SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM THE
BASKETMAKER II-III DARKMOLD SITE (5LP4991) LA PLATA COUNTY,
SOUTHWEST COLORADO

by

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INTRODUCTION

The analysis here of 20 obsidian artifacts from the Basketmaker II-III Darkmold Site in southwest Colorado exhibits a mix of Jemez Mountains, New Mexico El Rechuelos and Valles Rhyolite (Cerro del Medio) obsidian in proportions opposite found in earlier studies (see Arakawa et al. 2011; Table 1, Figures 1 and 2 here) in slightly later chronological contexts. The possible implications of which are discussed below. Two samples analyzed in June 2013 increased the number of Valles Rhyolite samples by one. One of the samples (#568) is a glassy dacite with no known provenance based on an analysis of the oxides (see Table 2 and Figure 3).

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 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 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.

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 $\text{Fe}_2\text{O}_3^T$), 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 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 up to 1.0 mA, ratioed to the bremsstrahlung region (see Davis 2010; 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 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). 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 (see also Figure 1).

**DISCUSSION**

**The Jemez Sources of Archaeological Obsidian**

Taken together, the pre-caldera and caldera sources of archaeological obsidian in the Jemez Mountains of northern New Mexico (approximately 200 km SW of this site) are volumetrically the largest sources in the Southwest (Shackley 2005). El Rechuelos obsidian derived from a rhyolite dome complex along Cañada del Ojitos north of the Valles Caldera is a pre-caldera event dated to about 2.09 mya (Kempter et al. 2007). El Rechuelos obsidian erodes into the Chama River and then into the Rio Grande, probably not an issue for this procurement (Shackley 2005).

Cerro del Medio a resurgent dome from the Valles Rhyolite caldera collapse is dated to about 1.23 mya and is volumetrically the largest single archaeological obsidian source in the Southwest (Gardner et al. 2007; Phillips 2004; Shackley 2005). This eruptive event was
relatively quiet compared to the previous Cerro Toledo eruption that carried ash well to the southeast of the caldera and created the Bandelier Tuff and high quality obsidian. Unlike Cerro Toledo Rhyolite obsidian, Valles Rhyolite has not eroded outside the caldera in any quantity, and so had to be originally procured from Cerro del Medio proper (Shackley 2005, 2012).

Prehistoric Procurement

With respect to media for tool production, El Rechuelos and Valles Rhyolite can be considered equal. While Valles Rhyolite is available in larger nodule sizes and quantities, much of it contains spherulites, while the El Rechuelos glass generally does not (Shackley 2005). Both sources have been used throughout prehistory from Clovis periods onward, and Valles Rhyolite has been recovered from archaeological contexts continent wide (Hamilton et al. 2013; Steffen and LeTourneau personal communication).

Recent obsidian provenance research in the greater Mesa Verde region by Fumi Arakawa and Scott Ortman has shown shifts in procurement from about A.D. 600 to A.D. 1280 (Arakawa et al. 2011). During Basketmaker periods the diversity of obsidian source procurement is quite diverse mirroring relatively high residential mobility and a lack of social boundary defense or physically defended boundaries. By A.D. 1060 most of the obsidian raw material was procured exclusively from the Jemez Mountains sources. During Basketmaker III-Pueblo I periods about 61% came from El Rechuelos, 37% from Valles Rhyolite, and the remainder (about 2%) from Cerro Toledo (Arakawa et al. 2011: Fig. 7; Figure 2 here). This is the opposite case with these 19 samples from BM II-III contexts with 63.2% from Valles Rhyolite, and 36.8% from El Rechuelos (Figure 4). While it is a small sample, it could suggest that procurement during Basketmaker I was slightly different. It could also be sampling error, however, since the quantity of obsidian provenance studies in this early period is limited. I suspect that procurement was quite diverse during BM I times, and while this could be typical, perhaps not.
Parenthetically, I personally find El Rechuelo obsidian a better media for projectile point production than Valles Rhyolite, but I’m obviously not a BM I knapper.

REFERENCES CITED

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Hildreth, W.

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Kempter, K.A., S.A. Kelley, and J.R. Lawrence

Mahood, Gail A., and James A. Stimac
McCarthy, J.J., and F.H. Schamber

Phillips, E.H.

Schamber, F.H.

Shackley, M. Steven


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Table 2. Oxide analysis of sample 568 and USGS RGM-1 standard (see Figure 3).

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Figure 1. Nb, Y, Zr three-dimensional plot of the elemental concentrations for all archaeological specimens.
Figure 2. Left – proportional frequency distribution of obsidian source provenance through time in the Arakawa et al. (2011; Fig. 7) study; Right – proportional frequency distribution of obsidian source provenance in this study (not including one Valles Rhyolite sample analyzed later (#988)).
Figure 3. TAS plot of sample 568, a dacite.