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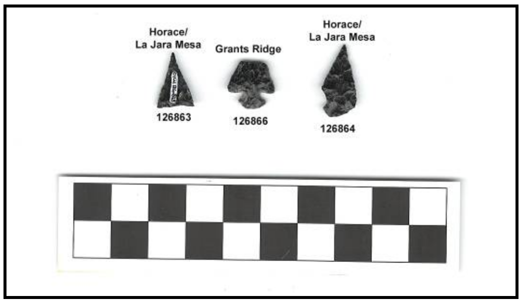

Three projectile point fragments from the site, all produced from Mount Taylor sources, as is much of the debitage in the site (to approximate scale)

by

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Report Prepared for

Chaco Culture National Historic Park
Nageezi, New Mexico

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INTRODUCTION

The analysis here of 63 artifacts from a BMIII site at Chaco Culture National History Park, northwest New Mexico indicates a diverse obsidian provenance assemblage dominated by northern New Mexico Jemez Lineament obsidian sources, particularly those in the southern Jemez Mountains (Canovas Canyon Rhyolite - 48.3%, and the two sources in the Mount Taylor Volcanic Field (Horace/La Jara Mesa - 31.7%, and Grants Ridge - 10%). A few of the artifacts were produced from three other Jemez Mountains sources (Valles Rhyolite-Cerro del Medio, n=4; and Cerro Toledo Rhyolite and El Rechuelos, one each). Based on the obsidian source provenance, the results suggest a relatively large procurement range/interaction sphere, and habitation of this site possibly after movement from the south and/or east (see discussion).

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

All archaeological samples are analyzed whole. The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984; Shackley 2011).

All analyses for this study were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer, located in the Geoarchaeological XRF Laboratory, Albuquerque, New Mexico. It is equipped with a thermoelectrically Peltier cooled solid-state Si(Li) X-ray detector, with a 50 kV, 50 W, ultra-high-flux end window bremsstrahlung, Rh target X-ray tube and a 76 µm (3 mil) beryllium (Be) window (air cooled), that runs on a power supply operating 4-50 kV/0.02-1.0 mA at 0.02 increments. The spectrometer is equipped with a 200 l min^{-1} Edwards vacuum pump, allowing for the analysis of lower-atomic-weight elements between sodium (Na) and titanium

(Ti). Data acquisition is accomplished with a pulse processor and an analogue-to-digital converter. Elemental composition is identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities and net peak intensities above background.

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 100 or 200 seconds livetime, depending on artifact size (Davis et al. 2011) to generate x-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (as $Fe_2O_3^T$), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). Not all these elements are reported since their values in many volcanic rocks are very low. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements. When barium (Ba) is acquired in the High Zb condition, the Rh tube is operated at 50 kV and up to 1.0 mA, ratioed to the bremsstrahlung region (see Davis 2011; Shackley 2011). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1995, 2005; also Mahood and Stimac 1991; and Hughes and Smith 1993). Nineteen specific pressed powder standards are used for the best fit regression calibration for elements Ti-Nb, Pb, Th, and Ba, include G-2 (basalt), AGV-2 (andesite), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (hawaiite), STM-1 (syenite), QLO-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), NOD-A-1 and NOD-P-1 (manganese) all US Geological Survey standards, NIST-278 (obsidian), U.S. National Institute of Standards and Technology, BE-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France, and JR-1 and JR-2 (obsidian) from the Geological Survey of Japan (Govindaraju 1994).

The data from the WinTrace™ software were translated directly into Excel for Windows for manipulation and on into SPSS™ 21.0 for Windows and JMP™ 4.0.1 for Windows for statistical analyses. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 a USGS obsidian standard is analyzed during each sample run for obsidian artifacts to check machine calibration (Table 1). Source assignments were made with reference to Shackley (1995, 1998, 2005, 2009), Shackley et al. (2016) and source standard data at this lab (Table 1, and Figures 1 and 2). Many of the samples were near or below the minimum size to insure confident source assignment (Davis et al. 2011). Longer counts and acquisition of Ba was used to mitigate this issue (see Davis et al. 2011; Shackley2011).

DISCUSSION

As noted above, all of the artifacts were produced from obsidian sources well to the south and east of Chaco Canyon, dominated by Canovas Canyon Rhyolite, also called Bear Springs Peak (over 125 linear km east), and the two sources in the Mount Taylor Volcanic Field (about 100 km south; Tables 1 and 2, and Figures 3 and 4). This is a minimum procurement range for these Basketmaker III knappers that is over a 125 linear km radius east and south, not unusual in Archaic/Basketmaker periods (Shackley 1989, 1996, 2005).

