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Source Provenance of Unknown Obsidian Samples

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Author
Shackley, M. Steven

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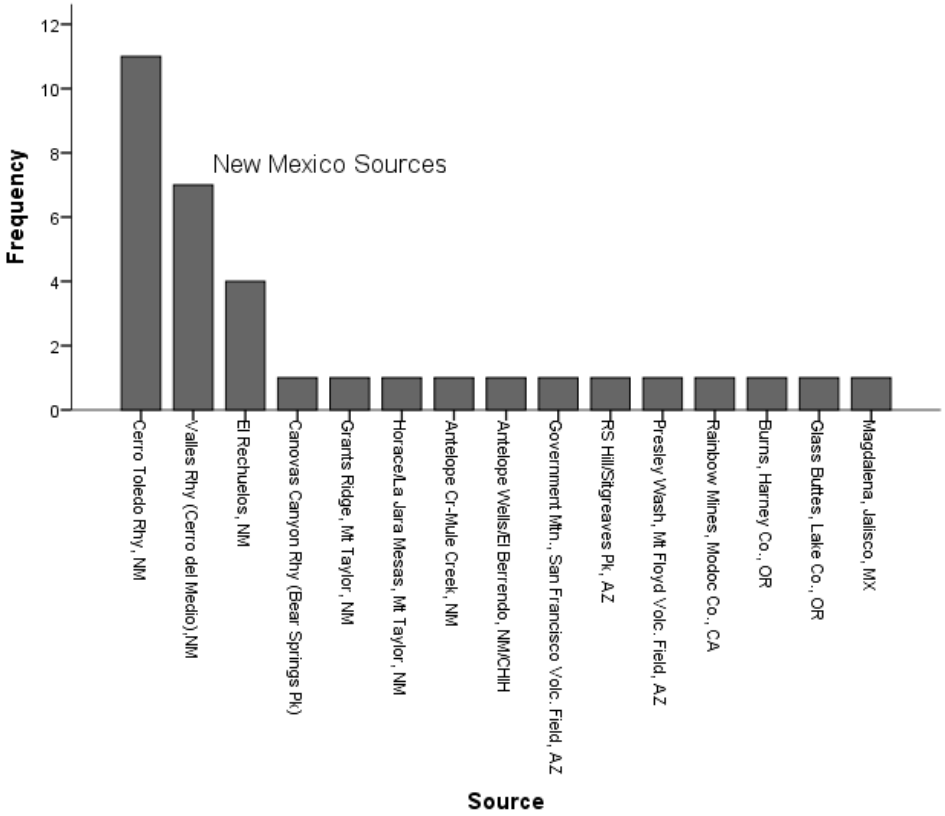
GEOARCHAEOLOGICAL XRF LAB

GEOARCHAEOLOGICAL X-RAY FLUORESCENCE SPECTROMETRY LABORATORY
8100 Wyoming Blvd., Ste M4-158 Albuquerque, NM 87113
USA

SOURCE PROVENANCE OF UNKNOWN OBSIDIAN SAMPLES



by

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

Report Prepared for

Robin Mario Cordero
Office of Contract Archaeology
Maxwell Museum of Anthropology
University of New Mexico
Albuquerque, New Mexico

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INTRODUCTION

The analysis here of 35 obsidian rock samples from the collection at OCA indicates a dominance of obsidian from New Mexico sources, particularly Jemez Mountains sources, but outlier samples from Arizona, California, and Oregon that are mainly well known sources used for flintknapping and often available in rockhound outlets. The Magdalena, Jalisco, Mexico source is more difficult to explain.

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.

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 generally using an 8.8 mm tube collimator to generate x-ray intensity Ka-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). 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 software for manipulation and on into SPSS for Windows (Release 21) 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 of ≤ 20 for obsidian artifacts to check machine calibration (Table 1).

