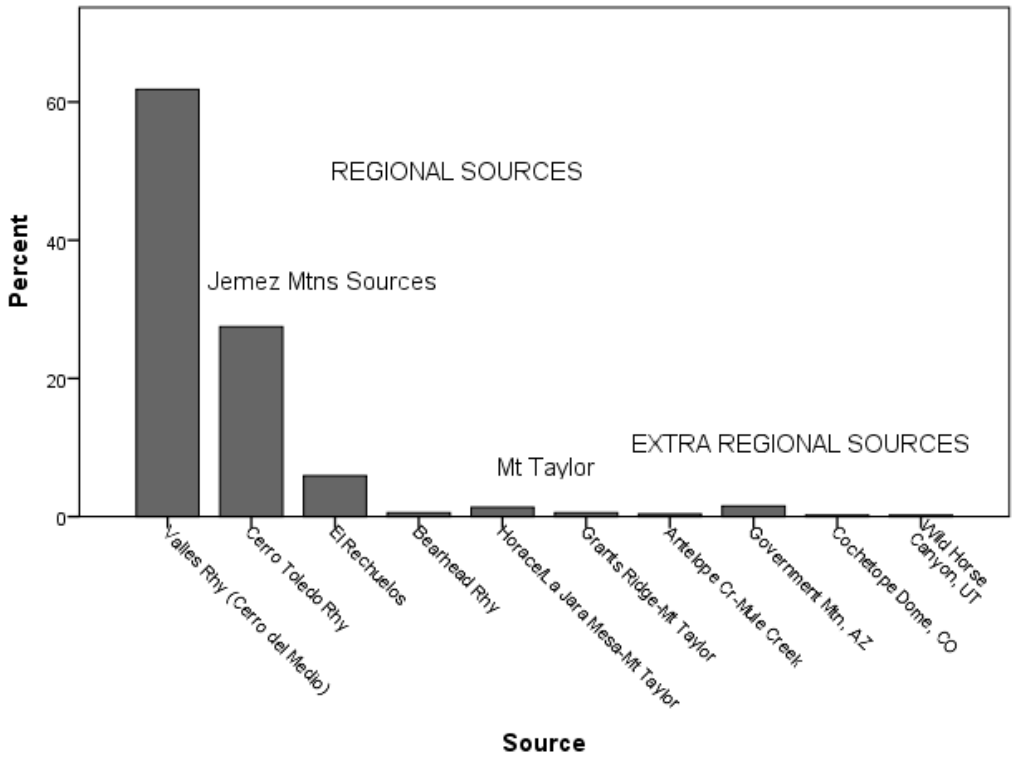


Figure 1. Histogram of source provenance data from all contexts.

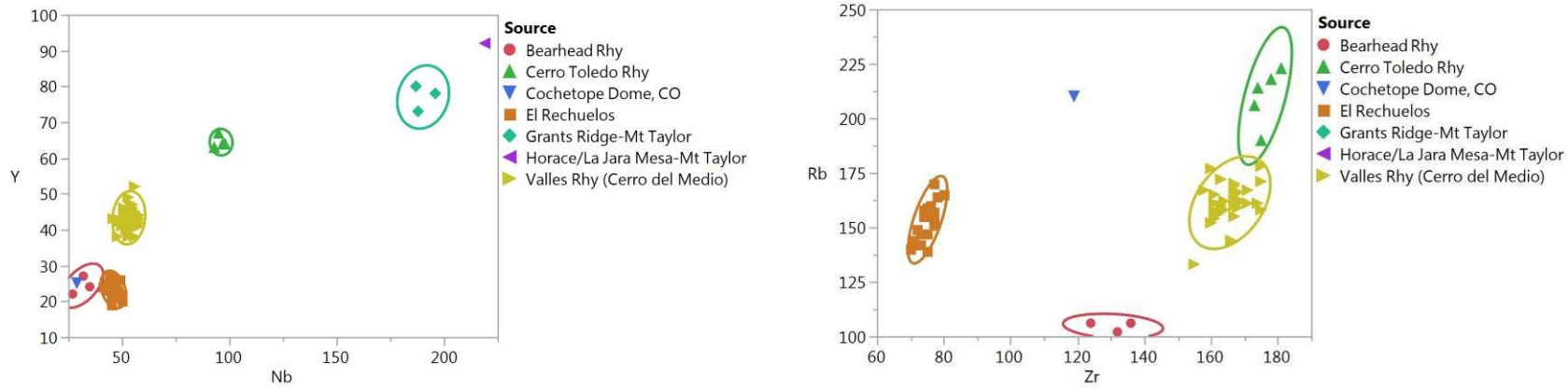


Figure 2. Nb/Y bivariate plot (left top) of all Archaic samples effectively discriminating, Horace/La Jara Mesa, Grants Ridge, Cerro Toledo, and Valles Rhyolite; Zr/Rb bivariate plot of the high Sr group Archaic samples (right top) providing better discrimination El Rechuelos, Bearhead Rhyolite, and the one Cochetope (Cochetopa) Dome, Colorado. Confidence ellipses at 95%.

