Title
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SOURCE PROVENANCE OF ARCHAEOLOGICAL OBSIDIAN FROM MESA COUNTY, COLORADO

by

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Report Prepared for

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INTRODUCTION

The analysis here of 8 obsidian artifacts from sites in Mesa County, western Colorado indicates an extremely diverse assemblage with artifacts produced from sources in northern Arizona (Government Mountain), northern New Mexico (Valles Rhyolite-Cerro del Medio), Idaho (Malad), Wyoming (Teton Pass), and western Utah (Wild Horse Canyon; see Figures 1 through 4). These sources are hundreds of kilometers from Mesa County in three cardinal directions (west, south, north). One sample could not be assigned to source in the Skinner/Shackley database that included over 260 North American obsidian sources.

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 from 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.

Trace Element Analysis

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 100 seconds livetime 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 linear 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 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; c.f. 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, and 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 and into JMP 12.0.1 for statistical manipulation. The USGS rhyolite standard RGM-1 is analyzed during each sample run of ≤20 samples for obsidian artifacts to evaluate machine calibration (Table 1). Source assignments were made by reference to source data in the Skinner/Shackley database of >260 North American obsidian sources.

Table 1. Elemental concentrations and probable source assignments for the archaeological obsidian, and RGM-1 a USGS rhyolite/obsidian standard. All measurements in part per million (ppm).

Site/Sample	Ti	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Ba	Source
5ME18555-1	1064	366	10350	57	128	124	29	82	17	1518	Teton Pass, WY
5ME944-1	1312	281	10197	112	127	80	37	91	14	1919	Malad, ID
5ME3891-1	1050	402	10834	118	169	12	46	176	62	0	Valles Rhy (Cerro del Medio), NM
5ME18552-1	936	255	9869	58	148	36	37	120	11	529	unknown[1]
5ME19743-1	954	373	10677	89	168	17	44	169	60	0	Valles Rhy (Cerro del Medio), NM
5ME22579-1	801	476	9839	101	118	78	21	86	55	358	Government Mtn, AZ
5ME22586-1	875	491	9924	103	112	87	23	79	55	318	Government Mtn, AZ
ISOLATE-1	1101	368	9123	44	211	46	26	123	29	186	Wild Horse Canyon, UT
RGM1-S4	1534	302	13197	38	151	106	27	219	12	833	standard

[1] I requested confirmation of the "unknown" characterization of this sample, and he came to the same conclusion.

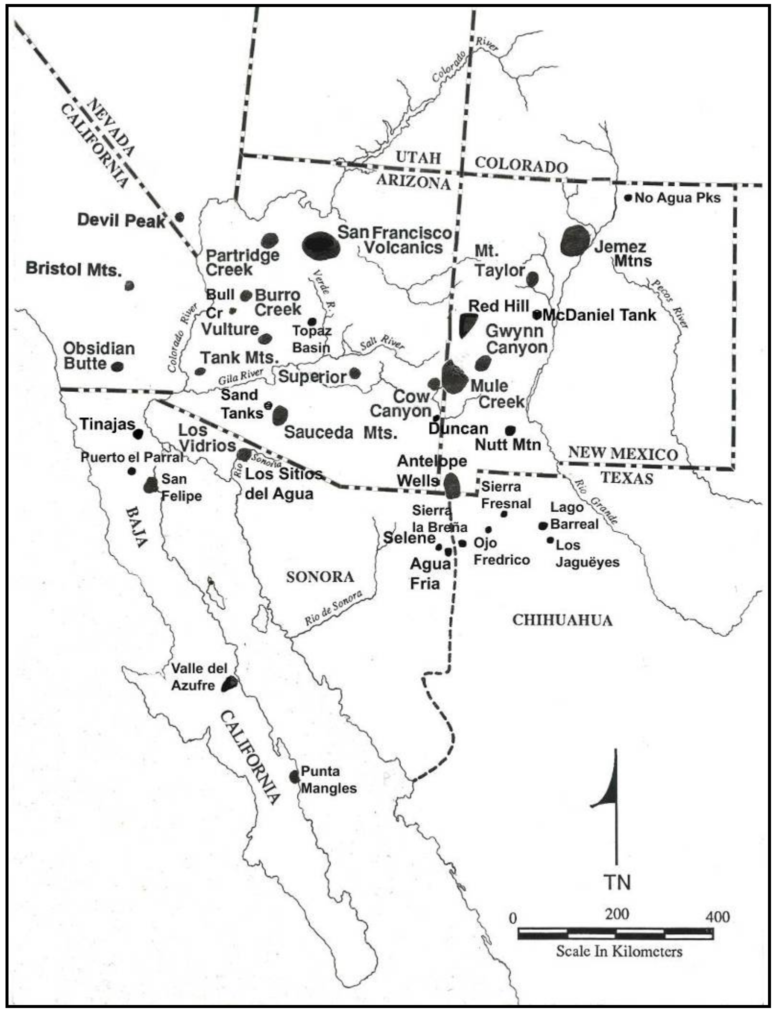

Figure 1. Approximate obsidian source locations in the North American Southwest including Government Mountain and the Valles Rhyolite source in the Jemez Mountains. Adapted from Shackley (2005; Panich et al. 2017).

