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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM PIEDRAS MARCADAS PUEBLO RUIN (LA 290), MIDDLE RIO GRANDE VALLEY, NEW MEXICO

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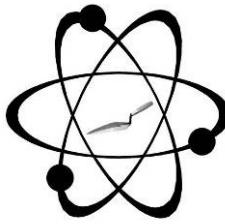
### **Author**

SHACKLEY, M Steven

### **Publication Date**

2021-08-17

Peer reviewed

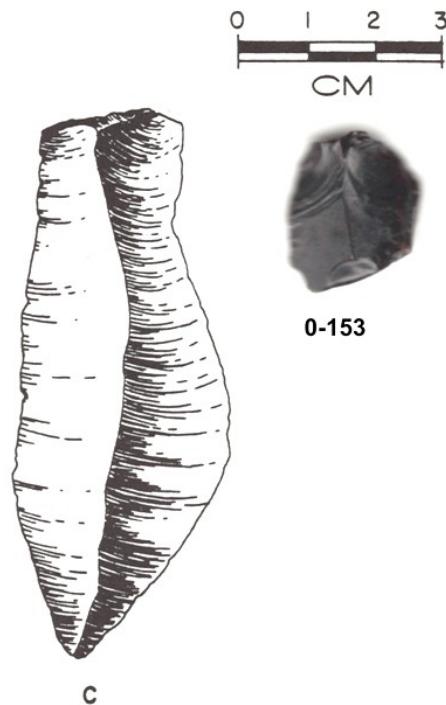


GEOARCHAEOLOGICAL XRF LAB

GEOARCHAEOLOGICAL X-RAY FLUORESCENCE SPECTROMETRY LABORATORY  
8100 WYOMING BLVD., SUITE M4-158  
87113 USA

ALBUQUERQUE, NM

**SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM PIEDRAS  
MARCADAS PUEBLO RUIN (LA 290), MIDDLE RIO GRANDE VALLEY, NEW  
MEXICO**



One of the obsidian blade  
fragments (0-153) from Piedras Marcadas and an illustrated Late Classic chert blade from Colha, Belize (Roemer 1991)  
See text and Figure 5.

M. Steven Shackley, Ph.D., Director  
Geoarchaeological XRF Laboratory  
Albuquerque, New Mexico

Report Prepared for  
Dr. Matthew Schmader  
Albuquerque, New Mexico

17 August 2021

## INTRODUCTION

The analysis here of 195 obsidian artifacts from the surface and subsurface of Piedras Marcadas Pueblo ruin (LA 290) in the middle Rio Grande River valley indicates a source provenance similar to previous analyses of surface and subsurface contexts dominated by sources from the Jemez Mountains, both pre-and-post caldera, (Shackley 2009, 2013a, 2014a, 2014b). All these sources are present in the Rio Grande alluvium as far south as Albuquerque, although the Valles Rhyolite (Cerro del Medio) nodules are very small, probably too small to produce the one projectile point made from this source (Sample 1911; Shackley 2021). Mount Taylor is not available in Rio Grande Quaternary sediments this far north (Shackley 2021). Refer to Shackley (2021) for a thorough discussion of the sources and secondary distribution.

Most unique and important for the history of the site, and indeed the Coronado presence in the Middle Rio Grande valley is the occurrence of two polyhedral blade fragments produced from the Zinapecuaro obsidian source near the town of the same name in northeastern Michoacan state of west central Mexico (see discussion below). This blade fragments from a source thousands of kilometers south into Mexico was most likely transported to the site during the siege of Piedras Marcadas by Coronado in 1540 by one or more of the West Mexican Indians traveling with Coronado. This source has never been recovered in the U.S. portion of the Southwest to my knowledge, and blade production after the Paleoindian period in North America was not practiced by native artisans (Bradley et al. 2010; Collins 1999). The only other obsidian Mexican artifacts recovered from Arizona and New Mexico are blades and blade fragments produced from one of the Sierra de Pachuca sources from Hidalgo state, Mexico, and no documented obsidian has been recovered in the Southwest from central Mexican or sources south of central Mexico other than these here and the four blades produced from Pachuca sources (Dolan and Shackley 2021).

## 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).

The trace element analyses were performed in the Geoarchaeological XRF Laboratory, Albuquerque, New Mexico, using a Thermo Scientific *Quant'X* energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with a ultra-high flux peltier air cooled Rh x-ray target with a 125 micron beryllium (Be) window, an x-ray generator that operates from 4-50 kV/0.02-1.0 mA at 0.02 increments, using an IBM PC based microprocessor and WinTrace™ 4.1 reduction software. The spectrometer is equipped with a 2001 min<sup>-1</sup> Edwards vacuum pump for the analysis of elements below titanium (Ti). Data is acquired through a pulse processor and analog to digital converter. This is a significant improvement in analytical speed and efficiency beyond the former Spectrace 5000 and *QuanX* analog systems (see Davis et al. 2011; Shackley 2011).

