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2013-2014 PROJECTS

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Faculty: *ROB STERNBERG*, Franklin & Marshall College, *JOSHUA FEINBERG*, Univ. Minnesota, *STEVEN SHACKLEY,* Univ. California, Berkeley, *ANASTASIA STEFFEN*, Valles Caldera Trust, and Dept. of Anthropology, University of New Mexico
Students: *ALEXANDRA FREEMAN*, Colorado College, *ANDREW GREGOVICH*, Colorado College, *CAROLINE HACKETT*, Smith College, *MICHAEL HARRISON,* California State Univ.-Chico, *MICHAELA KIM*, Mt. Holyoke College, *ZACHARY OSBORNE*, St. Norbert College, *AUDRUANNA POLLEN*, Occidental College, *MARGO REGIER*, Beloit College, *KAREN ROTH*, Washington & Lee University

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Faculty: *JOHN GARVER*, Union College, *CAMERON DAVIDSON*, Carleton College
Students: *BRIAN FRETT*, Carleton College, *KATE KAMINSKI*, Union College, *BRIANNA RICK*, Carleton College, *MEGHAN RIEHL*, Union College, *CLAUDIA ROIG*, Univ. of Puerto Rico, Mayagüez Campus, *ADRIAN WACKETT*, Trinity University,

EVALUATING EXTREME WEATHER RESPONSE IN CONNECTICUT RIVER FLOODPLAIN ENVIRONMENT*:*
Faculty: *ROBERT NEWTON*, Smith College, *ANNA MARTINI*, Amherst College, *JON WOODRUFF*, Univ. Massachusetts, Amherst, BRIAN YELLEN, University of Massachusetts
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GEOCHEMICAL VARIABILITY OF OBSIDIAN IN WESTERN NEW MEXICO WITH LABORATORY-BASED PXRF

KAREN ROTH,Washington and Lee University
Research Advisor: Jeffrey Rahl

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GEOCHEMICAL CHARACTERIZATION OF THE MULE CREEK OBSIDIAN, NEW MEXICO

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Research Advisor: Mark Brandriss

INTRODUCTION

Obsidian had great importance in the culture and life of the prehistoric peoples in the American Southwest. Its ability to be knapped into a sharp tools and weapons made it extremely useful. The geochemical characterization of obsidian from outcrops and artifacts have allowed archaeologists to determine the sources of many artifacts (Shackley 2005). By identifying these sources, archaeologists can establish a range of procurement and trade strategies (Shackley 2005). The goal of the summer 2013 Keck Project, Magnetic and Geochemical Characterization of In Situ Obsidian, New Mexico, was to determine whether obsidian nodules and artifacts can be sourced to a specific area in an outcrop within an individual flow (known as intra-flow sourcing or sub-sourcing). Knowing the different source areas of artifacts from the same flow may give archaeologists the ability to determine a more precise use of resources, especially through time (Frahm and Feinberg, 2013). The goal of this study is to characterize three obsidian sites by high-precision XRF trace element analysis and compare the results with those obtained by non-destructive EDXRF analysis in order to assess the accuracy and precision of the EDXRF technique.

GEOLOGIC SETTING

North Sawmill Creek, Antelope Creek and West Antelope Creek are different obsidian sites located in the Mogollon-Datil volcanic province in southwestern New Mexico. The Mogollon-Datil volcanic field was formed due to east-west spreading of the Rio Grande Rift. The three sites are part of the Mule Creek source area (Sternberg, this volume. Fig.1), erupted ~17.7 Mya (Shackley, 2005). The vent is located approximately 10 km north of the settlement of Mule Creek, which is approximately 3.5 km east of the Arizona state line on NM-78 (Ratté, 2004).

METHODOLOGY

Sample Collection and Field Relationships

Samples were collected from three locations: North Sawmill Creek, Antelope Creek and West Antelope Creek. Obsidian nodules were collected from outcrops *in situ* or loose from the ground. Individual nodules or groups of nodules were georeferenced using a Trimble Juno Sb with a precision of ±3 meters.

North Sawmill Creek consists of a weathered ashflow. Each of the nodules collected at the site were georeferenced by GPS. All 17 samples in this study were loose nodules, also known as marakenites, lying on the road. Groups collected single nodules every 5 m along roughly linear profiles.

At Antelope Creek, obsidian covers about 4050 m^2 (Ratté, 2004). Nodules were collected *in situ* or from the ground, in the wash. The *in situ* nodules were removed from a perlite matrix after being georeferenced (perlite is a heavily devitrified rhyolitic glass). The *in situ* nodules were collected approximately every 25 m from walls of the outcrop. There were 2-3 nodules to a georeferenced point. The nodules at each georeferenced point were collected in close proximity, within 1 meter to one another. Multiple groups of 20 free floating obsidian nodules were collected from the wash. Groups were approximately 20 to 110 meters from one another.