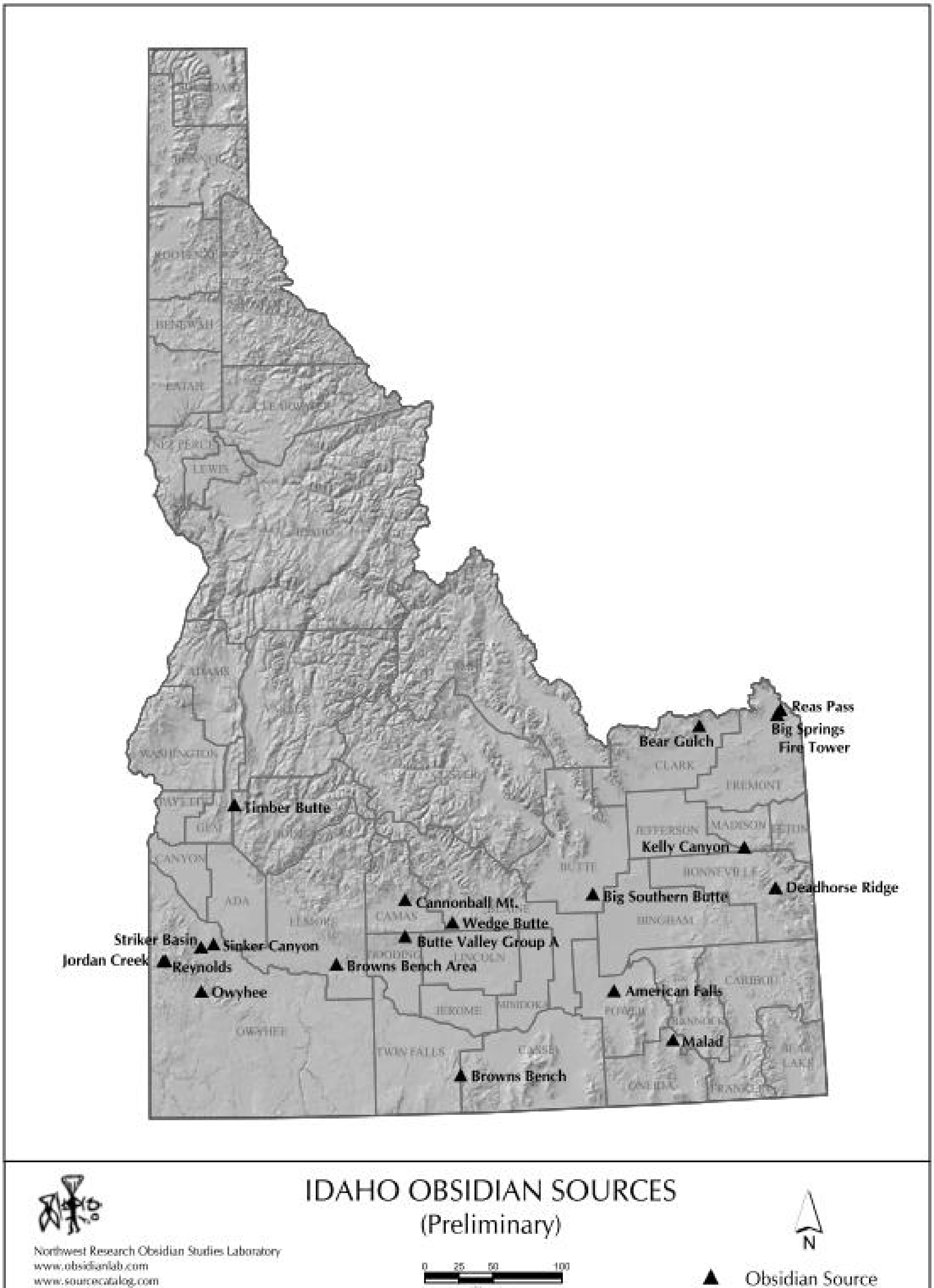

Figure 2. Location of Idaho obsidian sources, including Malad.

Figure 3. Location of obsidian sources in Utah, including Wild Horse Canyon.