The dominance of Canovas Canyon Rhyolite is unusual in my experience in this time period in the region, even in sites nearer the source (Shackley 2014, 2015; Shackley et al. 2016). Another Keres Member source in the southern Jemez Mountains, Bearhead Rhyolite, also called

Paliza Canyon, that is numerically superior at the source, is absent in the assemblage even though it is located in the same area (Shackley et al. 2016). This could mean that the Canovas Canyon raw material was collected in secondary deposits along Vallecito Creek south of the primary source around Bear Spring Peak, and potentially on the way to or from Mount Taylor, or simply part of the procurement range, or interaction sphere (see Figure 4). To be fair, these are the nearest sources to Chaco Canyon, but there seems to be some raw material selection, particularly given the dominance of Canovas Canyon Rhyolite versus the numerically superior Bearhead Rhyolite (similar flaking properties and more nodules and larger nodule sizes).

Regardless or what agency was used to get raw material to the site (direct procurement or exchange) the technology dominated by biface thinning flakes, and an absence of cores suggests projectile point maintenance and rejuvenation. The three projectile points were produced from the Mount Taylor sources that comprises about 42% of the obsidian assemblage (see cover image). Other projectile points and cores could have been present in a portion of the site not excavated, or more likely primary reduction occurred at the source or on the way from these source areas. If correct, this would be an argument for direct procurement and the obsidian source provenance as a reflection of procurement range (see Shackley 1996, 2005).

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

Sample	Mn	Zn	Rb	Sr	Y	Zr	Nb	Ba[1]	Source
126863	603	266	529	14	95	131	217		Horace/La Jara Mesa-Mt Taylor
126864	629	244	552	15	94	143	224		Horace/La Jara Mesa-Mt Taylor
126866	791	225	572	11	80	121	187		Grants Ridge-Mt Taylor
126877	576	242	548	10	89	140	222		Horace/La Jara Mesa-Mt Taylor
126880	550	190	487	16	87	132	220		Horace/La Jara Mesa-Mt Taylor
126887	533	391	105	40	17	78	38	80	Canovas Canyon Rhy
126888	437	122	118	44	23	98	53	397	Canovas Canyon Rhy
126898	852	232	606	16	83	112	187		Grants Ridge-Mt Taylor
126882-1	411	87	115	48	22	98	51		Canovas Canyon Rhy
126882-2	672	273	557	13	99	139	231		Horace/La Jara Mesa-Mt Taylor
126882-3	590	268	518	14	90	135	217		Horace/La Jara Mesa-Mt Taylor
126885	719	337	588	17	96	142	218		Horace/La Jara Mesa-Mt Taylor
126895-1	620	274	554	12	95	141	217		Horace/La Jara Mesa-Mt Taylor
126895-2	550	141	136	48	18	101	47		Canovas Canyon Rhy
126900	453	296	115	44	19	88	41	348	Canovas Canyon Rhy
126901-1	636	492	506	13	80	115	175		Grants Ridge-Mt Taylor
126901-2	594	224	539	11	90	145	221		Horace/La Jara Mesa-Mt Taylor
126901-3	765	320	595	13	89	143	228		Horace/La Jara Mesa-Mt Taylor
126901-4	835	391	618	13	85	144	209		Horace/La Jara Mesa-Mt Taylor
126901-5	587	256	488	17	81	132	215		Horace/La Jara Mesa-Mt Taylor
126901-6	646	261	567	13	95	142	234		Horace/La Jara Mesa-Mt Taylor
126901-7	589	226	501	17	82	134	208		Horace/La Jara Mesa-Mt Taylor
126901-8	643	263	554	13	89	142	229		Horace/La Jara Mesa-Mt Taylor
126902	466	77	120	47	19	108	55		Canovas Canyon Rhy
126913	434	70	169	13	47	179	58		Valles Rhy (Cerro del Medio)
126928	413	74	124	46	21	109	46		Canovas Canyon Rhy
126938-1	482	696	157	19	41	125	42		Valles Rhy (Cerro del Medio)
126938-2	655	265	516	18	87	151	226		Horace/La Jara Mesa-Mt Taylor
127404-1	475	216	154	12	15	74	38		El Rechuelos Rhy
127404-2	775	381	537	13	72	102	166		Grants Ridge-Mt Taylor
127444	475	154	203	9	56	171	88		Cerro Toledo Rhy
127453	581	230	532	12	92	141	217		Horace/La Jara Mesa-Mt Taylor
127455	485	335	396	12	57	105	154		Grants Ridge-Mt Taylor
127466	287	25	-3	19	7	39	2		not obsidian
127467	405	37	116	40	19	100	48		Canovas Canyon Rhy