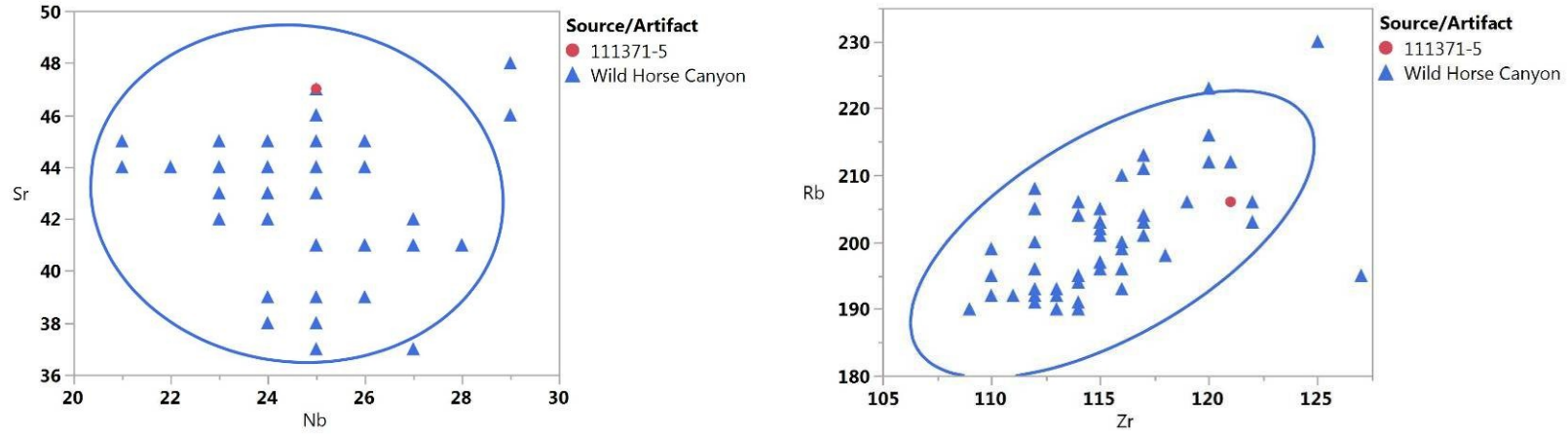


Figure 3. Nb/Sr bivariate plot of Wild Horse Canyon source standards and artifact 111371-5 (left); and Zr/Sr bivariate plot of the Wild Horse Canyon source standards and the artifact (right). Confidence ellipses at 95%.

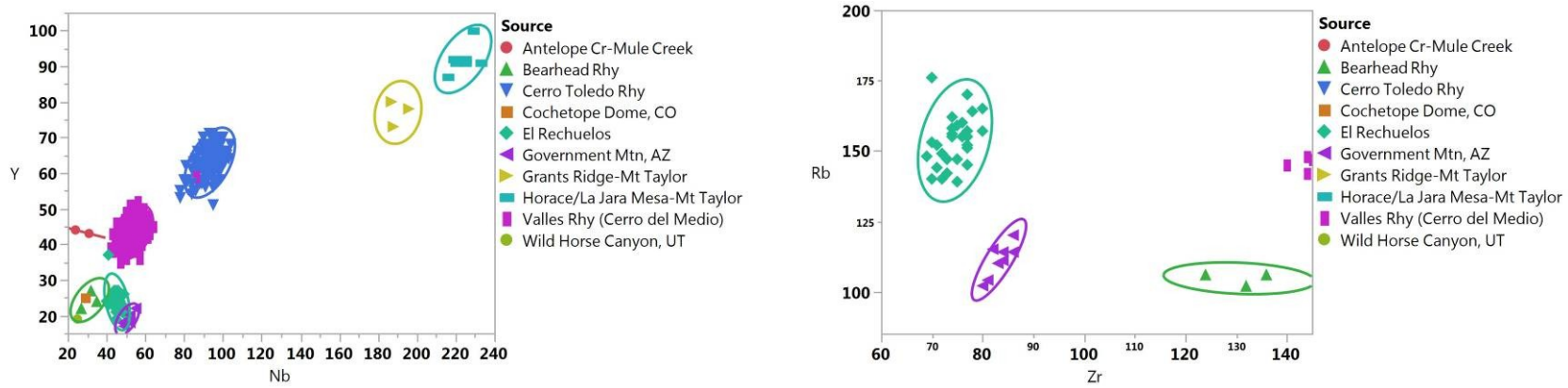


Figure 4. Nb/Y bivariate plot of all the Late Period samples effectively discriminating the Mount Taylor source localities, Cerro Toledo Rhyolite and Valles Rhyolite (Cerro del Medio), and Antelope Creek (left). Zr/Rb bivariate plot of the Late Period samples effectively discriminating the relatively high Sr El Rechuelos, Government Mountain, and Bearhead Rhyolite. Confidence ellipses at 95%.



