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# BERKELEY ARCHAEOLOGICAL



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### SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM POTTERY MOUND (LA 416), MIDDLE RIO GRANDE VALLEY, NEW MEXICO



by

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Report Prepared for

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## INTRODUCTION

The analysis here of 55 obsidian artifacts from Pottery Mound (LA 416) in the Middle Rio Grande Valley, New Mexico is the first source provenance analysis of obsidian artifacts from this site. While the assemblage is dominated by artifacts produced from one of the two chemical groups in the Mount Taylor Volcanic Field, the assemblage indicates procurement from both the primary sources, and secondary deposits, possibly along the Rio San Jose or the lower reaches of the Rio Puerco. The entire production trajectory of projectile points is present in this collection from obsidian core fragments, to all stages of preforms, to finished projectile points, and rejuvenated points. Obsidian stone tool production was well developed at the late period site.

## 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).

All analyses for this study were conducted on a Thermo Scientific *Quant'X* EDXRF spectrometer, located in the Department of Anthropology, University of California, Berkeley. 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  $\mu\text{m}$  (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  $\text{l min}^{-1}$  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.

The trace element analyses were performed in the Geoarchaeological XRF Laboratory, Department of Anthropology, University of California, Berkeley, using a Thermo/ARL *Quant'X* energy dispersive x-ray fluorescence spectrometer. The analysis for 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 to generate x-ray intensity Ka-line data for elements titanium (Ti), manganese (Mn), iron (as  $\text{Fe}_2\text{O}_3^{\text{T}}$  reported elementally), 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 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 analyzed in the High Zb condition, the Rh tube is operated at 50 kV and 0.5 mA, ratioed to the bremsstrahlung region (see Davis et al. 1998). 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). Specific standards used for the best fit regression calibration for elements Ti- Nb, Pb, Th,

and Ba, include G-2 (basalt), AGV-2 (andesite), GSP-1 (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), all US Geological Survey standards, 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 software for manipulation and on into SPSS for Windows for statistical analyses when necessary. 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 by reference to Shackley (1995, 1998, 2005; see Table 1 and Figures 1 and 2 here), as well as source standard data at Berkeley. One sample was not obsidian.

## **DISCUSSION**

Virtually no source provenance analyses of obsidian artifacts from late period sites south of Albuquerque has been attempted thus far (Shackley 2009). What is most remarkable here is the nearly total dominance of Mount Taylor obsidian, even though three of the Jemez Mountains obsidian sources are available in the Rio Grande Quaternary alluvium in the area (Shackley 2005, 2010). Cerro Toledo Rhyolite obsidian is present here, but in very small proportions (Table 1). The assemblage analyzed does indicate an active chipped stone assemblage with all stages of projectile point and flake tool production from raw cores with complete cortical coverage to finished and rejuvenated projectile points (Figures 3 and 4). Both waterworn and angular cortex is present on the cores and preforms indicating procurement at the source at Mount Taylor and in the Rio San Jose or Rio Puerco stream systems (see Shackley 1998, 2005). There seems to be a nearly equal proportion of Grants Ridge and Horace Mesa chemical groups

from Mount Taylor, so if this assemblage is representative, it suggests that the knappers were not necessarily selecting one over the other (Figure 2).

There were a few, what appear to be, Archaic period projectile points in the assemblage, and could be scavenged/curated objects by the inhabitants of Pottery Mound. I'll leave this to others to determine.

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Table 1. Elemental concentrations and source assignments for the archaeological specimens. All measurements in parts per million (ppm).