Sample	Mn	Zn	Rb	Sr	Y	Zr	Nb	Ba	Source
127470	430	380	101	37	22	83	33	259	Canovas Canyon Rhy
127471	245	28	0	16	3	15	1		not obsidian
127484	458	79	121	42	27	108	55		Canovas Canyon Rhy
127485	473	101	133	50	26	105	52		Canovas Canyon Rhy
127488-1	419	226	99	40	21	81	39	313	Canovas Canyon Rhy
127488-2	661	406	532	20	91	131	206		Horace/La Jara Mesa-Mt Taylor
127492-1	560	201	187	13	41	172	55		Valles Rhy (Cerro del Medio)
127492-2	453	195	179	15	44	160	49		Valles Rhy (Cerro del Medio)
127492-3	340	456	114	12	28	97	30	<1	Canovas Canyon Rhy
127494	571	100	145	50	23	105	53		Canovas Canyon Rhy
127500-1	392	411	74	29	15	59	20		too small, probably Canovas Cnyn
127500-2	591	222	132	45	24	102	41		Canovas Canyon Rhy
127501-1	470	106	123	48	18	102	50		Canovas Canyon Rhy
127501-2	545	271	115	45	21	88	41	261	Canovas Canyon Rhy
127501-3	560	127	125	48	21	113	46		Canovas Canyon Rhy
127501-4	487	57	130	43	20	108	57		Canovas Canyon Rhy
127501-5	469	74	123	44	26	107	46		Canovas Canyon Rhy
127504	420	130	116	43	21	97	48		Canovas Canyon Rhy
127508	571	226	136	47	17	105	49		Canovas Canyon Rhy
127511	681	348	538	13	79	125	195		Grants Ridge-Mt Taylor
127512	460	73	125	48	25	109	57		Canovas Canyon Rhy
127514-1	464	100	123	47	21	107	50		Canovas Canyon Rhy
127514-2	457	65	127	47	22	113	56		Canovas Canyon Rhy
127516	467	182	114	47	24	103	46		Canovas Canyon Rhy
127523	422	95	117	46	18	98	54		Canovas Canyon Rhy
127528	634	458	125	45	19	85	43		Canovas Canyon Rhy
127529	485	95	133	46	25	105	52		Canovas Canyon Rhy
127531	576	245	575	12	95	140	226		Horace/La Jara Mesa-Mt Taylor
RGM1-S4	309	42	147	106	23	216	3	813	standard
RGM1-S5	296	43	139	106	21	214	10		standard
RGM1-S4	316	45	141	111	19	214	9		standard
RGM1-S4	291	40	143	101	24	209	12		standard

[1] Ba analyzed only when helpful in source assignment (see Davis et al. 2011).

Table 2. Frequency distribution of obsidian source provenance (non-obsidian and samples to small to assign not tabulated).

		Frequency	Percent
	MOUNT TAYLOR SOURCES		
Source	Horace/La Jara Mesa-Mt Taylor	19	31.7
	Grants Ridge-Mt Taylor	6	10.0
	JEMEZ MOUNTAINS SOURCES		
	Canovas Canyon Rhy	29	48.3
	Valles Rhy (Cerro del Medio)	4	6.7
	Cerro Toledo Rhy	1	1.7
	El Rechuelos Rhy	1	1.7
	Total	60	100.0