Source assignments were made by reference to the laboratory data base (see Shackley 1995, 2005; online at http://swxrflab.net/swobsrcs.htm), and consultation with Craig Skinner at the Northwest Research Obsidian Laboratory in Corvallis, Oregon. Further information on the laboratory instrumentation can be found at: http://www.swxrflab.net/. Trace element data exhibited in Table 1 are reported in parts per million (ppm), a quantitative measure by weight.

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Table 2. Elemental concentrations for the rock samples and USGS RGM-1 rhyolite standard.

Sample	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Source
1	803	544	17845	156	167	13	72	762	57	Magdalena, Jalisco, MX
2	1788	339	14451	46	89	180	14	141	19	Presley Wash, Mt Floyd Volc. Field, AZ
3	586	449	11729	110	193	14	63	172	94	Cerro Toledo Rhy, NM
4	925	527	13170	240	211	10	59	164	87	Cerro Toledo Rhy, NM
5	570	512	11925	104	209	12	63	175	93	Cerro Toledo Rhy, NM
6	569	379	10068	44	147	15	21	71	42	El Rechuelos, NM
7-1	643	411	12002	71	161	12	44	172	53	Valles Rhy (Cerro del Medio),NM
7-2	548	523	12151	103	210	9	70	182	99	Cerro Toledo Rhy, NM
8	1157	387	12452	66	149	16	43	166	54	Valles Rhy (Cerro del Medio),NM
9	1317	325	12247	35	148	142	26	108	42	vitrophyre, no source
10	1037	321	12299	52	122	65	20	161	17	Rainbow Mines, Modoc Co., CA
11	762	481	12192	113	205	11	67	170	90	Cerro Toledo Rhy, NM
12	650	527	12149	117	207	12	65	178	100	Cerro Toledo Rhy, NM
13	852	348	11181	49	88	33	55	103	11	Glass Buttes, Lake Co., OR
14	717	509	11457	64	107	82	22	83	54	Government Mtn., San Francisco Volc. Field, AZ
15	684	384	11590	54	238	21	40	115	29	Antelope Cr-Mule Creek, NM
16	586	489	11987	104	205	10	67	180	96	Cerro Toledo Rhy, NM
17	522	772	11462	207	579	12	81	123	194	Grants Ridge, Mt Taylor, NM
18	1385	897	19627	197	372	10	142	1259	103	Antelope Wells/El Berrendo, NM/CHIH
19	642	403	11802	66	162	16	43	165	55	Valles Rhy (Cerro del Medio),NM
20	995	432	16629	142	102	12	83	618	45	Burns, Harney Co., OR
21	622	467	11855	97	201	9	65	178	95	Cerro Toledo Rhy, NM
22	327	384	11516	146	380	10	87	166	251	RS Hill/Sitgreaves Pk, AZ
23	593	364	11389	64	155	13	45	161	53	Valles Rhy (Cerro del Medio),NM
24	595	407	10027	36	149	12	20	75	46	El Rechuelos, NM
25-1	596	517	12153	128	212	12	64	175	95	Cerro Toledo Rhy, NM
25-2	415	585	11793	200	514	15	85	135	225	Horace/La Jara Mesas, Mt Taylor, NM
26	576	389	11368	61	153	12	45	155	52	Valles Rhy (Cerro del Medio),NM
27	599	340	11219	67	148	12	41	159	54	Valles Rhy (Cerro del Medio),NM
28	528	447	11680	101	197	10	64	172	90	Cerro Toledo Rhy, NM
29	1867	470	11630	110	202	10	64	175	92	Cerro Toledo Rhy, NM
30	607	412	10109	42	147	14	22	74	44	El Rechuelos, NM

31	1135	2253	11154	55	143	16	23	73	46	El Rechuelos, NM
Sample	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Source
32	679	398	11817	97	157	14	44	168	51	Valles Rhy (Cerro del Medio),NM
33	723	411	10390	43	113	44	22	102	49	Canovas Canyon Rhy (Bear Springs Pk)
RGM1-S4	1550	301	13741	38	147	107	25	222	10	standard
RGM1-S4	1504	313	13762	42	150	104	25	222	10	standard