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
1	451	589	8752	517	9	85	131	230	Mount Taylor Cerro Toledo
2	687	522	9644	207	4	63	168	102	Rhy
3	392	555	8055	480	6	84	126	221	Mount Taylor
4	762	558	9135	442	7	79	124	219	Mount Taylor
5	704	627	9300	510	8	82	131	225	Mount Taylor
6	436	636	8789	517	7	85	130	225	Mount Taylor
7	572	624	9075	510	7	86	128	219	Mount Taylor
8	454	705	9545	540	7	84	131	230	Mount Taylor
9	544	664	9367	544	8	87	135	224	Mount Taylor
10	628	710	9579	547	11	86	137	233	Mount Taylor
11	497	640	8643	512	8	84	129	216	Mount Taylor
12	446	674	9359	538	9	84	141	237	Mount Taylor
13	591	682	9562	559	6	92	138	231	Mount Taylor Cerro Toledo
14	661	561	10084	219	6	70	177	103	Rhy
15	548	606	9055	520	10	90	132	225	Mount Taylor
16	556	647	9454	528	9	93	139	232	Mount Taylor
17	585	566	9006	506	12	90	126	226	Mount Taylor
18	495	911	8382	594	5	75	115	201	Mount Taylor Cerro Toledo
19	636	543	9586	210	4	67	175	97	Rhy
20	452	826	7714	557	6	76	113	200	Mount Taylor
21	444	623	8675	499	9	86	130	222	Mount Taylor
22	389	846	7930	569	6	71	115	193	Mount Taylor
23	539	129	5975	2	57	6	22	0	not obsidian
24	441	621	8506	521	6	90	135	227	Mount Taylor
25	397	642	9444	528	3	86	130	224	Mount Taylor
26	493	655	9290	538	8	92	133	227	Mount Taylor
27	403	645	9010	525	11	86	133	225	Mount Taylor
28	375	649	9098	525	7	89	129	227	Mount Taylor
29	397	694	9434	555	5	87	138	235	Mount Taylor
30	452	655	9006	528	6	88	131	228	Mount Taylor
31	388	575	8441	513	4	89	130	224	Mount Taylor
32	352	802	7632	566	5	79	114	207	Mount Taylor
33	538	679	9440	527	8	88	132	226	Mount Taylor
34	378	779	7584	565	8	75	113	194	Mount Taylor
35	395	614	8488	508	5	87	129	224	Mount Taylor
36	403	621	6555	486	7	71	103	184	Mount Taylor
37	360	614	8756	520	5	88	131	233	Mount Taylor
38	398	759	7601	547	6	75	114	190	Mount Taylor
39	418	811	7977	566	9	79	112	194	Mount Taylor
40	451	555	8157	485	6	82	125	217	Mount Taylor
41	420	685	9498	540	6	87	137	236	Mount Taylor
42	408	636	8899	539	5	91	139	241	Mount Taylor
43	427	849	8556	607	6	78	116	204	Mount Taylor
44	469	622	9017	521	7	87	133	229	Mount Taylor
45	677	369	6110	364	6	78	112	197	Mount Taylor
46	376	862	7918	578	8	75	111	210	Mount Taylor
47	446	725	9752	564	6	90	140	240	Mount Taylor Cerro Toledo
48	571	490	9039	201	6	63	171	93	Rhy
49	447	650	9183	527	8	90	137	237	Mount Taylor



Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
50	364	617	8546	508	7	85	131	226	Mount Taylor
51	343	724	7348	522	7	73	106	182	Mount Taylor
52	449	632	8785	538	10	91	137	237	Mount Taylor
53	364	739	10130	576	9	91	141	246	Mount Taylor
54	349	827	7792	569	8	80	113	187	Mount Taylor
55	441	805	7740	547	6	75	107	184	Mount Taylor
RGM1-S4	1676	296	12986	157	110	27	221	12	standard
RGM1-S4	1587	300	13009	153	107	25	220	7	standard
RGM1-S4	1583	299	12985	151	106	27	216	8	standard