Nodules from the West Antelope Creek site were randomly collected. The area is wide open and loose obsidian nodules lie on the surface. There are no exact georeferenced marakenites. The source and vent areas of obsidian nodules from this site are not currently known.

Lab Methods

Trace element concentrations were determined by X-ray fluorescence (XRF) analysis. All sample preparation and analysis took place in the Ronald B. Gilmore lab at the University of Massachusetts Amherst under the guidance of Michael Vollinger and J. Michael Rhodes.

A Phillips PW2400 sequential spectrometer was used for analysis. For XRF preparation, nodules were crushed, powdered, pressed and baked.

Crushing

Nodules were crushed with a mortar and pestle until there were no shards larger than 0.5 cm. The mortar and pestle were scrubbed with hot water, doused with acetone, and cleaned with a high pressure air compressor after crushing every crushed nodule. Each nodule from an individual locality was treated as a separate sample.

Powdering

A tungsten carbide shatterbox was used to powder the glass shards to the appropriate size needed for analysis. The shatterbox components were handled with Kimwipes to avoid contamination. All shatterbox components were cleaned at the beginning and end of each day by processing quartz beach sand and scrubbing them with hot water and rinsing with acetone. All parts of the shatterbox and the platform on which it rested, were cleaned between samples. All pieces were scrubbed with hot water, doused with acetone and dried with compressed air.

PRESSING AND BAKING

Samples were pressed into pellets for analysis. For each sample, 10 g was measured out and mixed with polyvinyl alcohol, which acted as a temporary binder. The mixture was placed in a steel press and a pressure of 6 tons was applied. The pellet was then placed on a tray and baked at 60ºC to remove the alcohol.

RESULTS

Bivariate plots were constructed showing Y, Nb, Sr and Zr concentrations. These trace elements were chosen due to their high inter-site variability and for comparison with the Shackley (2010) study. North Sawmill Creek and Antelope Creek are chemically distinct from one another (Figs. 1 and 2), whereas the West Antelope Creek and Antelope Creek sites are similar to each other (Figs. 1 and 2). There is very little chemical variation within each locality (Figs. 1 and 2). Within all three Mule Creek localities, no chemical distinctions can be found among nodules from the same outcrop.

DISCUSSION

Data for the North Sawmill Creek and Antelope Creek localities collected in this study were compared to the data collected by Steven Shackley (2010). The older analyses were completed with a ThermoScientific Quant'X EDXRF spectrometer (Shackley 2010). Nodules analyzed by the EDXRF were not destroyed, unlike the samples analyzed for this study, which were powdered.

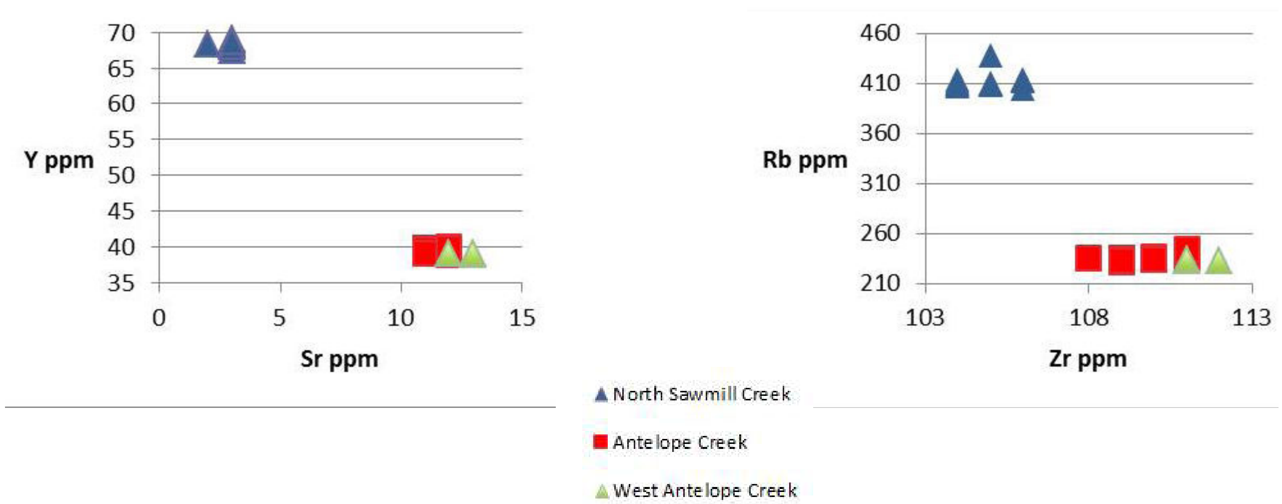
The most recent element concentration data display tighter clusters, meaning they are more precise than past data (Figs. 3, 4 and 5). This is related to the destructive nature of this study's XRF analysis and use of a precise analytical instrument. The preparation process of nodules in this study resulted in homogeneous pellets. The analyses of these homogeneous pellets and the use of a more precise analytical instrument resulted in more precise data for each locality. Both sets of data were able to differentiate between North Sawmill Creek and Antelope Creek localities. The West Antelope Creek site was not analyzed in the last study. Neither set of data are able to intra-source nodules. Plots in figures 1 through 5 display no pattern in data within individual sites.