For Ti-Nb, Pb, Th elements the mid-Z<sub>b</sub> condition is used operating the x-ray tube at 30 kV, using a 0.05 mm (medium) Pd primary beam filter in an air path at 100 seconds livetime to generate x-ray intensity K $\alpha_1$ -line data for elements titanium (Ti), manganese (Mn), iron (as Fe<sup>T</sup>), 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 is very low. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements but Fe where a derivative fitting is used to improve the fit

for iron and thus for all the other elements. When barium (Ba) is acquired, the Rh tube is operated at 50 kV and 0.5 mA in an air path at 200 seconds livetime to generate x-ray intensity  $K\alpha_1$ -line data, through a 0.630 mm Cu (thick) filter ratioed to the bremsstrahlung region (see Davis et al. 2011). Further details concerning the petrological choice of these elements in North American obsidians is available in Shackley (1988, 1990, 1995, 2005; Shackley et al. 2018; also Mahood and Stimac 1991; and Hughes and Smith 1993). A suite of 17 specific standards used for the best fit regression calibration for elements Ti- Nb, Pb, and Th, 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), BCR-2 (basalt), TLM-1 (tonalite), SCO-1 (shale), all US Geological Survey standards, NBS-278 (obsidian) from the National Institute of Standards and Technology, BR-1 (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 and, and on into SPSS ver. 27 and JMP 12.0.1 for statistical analyses (Tables 1 and 2). In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run (Table 2). RGM-1, a USGS rhyolite standard is analyzed during each sample run of  $\leq 20$  for obsidian artifacts to check machine calibration (Table 1). Source assignments made by reference to source data at the lab and (Glascock 2011; Healan 1997; Shackley 1995, 2005, 2021; Shackley et al. 2016).

## DISCUSSION

The distribution of obsidian source provenance dominated by Jemez Lineament sources from the Jemez and Mount Taylor volcanic fields of northern New Mexico is perfectly reasonable (Shackley 2021:Supplement 1). The distribution of sources from the Jemez Mountains closely mirrors that recovered in secondary deposits just south of Albuquerque in Rio Grande Quaternary sediments at the mouth of Tijera Wash (see Shackley 2021). It is perfectly reasonable to expect that most of the obsidian recovered at Piedras Marcadas was procured in Rio Grande Quaternary alluvium. The Grants Ridge and Horace/La Jara Mesa obsidian from the Mount Taylor volcanic field of northwestern New Mexico however, was either procured from the primary sources at Mount Taylor or as secondary deposits from the Rio Puerco south toward Socorro, New Mexico, or points south, more likely from the primary sources either directly or through exchange. This procurement pattern is typical of archaeological contexts throughout the Middle Rio Grande valley in all time periods (Shackley 2021).

The presence of two blade fragments produced from the Zinapecuaro obsidian source in northeast Michoacan state, central Mexico thousands of kilometers south of Piedras Marcadas requires some explanation (see Figures 1 through 6). As noted above, this is the first recovery of central Mexican obsidian in U.S. Southwestern sites other than four blades produced from one of the Sierra de Pachuca sources in Hidalgo state, Mexico (Dolan and Shackley 2021). All these artifacts are likely from some facet of the Coronado expedition in the middle 16th century, and are directly associated with the well over 1000 Mexican Indians traveling with Coronado into what is now North America. The two blades recovered from Piedras Marcadas are unique in that while Pachuca has been recovered, although rare, throughout archaeological contexts in the southern portion of North America, this is the first evidence of obsidian artifacts from a west Mexican source. Parenthetically, Zinapecuaro is part of a volcanic field with multiple sources, including the Ucareo source, one of the most commonly recovered obsidian sources in central Mexican archaeological contexts (Healan 1997; Michael Glascock, personal communication, August 2021; Glascock 2011). It is quite possible that the two blades were simply carried north among the materials of someone from that region of Mexico, and deposited at Piedras Marcadas during the long-term siege of that Pueblo by Coronado's "army" including the Mexican Indians. So what could they have been used for?

Blade fragment 0-153 does indicate some marginal and platform usewear, possibly from long term cutting or scraping hard substances. Another use of obsidian blades from Mexico are blades inserted in *macuahuitl*, a Nauatl word for a large wooden club used in warfare (see Figure 6). To my knowledge there is no evidence that these types of weapons were used during the Coronado campaign, but it is possible. Nevertheless, this is direct evidence of the presence of Mexican Indians, probably West Mexican Indians at Piedras Marcadas Pueblo during the siege of that pueblo.

Finally, does the presence of artifacts produced from non-Pachuca Mexican obsidian suggest that we have simply missed some of these other sources in Southwestern archaeological contexts? Many North American archaeologists do not have much if any experience recognizing blade production versus biface production - that's the way we're trained. Unless an archaeologist has experience in the Old World or one of the other Americas where blade production is much more common in prehistory, they could very well go unnoticed. And without source provenance, blade fragments may never be discovered. Then again, the case at Piedras Marcadas could be an isolated incident.