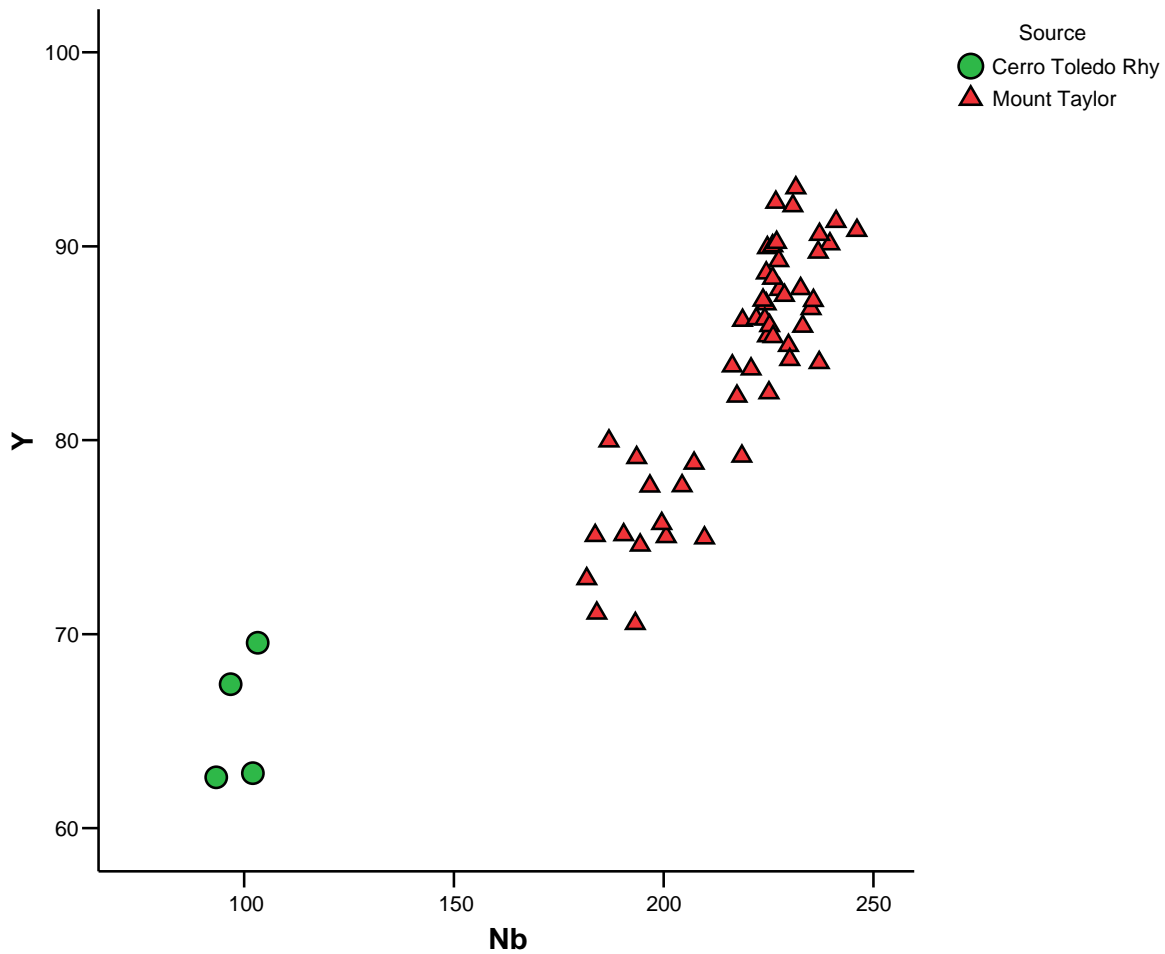


Figure 1. Nb versus Y bivariate plot of the elemental concentrations for the archaeological specimens from this study.