Compared to the EDXRF data, the XRF data are consistently more precise. All plots of XRF data display tight groups, while plots of EDXRF data are much more scattered. EDXRF analysis works better for certain element pairs than others. The Y/Nb bivariate EDXRF data displays tighter plots than the Rb/Zr bivariate data. (Figs. 3 and 4).

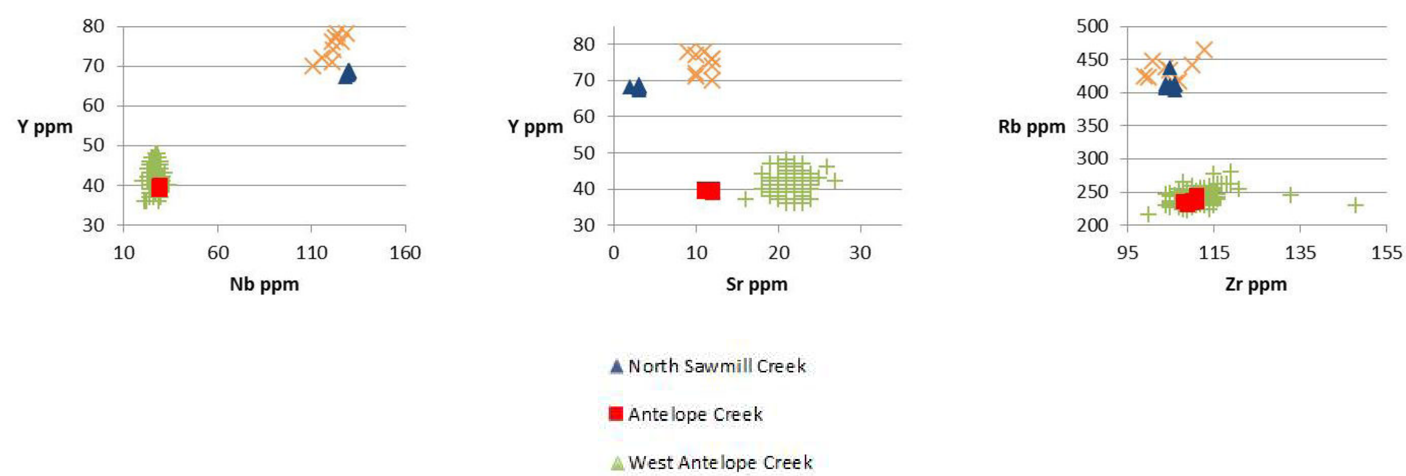
The similar chemical composition of Antelope Creek and the West Antelope Creek site could be due to a shared source. Because the West Antelope Creek site is approximately 3 km from of Antelope Creek, the obsidian nodules could be from a common vent. Magnetic analysis may be able to verify this.

CONCLUSION

XRF data are capable of determining from which flows the nodules are derived from, but not from which outcrop or quarry within a flow. Though less precise, EDXRF is also capable of sourcing nodules by distinguishing between flows. The EDXRF preparation process used in Shackley's (2010) study was non-destructive, while the XRF preparation in this study required destruction of nodules. Given



Figures 1 & 2. Bivariate plots of summer 2013 data. North Sawmill Creek nodules are distinguished from Antelope Creek and West Antelope Creek. There is no evidence of substantial intra-source variations.



Figures 3, 4 & 5. Bivariate plots of summer 2013 data and past (Shackley, 2010) data. XRF analysis yielded more precise data than EDXRF data. The intrasource variability in the EDXRF data appears to be due to the lower precision of the analyses rather than actual chemical variations in the obsidian.

the inability of either process to distinguish between outcrops or quarries within a flow, EDXRF analysis would be sufficient in future geoarchaeological obsidian studies, given its quicker process, non-destructive nature and practical results.

Other participants of the summer 2013 Keck project in New Mexico are determining whether magnetic analysis techniques are able to intra-source nodules or artifacts.

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