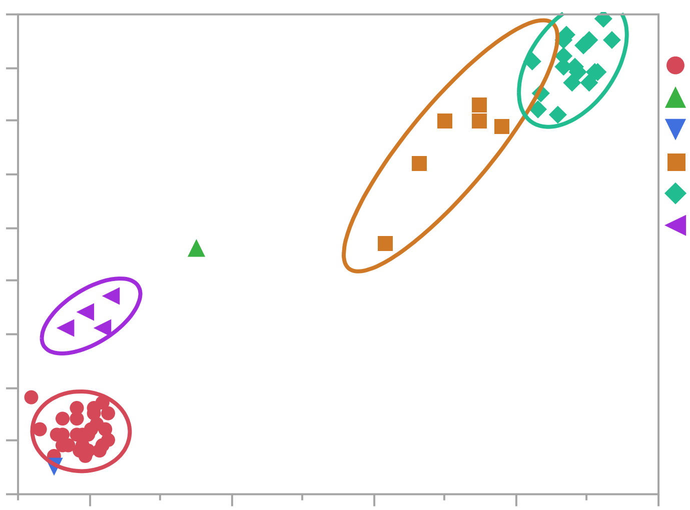

Figure 1. Nb versus Y bivariate plot of all artifacts. Ellipses are at 95% confidence intervals for individual sources.

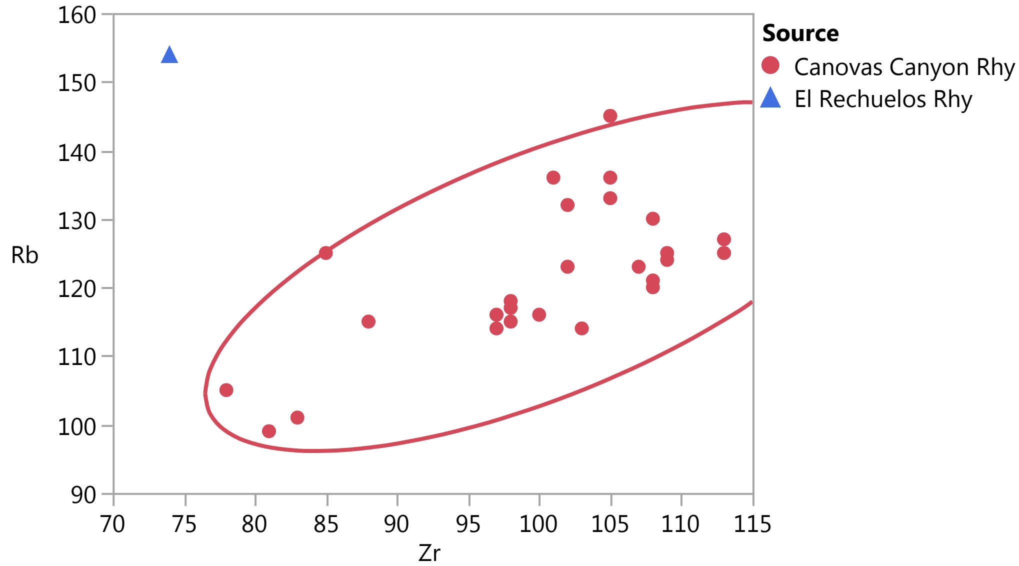

Figure 2. Zr versus Rb bivariate plot of the high Sr artifacts assigned as Canovas Canyon Rhyolite or El Rechuelos Rhyolite. Ellipse is at 95% confidence interval for individual sources.

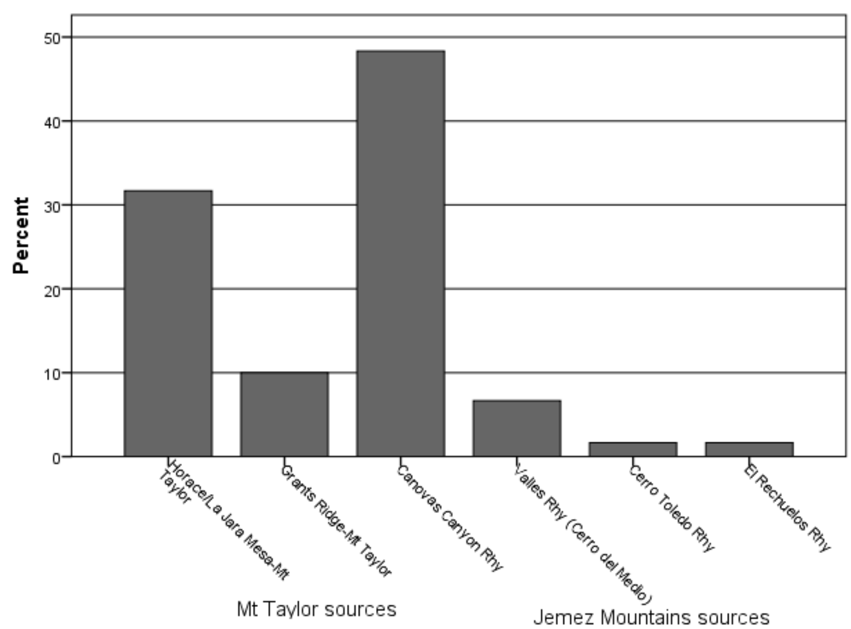

Figure 3. Frequency histogram of obsidian source provenance. See Table 2.