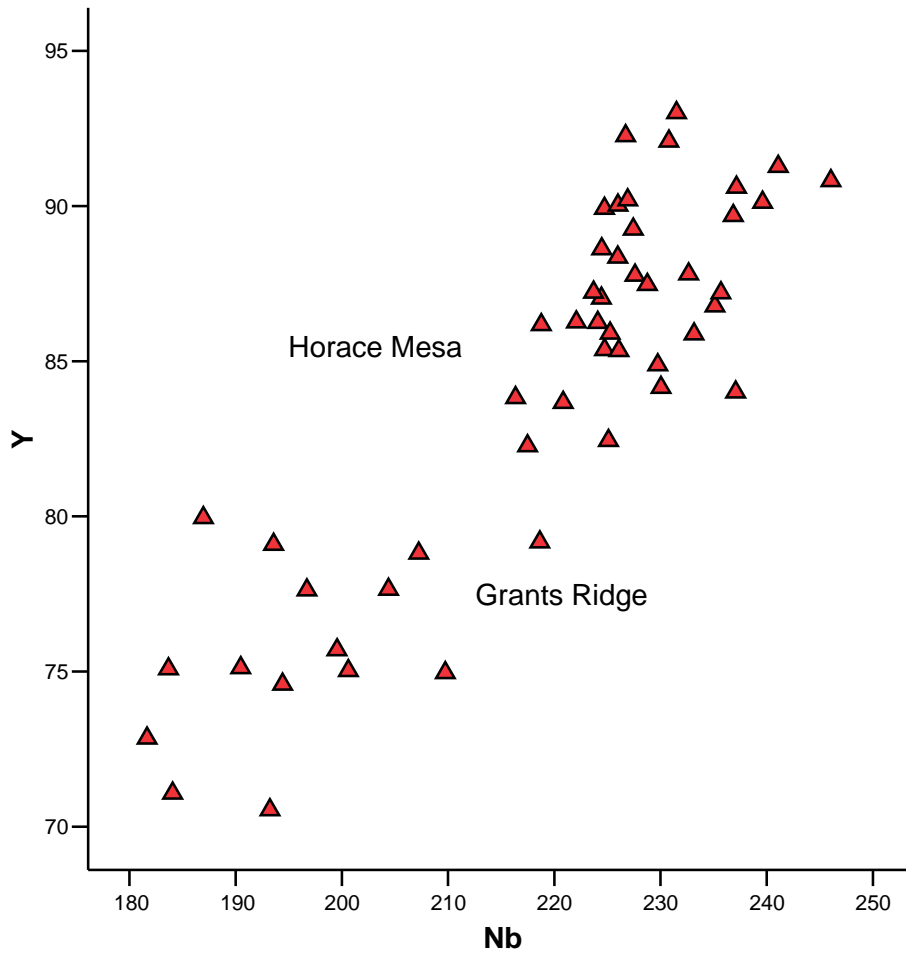
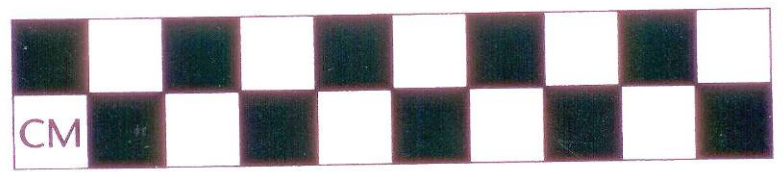


Figure 2. Nb versus Y bivariate plot of the elemental concentrations for the Mount Taylor chemical groups (see Shackley 1998)

### EARLY TO LATE STAGE POINT PREFORMS



### CORE FRAGMENTS



Figure 3. Core fragments and projectile point production stages. Note angular versus waterworn cortex on cores (bottom row). All artifacts produced from Mount Taylor obsidian.

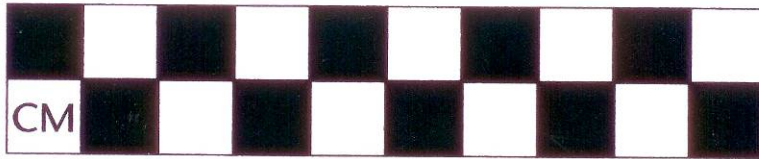


Figure 4. Obsidian projectile points from Pottery Mound. Arrowpoints (top row) represent in-haft breaks, and possible in-haft rejuvenation. Projectile points bottom row are likely Archaic and Basketmaker forms. All points produced from Mount Taylor obsidian except 80.61.417-19 (bottom row) produced from Cerro Toledo Rhyolite obsidian.