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

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba <sup>1</sup>	Source
0-1	583	49 0	1195 7	21 1	9	7 1	18 3	10 1		Cerro Toledo Rhy
0-2	567	50 2	1208 2	20 6	9	6 3	18 0	92		Cerro Toledo Rhy
0-3	500	50 8	1174 7	19 7	12	6 1	16 8	95		Cerro Toledo Rhy
0-4	851	43 0	1238 6	16 4	11	4 3	16 3	50		Valles Rhy (Cerro del Medio)
0-5	850	44 5	1061 2	11 4	42	2 3	11 1	53	391	Canovas Canyon Rhy
0-6	564	46 5	1154 6	18 9	10	6 2	16 3	88		Cerro Toledo Rhy
0-7	608	43 6	1028 7	16 2	11	2 2	81	51		El Rechuelos Rhy
0-9	608	49 6	1214 1	20 7	11	6 4	17 5	98		Cerro Toledo Rhy
0-10	609	51 4	1201 3	20 8	13	6 7	17 1	94		Cerro Toledo Rhy
0-11	738	51 2	9574	20 8	4	6 4	17 0	10 1		Cerro Toledo Rhy
0-12	811	57 7	1033 9	22 1	5	6 2	17 2	96		Cerro Toledo Rhy
0-13	759	50 2	9210	20 1	3	6 4	17 2	96		Cerro Toledo Rhy
0-14	703	54 8	9854	21 9	5	6 5	17 2	10 5		Cerro Toledo Rhy
0-15	745	50 8	9651	20 9	3	6 1	17 1	10 0		Cerro Toledo Rhy
0-16	681	50 9	9410	20 5	4	6 3	17 3	97		Cerro Toledo Rhy
0-17	776	41 0	8993	16 3	8	4 1	16 0	59		Valles Rhy (Cerro del Medio)
0-18	781	47 8	9132	19 3	3	6 0	16 3	89		Cerro Toledo Rhy
0-19	749	49 1	9643	21 1	3	6 5	16 8	10 0		Cerro Toledo Rhy
0-20	693	53 0	9557	21 0	5	5 8	16 4	98		Cerro Toledo Rhy
0-21	662	46 6	8916	19 8	5	6 0	16 7	99		Cerro Toledo Rhy
0-22	621	49 9	9410	20 9	3	6 1	16 4	98		Cerro Toledo Rhy
0-23	736	50 5	9650	21 2	3	6 3	16 7	99		Cerro Toledo Rhy
0-24	788	68 0	1177 1	24 0	5	6 7	17 8	94		Cerro Toledo Rhy
0-25	488	78 0	7462	53 7	6	7 8	11 0	19 7		Grants Ridge, Mt Taylor
0-26	733	52 6	9648	20 8	4	6 4	17 0	98		Cerro Toledo Rhy
0-27	769	52 4	1025 2	22 2	4	6 6	17 6	10 5		Cerro Toledo Rhy
0-28	727	56 2	1018 0	21 8	4	6 4	17 3	10 2		Cerro Toledo Rhy

0-29	733	53 1	9752	21 4	6	6 5	16 7	96		Cerro Toledo Rhy
0-30	657	49 8	9358	21 0	3	6 4	17 2	95		Cerro Toledo Rhy
0-31	781	44 5	6748	16 0	7	2 5	72	46		El Rechuelos Rhy
0-32	699	47 3	9072	20 2	4	6 0	16 5	99		Cerro Toledo Rhy
0-33	716	56 2	9927	21 7	6	6 1	17 3	10 1		Cerro Toledo Rhy
0-34	681	52 9	9709	21 0	3	6 1	16 8	98		Cerro Toledo Rhy
0-35	738	50 1	9632	21 0	5	6 7	17 2	97		Cerro Toledo Rhy
100	689	46 9	1209 3	20 3	9	6 7	17 0	10 0		Cerro Toledo Rhy
101	354	57 2	1163 3	51 3	12	8 8	13 1	23 3		Horace/La Jara Mesa, Mt Taylor
103	514	46 5	1174 3	20 5	8	6 8	17 2	98		Cerro Toledo Rhy
104	417	58 3	1170 0	52 9	13	8 4	13 2	22 3		Horace/La Jara Mesa, Mt Taylor
105	537	48 3	1183 5	20 5	8	6 8	18 0	10 2		Cerro Toledo Rhy
106	548	46 9	1183 7	19 9	10	6 2	17 3	98		Cerro Toledo Rhy
107	634	48 9	1235 0	20 6	8	6 3	17 0	99		Cerro Toledo Rhy
108	646	56 4	1264 7	23 2	9	6 8	18 8	10 4		Cerro Toledo Rhy
110	601	54 0	1262 3	22 4	11	6 8	18 5	10 4		Cerro Toledo Rhy
111	551	50 0	1219 2	21 0	8	6 7	17 8	10 1		Cerro Toledo Rhy
112	678	47 8	1223 6	20 3	11	5 9	17 4	98		Cerro Toledo Rhy
113	581	45 6	1180 3	20 1	8	6 5	17 0	94		Cerro Toledo Rhy
114	605	48 0	1194 2	19 9	9	6 1	16 9	99		Cerro Toledo Rhy
115	708	40 4	1214 5	16 6	11	4 6	16 7	54		Valles Rhy (Cerro del Medio)
116	524	46 6	1164 3	19 7	11	6 5	17 2	10 0		Cerro Toledo Rhy
Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba <sup>1</sup>	Source
117	660	57 7	1283 5	22 7	9	6 8	18 3	10 4		Cerro Toledo Rhy
118	548	44 1	1154 4	19 9	8	6 6	17 1	97		Cerro Toledo Rhy
119	473	44 9	1161 4	20 4	9	6 5	17 4	96		Cerro Toledo Rhy
120	112 1	49 6	1099 9	10 5	88	2 3	12 6	33		Bearhead Rhy
121-1	620	41 9	1147 0	18 5	9	5 9	15 7	96		Cerro Toledo Rhy
121-2	526	51	1211	21	9	6	17	96		Cerro Toledo Rhy