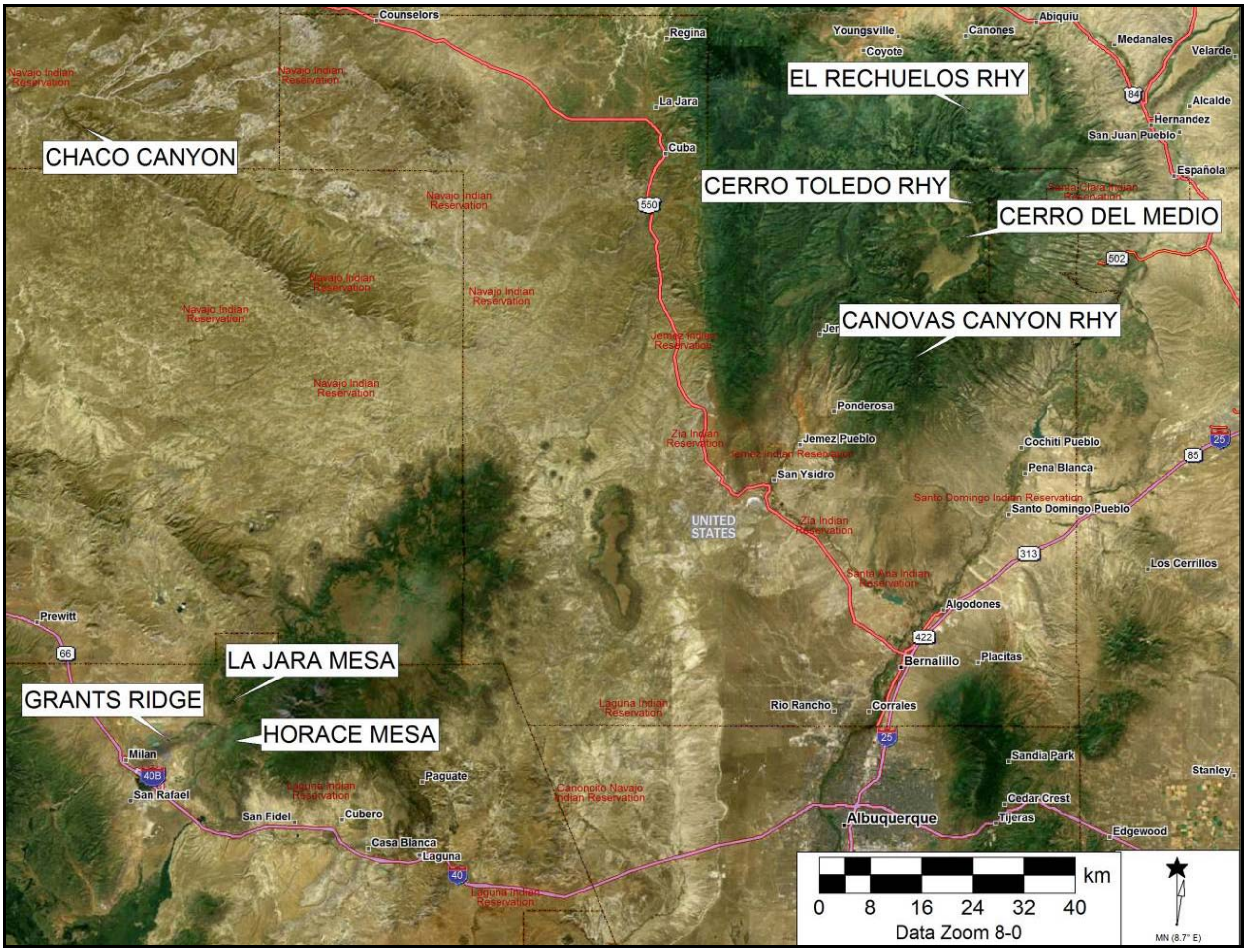

Figure 4. Satellite ortho-photo of Chaco Culture Historical Park and obsidian sources present in the assemblage.