Figure 5. Sample of Archaic period projectile points from the assemblage and source provenance.

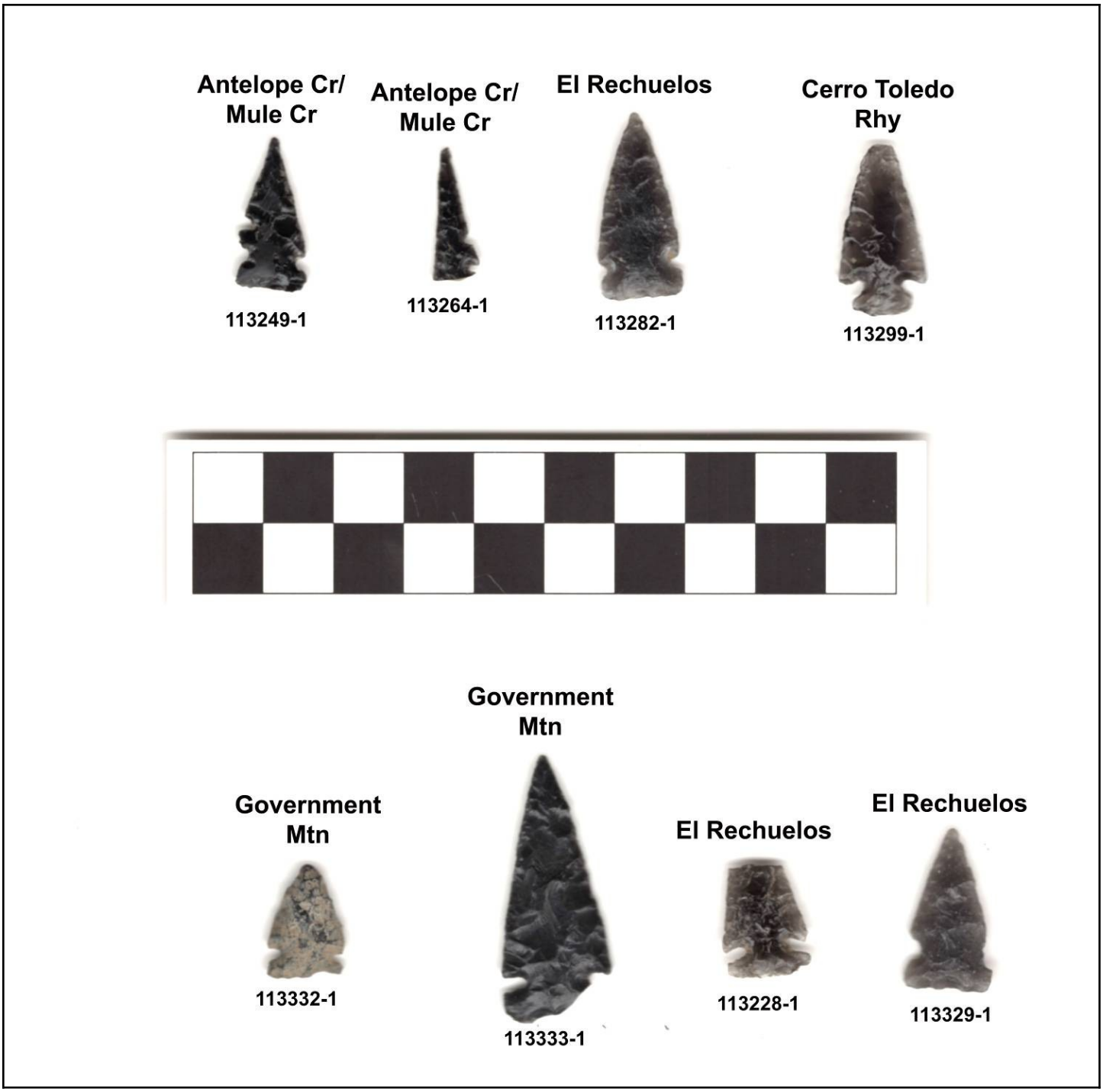


Figure 6. Sample of Late Period obsidian projectile points and source provenance. Sample 11332-1, bottom row appears to be burned.