		2	9	5		4	7			
122-1	599	40 1	1023 9	15 4	11	2 3	71	46		El Rechuelos Rhy
122-2	524	47 5	1173 0	19 9	10	6 1	17 3	94		Cerro Toledo Rhy
123-1	501	49 8	1186 5	20 7	10	6 6	16 8	98		Cerro Toledo Rhy
123-2	535	53 8	1224 2	21 5	8	6 7	17 7	96		Cerro Toledo Rhy
124	571	45 7	1166 1	20 7	16	6 1	16 3	97		Cerro Toledo Rhy
125	461	36 6	1096 1	17 9	8	5 9	16 1	92		Cerro Toledo Rhy
128	668	52 9	1221 9	19 8	10	6 1	17 1	97		Cerro Toledo Rhy
129	553	47 2	1190 1	20 2	10	6 5	17 4	99		Cerro Toledo Rhy
130	497	48 1	1182 8	20 1	8	6 7	16 9	99		Cerro Toledo Rhy
131	579	49 0	1188 5	20 7	8	6 5	17 7	10 1		Cerro Toledo Rhy
132	494	45 6	1164 8	20 0	10	6 1	16 7	10 0		Cerro Toledo Rhy
135	310	72 0	1084 5	54 4	12	7 8	11 8	19 4		Grants Ridge, Mt Taylor
137-1	594	47 9	1172 7	20 6	10	6 5	17 2	98		Cerro Toledo Rhy
137-2	483	45 9	1163 8	20 6	10	6 6	16 9	98		Cerro Toledo Rhy
138-1	493	46 5	1181 8	20 8	11	6 3	17 9	99		Cerro Toledo Rhy
138-2	522	49 5	1200 5	21 1	8	6 3	17 9	10 3		Cerro Toledo Rhy
139-1	502	47 5	1172 8	20 2	8	6 1	17 3	97		Cerro Toledo Rhy
139-2	535	51 5	1231 3	22 0	11	7 0	17 7	10 0		Cerro Toledo Rhy
140	456	48 2	1185 1	20 6	9	6 3	17 2	98		Cerro Toledo Rhy
141	574	45 7	1194 5	21 0	8	6 5	17 6	96		Cerro Toledo Rhy
142	559	47 2	1180 0	20 7	9	6 2	17 4	10 0		Cerro Toledo Rhy
143	508	46 3	1173 6	20 2	8	6 4	17 3	92		Cerro Toledo Rhy
144	545	52 4	1206 7	20 9	10	6 2	17 4	93		Cerro Toledo Rhy
145	569	46 5	1182 7	20 6	9	6 1	17 2	91		Cerro Toledo Rhy
537	851	48 9	1079 4	20 9	8	6 3	17 6	98		Cerro Toledo Rhy
1081	769	56 8	1007 3	50 8	14	9 3	13 2	22 6		Horace/La Jara Mesa, Mt Taylor
1641	865	50 3	1083 5	20 2	8	6 7	17 2	98		Cerro Toledo Rhy
1911	956	38 1	1016 6	15 9	13	4 5	16 6	54		Valles Rhy (Cerro del Medio)
70-80-1		52	1152	22	8	6	17	98		Cerro Toledo Rhy

		5	5	2		5	0			
70-80-2		53 1	1119 4	20 2	11	5 4	14 7	81		Cerro Toledo Rhy
70-80-3		42 2	9841	19 4	10	6 2	17 1	95		Cerro Toledo Rhy
70-80-4		52 4	1097 4	20 7	11	6 5	17 3	98		Cerro Toledo Rhy
70-80-5		44 0	8717	12 2	43	2 6	10 6	49		Canovas Canyon Rhy
70-80-6		46 1	1019 6	19 5	9	5 9	15 9	89		Cerro Toledo Rhy
70-80-7		51 2	1075 7	21 2	8	6 5	17 8	98		Cerro Toledo Rhy
80-90-1		41 7	9836	18 7	10	6 2	17 1	93		Cerro Toledo Rhy
80-90-2		50 4	1061 8	20 8	10	6 4	16 8	90		Cerro Toledo Rhy
80-90-3		48 8	1052 1	20 3	12	6 4	17 1	94		Cerro Toledo Rhy
90-100-1		51 7	1131 1	21 5	9	6 3	17 4	93		Cerro Toledo Rhy
90-100-2		49 2	1081 7	20 5	8	6 8	17 0	96		Cerro Toledo Rhy
110-120-1		48 4	1035 8	20 4	9	6 4	17 0	10 0		Cerro Toledo Rhy
120-130S-1		52 3	1096 5	20 4	19	6 0	17 0	93		Cerro Toledo Rhy
120-130S-2		51 0	1131 5	21 3	11	6 2	17 0	92		Cerro Toledo Rhy
130-140-1		46 1	1028 5	19 5	9	6 3	16 7	92		Cerro Toledo Rhy
140-150-1		48 7	1068 5	20 4	10	5 9	16 8	99		Cerro Toledo Rhy
140-150-2		49 4	1104 4	21 1	11	6 7	17 3	95		Cerro Toledo Rhy
Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba <sup>1</sup>	Source
140-150-3		47 3	1059 6	19 1	10	5 4	15 3	83		Cerro Toledo Rhy
220-230-1		50 7	1134 1	21 0	8	6 2	17 1	10 1		Cerro Toledo Rhy
220-230-2		57 3	1219 5	22 8	12	6 0	17 0	90		Cerro Toledo Rhy
20-30-1		47 3	1044 4	20 2	9	6 2	17 4	93		Cerro Toledo Rhy
20-30-2		54 7	1156 4	20 7	10	6 1	17 2	96		Cerro Toledo Rhy
20-30-3		53 9	1211 0	21 9	10	6 4	17 0	92		Cerro Toledo Rhy
20-30-4		51 5	1129 5	20 9	8	5 9	17 0	89		Cerro Toledo Rhy
40-50-1		54 5	1151 1	21 4	11	6 1	16 6	90		Cerro Toledo Rhy
50-60-1		49 5	1064 4	20 3	11	6 1	16 7	87		Cerro Toledo Rhy
50-60-2		41 2	1069 9	15 5	14	4 3	15 9	52		Valles Rhy (Cerro del Medio)
60-70-1		55 8	1178 2	21 8	8	6 3	17 6	10 5		Cerro Toledo Rhy