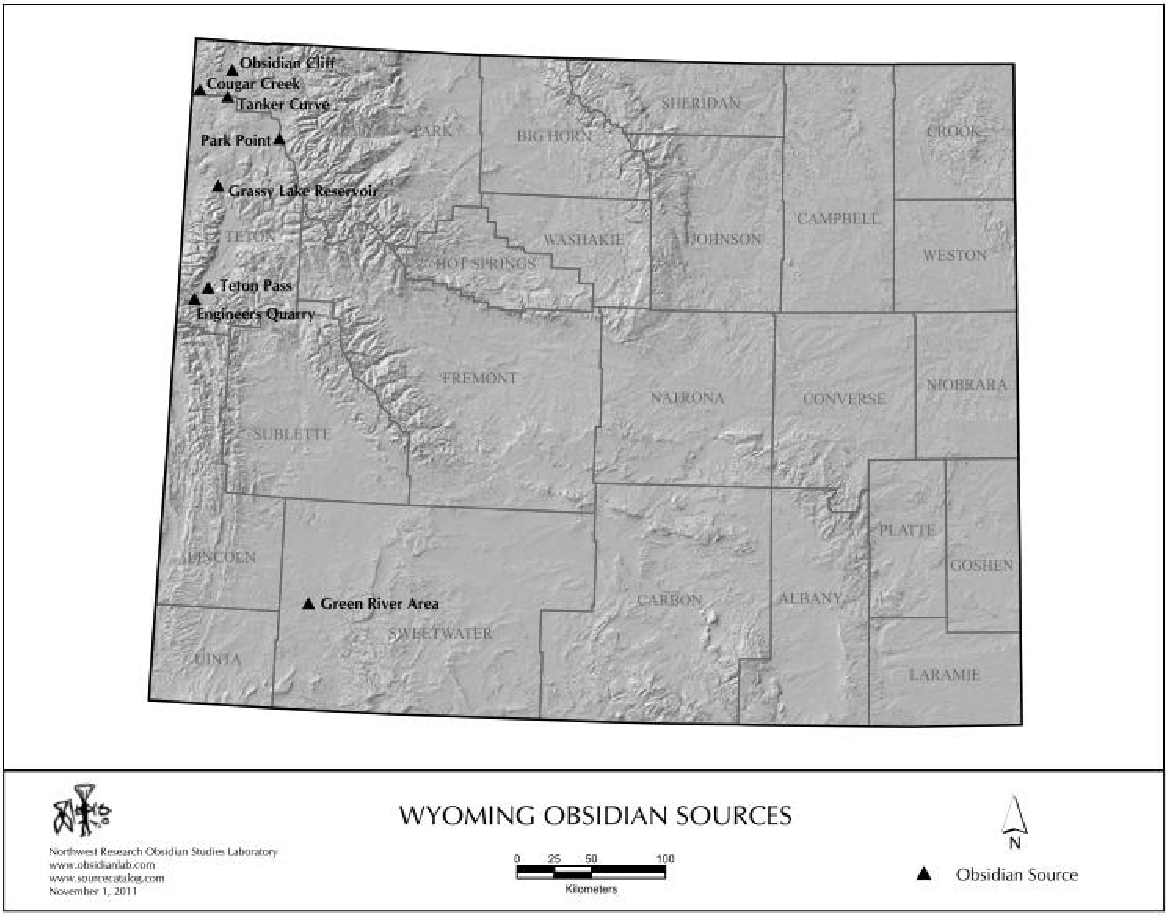

Figure 4. Location of Wyoming obsidian sources including Teton Pass.

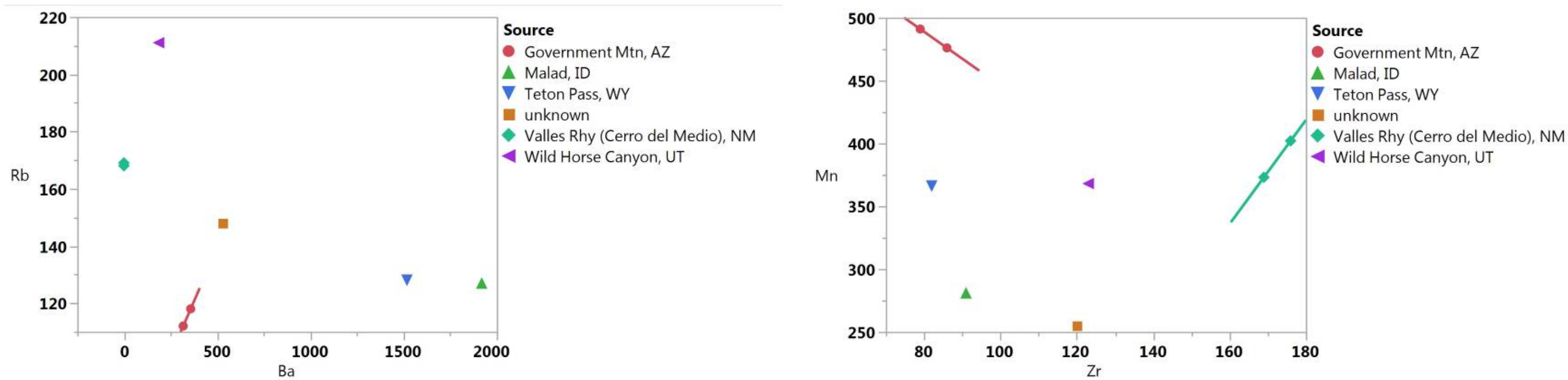

Figure 5. Ba/Rb and Zr/Mn bivariate plots of the archaeological samples. All measurements in parts per million (ppm). Confidence lines at 95%.

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