70-80-1		50 3	1098 8	21 1	10	6 6	17 0	96		Cerro Toledo Rhy
70-80-2		46 2	1056 0	20 7	11	6 6	18 4	10 1		Cerro Toledo Rhy
70-80-4		40 7	1106 6	15 1	14	3 8	15 0	47		Valles Rhy (Cerro del Medio)
80-85-1		51 4	1116 1	21 8	8	6 2	17 5	96		Cerro Toledo Rhy
85-90-1		48 9	1059 9	20 1	10	6 5	17 6	99		Cerro Toledo Rhy
90-100-1		47 4	9089	12 3	51	2 6	10 3	54		Canovas Canyon Rhy
90-100-2		54 0	1137 5	22 0	8	6 4	16 9	93		Cerro Toledo Rhy
90-100-3		47 8	1047 8	20 1	9	6 1	17 0	97		Cerro Toledo Rhy
100-110-1		55 2	1181 0	20 8	9	6 4	17 4	97		Cerro Toledo Rhy
100-110-2		55 3	1163 4	22 3	10	6 5	17 6	10 5		Cerro Toledo Rhy
100-110-3		49 5	1093 2	20 6	8	6 6	17 6	96		Cerro Toledo Rhy
120-130-1		50 4	1049 7	18 8	11	5 7	16 8	90		Cerro Toledo Rhy
0-30-1		50 1	1067 1	19 6	10	5 8	15 8	86		Cerro Toledo Rhy
0-30-2		56 8	1189 0	21 4	11	6 1	16 4	92		Cerro Toledo Rhy
30-40-2		46 0	1014 1	18 4	9	5 5	15 2	86		Cerro Toledo Rhy
40-50-1		44 7	1076 0	18 2	13	5 2	14 1	84		Cerro Toledo Rhy
50-60-1		50 6	1101 0	21 0	8	6 0	17 3	94		Cerro Toledo Rhy
60-70		50 4	1070 7	20 6	8	6 2	17 8	93		Cerro Toledo Rhy
90-100-1		50 3	1075 9	20 9	8	6 8	17 4	98		Cerro Toledo Rhy
90-100-2		43 7	8781	12 1	45	2 3	99	50		Canovas Canyon Rhy
90-100-3-1		54 3	1136 7	21 4	8	6 2	17 4	97		Cerro Toledo Rhy
100-110-1-1		47 1	1023 1	19 6	10	6 4	17 2	90		Cerro Toledo Rhy
110-120-1		54 5	1021 5	11 3	93	2 7	12 8	34		Bearhead Rhy
120-130-1-1		45 0	7916	17 3	11	2 7	75	50		El Rechuelos Rhy
120-130-2		52 6	1114 5	21 7	10	6 0	17 2	10 2		Cerro Toledo Rhy
130-140-1		54 8	1132 7	20 9	10	6 6	17 2	94		Cerro Toledo Rhy
130-140-2		38 7	1018 8	15 9	12	4 2	15 3	53		Valles Rhy (Cerro del Medio)
140-150-1		49 4	1074 9	19 1	9	5 0	14 7	81		Cerro Toledo Rhy
140-150-2		48 7	1055 1	20 8	12	6 4	16 7	99		Cerro Toledo Rhy

140-150-3		41 1	9489	11 5	64	2 1	10 7	41		Canovas Canyon Rhy
140-150-4		50 7	1099 6	20 5	11	6 3	16 4	94		Cerro Toledo Rhy
0-150	460	44 6	1126 1	19 1	9	5 8	16 4	87		Cerro Toledo Rhy
150-160-1		49 8	1086 3	19 5	10	5 6	16 0	85		Cerro Toledo Rhy
0-151	509	48 4	1184 2	20 4	13	6 5	17 6	97		Cerro Toledo Rhy
0-152	593	40 9	1152 8	16 2	9	4 1	16 2	57		Valles Rhy (Cerro del Medio)
0-153	810	24 6	9430	18 0	16	3 2	10 3	16	52	Zinapecuaro, Michoacan, MX
0-154	600	49 0	1195 9	21 0	10	6 2	18 4	10 0		Cerro Toledo Rhy
0-155	650	42 5	1024 4	15 7	15	2 1	76	39		El Rechuelos Rhy
0-156	486	54 1	1228 8	22 2	9	6 5	18 5	10 1		Cerro Toledo Rhy
0-157	655	52 1	1231 9	21 7	10	6 2	18 2	10 4		Cerro Toledo Rhy
0-158	544	53 7	1263 8	22 4	10	6 3	18 5	10 3		Cerro Toledo Rhy
Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba <sup>1</sup>	Source
0-159	562	51 5	1199 1	20 3	12	6 9	17 1	97		Cerro Toledo Rhy
0-160	627	51 4	1228 1	21 2	10	6 8	17 2	95		Cerro Toledo Rhy
0-161	680	40 2	1018 6	15 4	12	2 6	89	41		El Rechuelos Rhy
0-162	662	54 5	1212 7	21 9	11	6 3	17 7	99		Cerro Toledo Rhy
0-163	587	49 4	1182 0	20 1	13	6 0	17 6	10 0		Cerro Toledo Rhy
0-164	664	56 3	1228 0	21 2	10	6 4	17 4	94		Cerro Toledo Rhy
0-165	722	39 3	1042 6	11 3	46	2 2	10 5	50	365	Canovas Canyon Rhy
0-166	451	45 1	1163 0	20 1	12	6 3	17 5	97		Cerro Toledo Rhy
0-167	569	51 6	1209 0	21 8	11	6 3	18 6	92		Cerro Toledo Rhy
0-168	546	48 7	1198 3	19 9	10	6 4	17 6	10 1		Cerro Toledo Rhy
0-169	526	47 5	1170 2	20 0	10	5 8	17 3	93		Cerro Toledo Rhy
0-170	506	50 8	1233 1	21 2	13	6 8	18 2	10 4		Cerro Toledo Rhy
0-171	597	54 6	1238 4	21 1	10	6 7	17 7	10 2		Cerro Toledo Rhy
0-172	520	52 7	1240 7	22 2	11	6 0	17 4	97		Cerro Toledo Rhy
0-173	658	51 2	1222 9	21 6	9	6 2	17 7	96		Cerro Toledo Rhy
0-174	117 7	54 5	1143 4	10 6	95	2 3	13 0	35	160 9	Bearhead Rhy
0-181	484	63	1208	52	14	9	13	24		Horace/La Jara Mesa, Mt

		9	2	5		1	8	0		Taylor
0-182	591	48 2	1199 6	21 1	14	6 1	17 5	94		Cerro Toledo Rhy
0-183	680	40 3	1173 3	15 8	14	4 6	16 8	58		Cerro Toledo Rhy
0-184	108 8	46 1	1103 1	99	85	2 5	12 8	34	162 0	Bearhead Rhy
0-185	690	39 9	1182 6	16 2	14	4 5	16 5	56		Valles Rhy (Cerro del Medio)
0-186	651	51 6	1219 4	21 2	14	6 4	17 5	91		Cerro Toledo Rhy
0-200	814	28 4	1051 5	19 3	18	2 9	11 0	14	56	Zinapecuaro, Michoacan, MX
0-201	519	46 0	1145 3	18 7	9	5 8	17 0	88		Cerro Toledo Rhy
0-202	575	45 6	1181 0	21 0	9	5 6	18 1	10 0		Cerro Toledo Rhy
0-203	565	45 8	1170 9	19 9	9	5 8	17 8	99		Cerro Toledo Rhy
0-205	652	38 4	1168 4	15 5	14	4 7	15 8	55		Valles Rhy (Cerro del Medio)
0-206	526	46 5	1177 6	19 5	11	6 1	16 9	10 1		Cerro Toledo Rhy
0-207	519	51 2	1186 4	20 5	13	6 0	17 8	96		Cerro Toledo Rhy
0-208	464	60 3	1153 6	51 1	13	8 5	13 7	21 4		Horace/La Jara Mesa, Mt Taylor
0-209	575	46 4	1186 2	21 2	13	5 6	17 7	10 9		Cerro Toledo Rhy
0-210	559	49 2	1177 5	20 9	11	6 5	17 4	10 3		Cerro Toledo Rhy
0-211	641	50 8	1256 2	21 9	12	6 3	18 3	10 3		Cerro Toledo Rhy
0-212	685	39 5	1198 0	16 1	14	4 4	17 3	59		Valles Rhy (Cerro del Medio)
0-213	540	47 4	1176 5	21 0	11	6 4	17 6	10 2		Cerro Toledo Rhy
0-214	622	50 0	1221 2	20 5	11	6 8	17 5	96		Cerro Toledo Rhy
0-215	618	52 4	1206 8	21 4	9	6 0	17 9	10 2		Cerro Toledo Rhy
0-217	733	42 0	1204 7	16 0	12	4 4	17 3	55		Valles Rhy (Cerro del Medio)
3541	592	36 9	1000 5	14 3	15	2 3	77	49		El Rechuelos Rhy
3242	592	50 4	1221 8	21 8	10	7 0	18 4	10 0		Cerro Toledo Rhy
3243	627	50 4	1221 1	20 7	11	6 3	17 8	10 1		Cerro Toledo Rhy
3244	368	53 7	1114 6	48 5	13	8 9	12 8	21 9		Horace/La Jara Mesa, Mt Taylor
RGM1-S4	152 3	29 4	1318 7	14 9	10 7	2 4	21 9	6	787	standard
RGM1-S5	146 4	30 4	1366 3	14 2	10 9	2 1	21 4	9		standard
RGM1-S5	142 5	32 8	1370 9	14 9	10 9	2 4	21 5	8		standard
RGM1-S5	161	33	1367	14	10	2	21	9		standard

	6	3	8	7	7	3	4			
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<sup>1</sup> Barium acquired for clarity in discrimination when needed (Davis et al. 2011).

Table 2. Frequency distribution of obsidian source provenance.

<b>Source</b>	<b>Frequency</b>	<b>Percent</b>
Cerro Toledo Rhy	155	79.5
Valles Rhy (Cerro del Medio)	13	6.7
El Rechuelos Rhy	7	3.6
Canovas Canyon Rhy	6	3.1
Bearhead Rhy	4	2.1
Horace/La Jara Mesa, Mt Taylor	6	3.1
Grants Ridge, Mt Taylor	2	1.0
Zinapecuaro, Michoacan, MX	2	1.0
<b>Total</b>	<b>195</b>	<b>100.0</b>

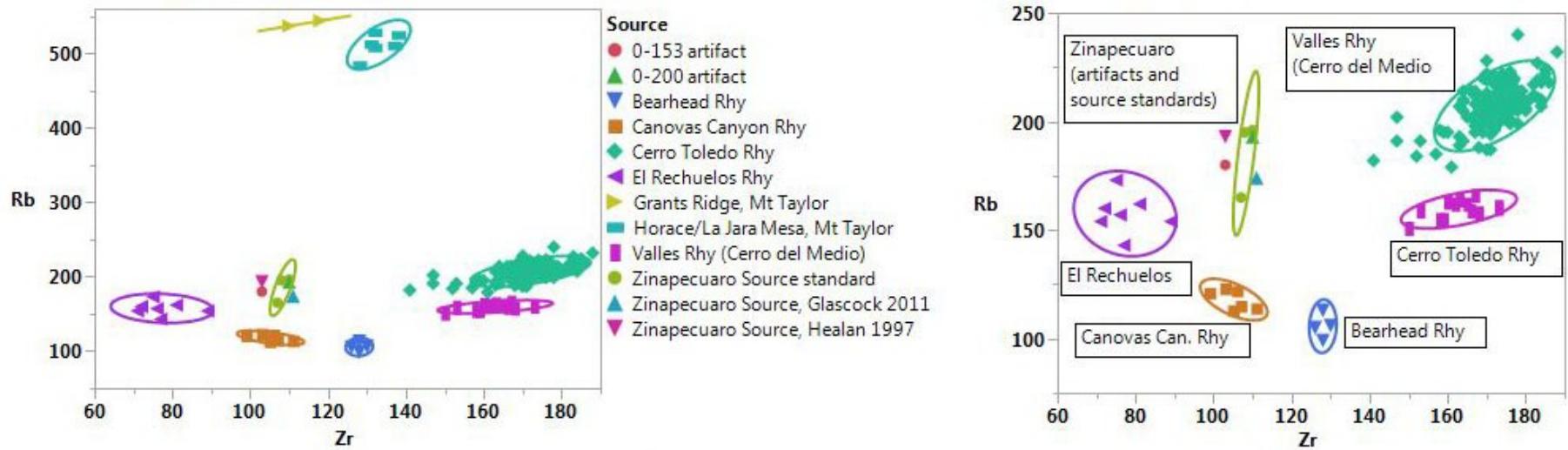


Figure 1. Zr/Rb bivariate plot of all artifacts (left), and Zr/Rb bivariate plot of lower Rb artifacts (right) providing greater discriminatory clarity. Confidence ellipses at 90%. Glascock and Healan source standard data for Zinapecuario are mean values (Glascock 2011; Healan 1997). The "Zinapecuario Source standard" are the results of three source standards in this laboratory.

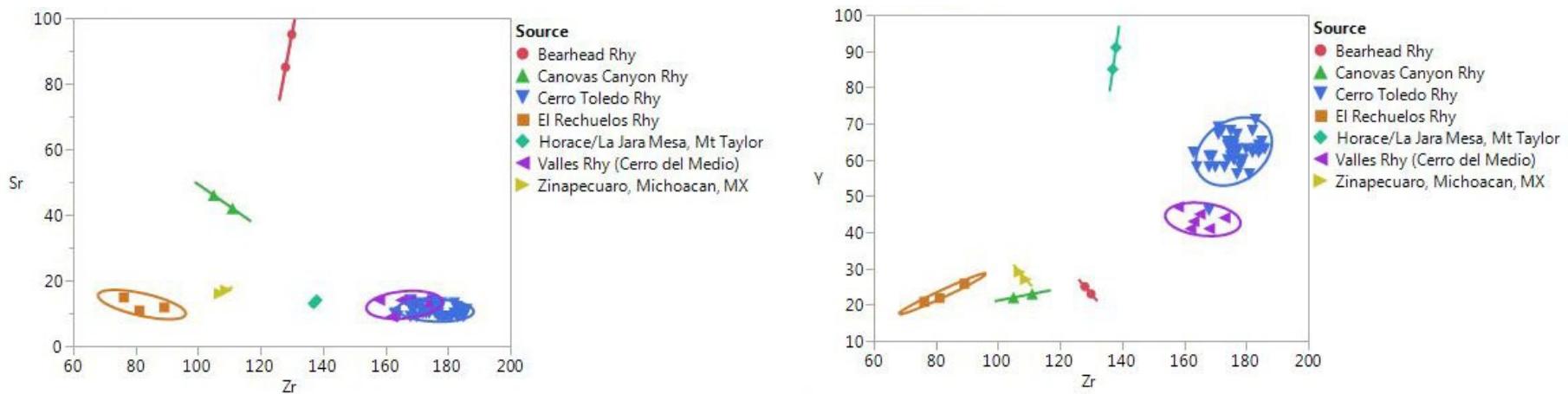


Figure 2. Zr/Sr bivariate plot of higher Sr artifacts, and Zr/Y bivariate plot providing discriminatory clarity for Jemez Lineament artifacts (see Shackley 2021). Confidence ellipses at 90%.

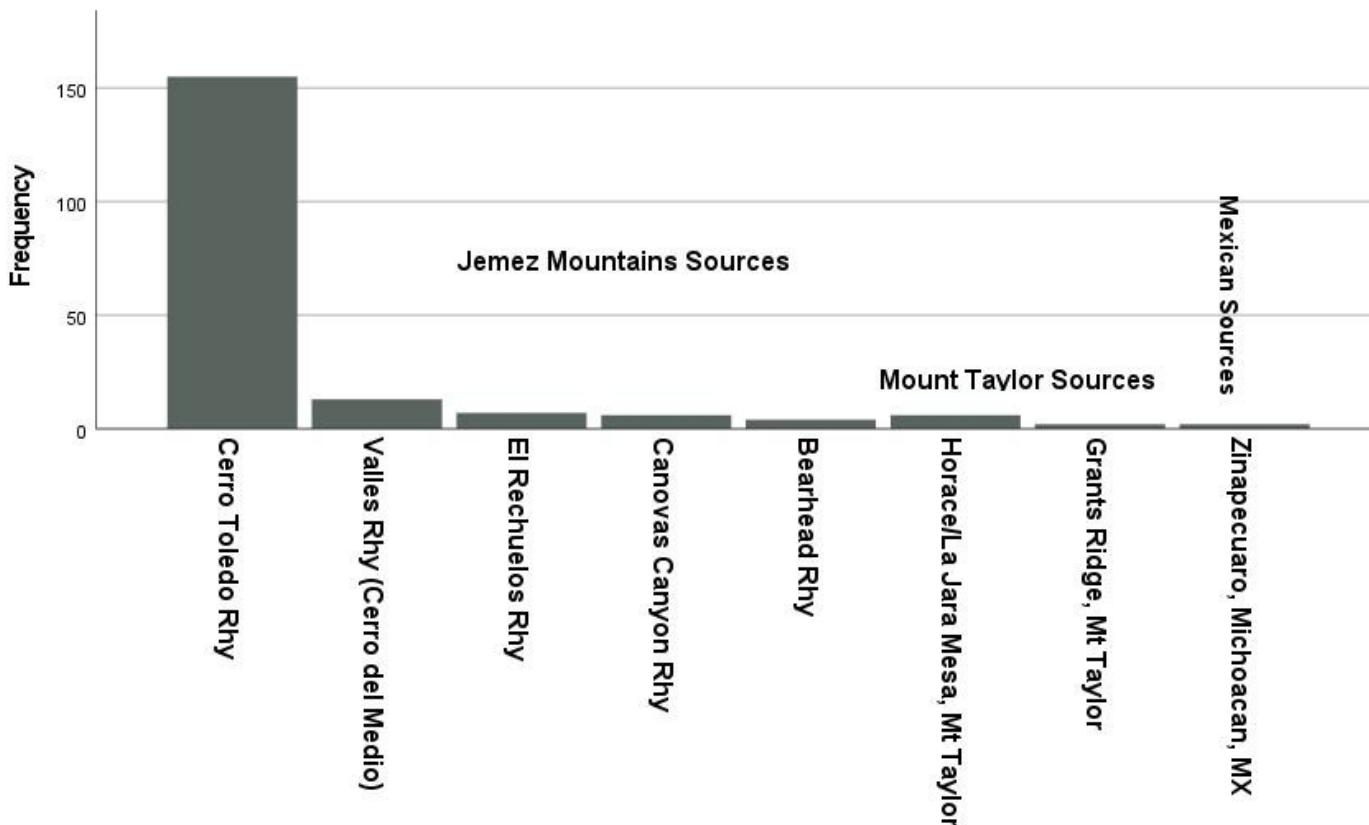


Figure 3. Frequency histogram of obsidian source provenance from Table 1 data.



Figure 4. Polyhedral Zinapecuaro obsidian blade fragments (see Figure 5).

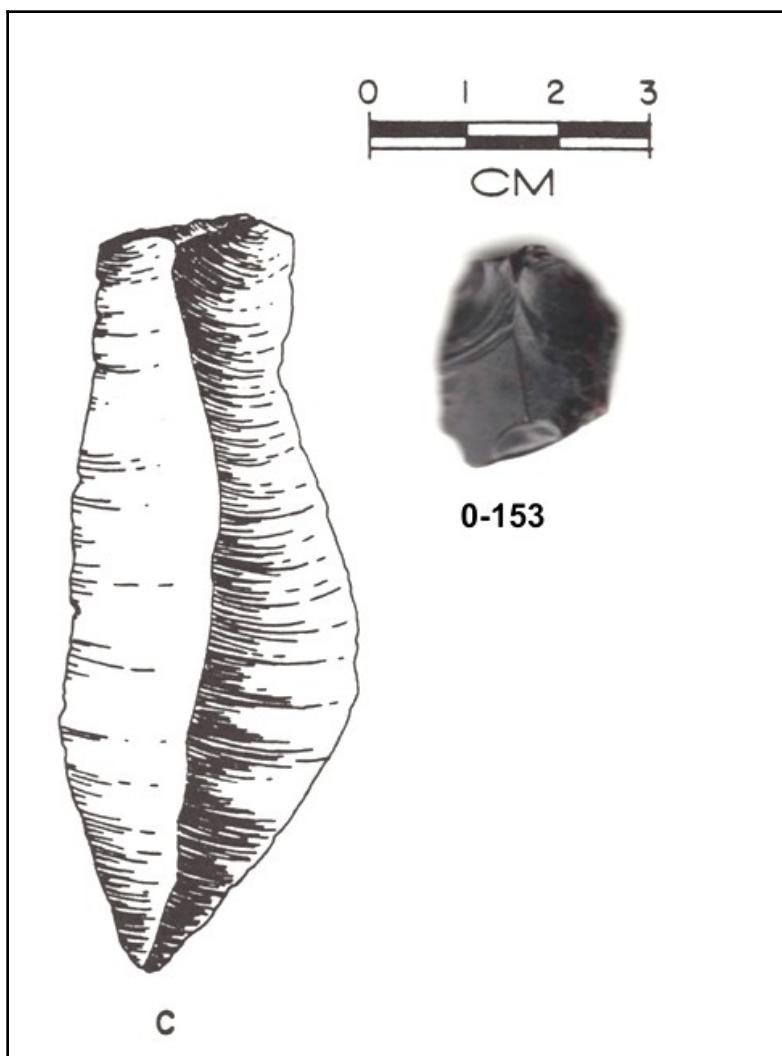


Figure 5. One of the obsidian blade fragments (0-153) from Piedras Marcadas and an illustrated Late Classic chert blade from Colha, Belize at the approximate same scale (Roemer 1991).



Figure 6. Aztec warriors brandishing *macuahuitl* a wooden club with inserted obsidian prismatic blades, from the 16th century Florentine Codex.