An Interview with Suzanne Lewis

Following the Path of Stone

Origins of a Continent
At the University of Southern Indiana (USI) Department of Geology and Physics, geology majors nearing the end of their undergraduate education are required to synthesize their coursework into a focused and integrated scholarly inquiry that is a hands-on and in-depth investigation of a geological topic of interest and significance. They must prepare and present this “capstone project” in both written and oral formats.

As an undergraduate, Amy Bleichroth had an interest in the geological facets of archeology. For her capstone coursework, Bleichroth and I, as her advisor, designed an investigation into the stratigraphic origins of the different rocks used for tool-making by Native Americans and native peoples around the world. Bleichroth investigated sources of chert, jasper, flint, quartzite, obsidian, and other types of stone commonly used by Native Americans and found in archeological contexts.

Identifying the geological sources of stone tools uncovered at archeological sites is a form of forensic geology that has proven to be a valuable contribution to archeological interpretations that might otherwise be speculative. Geologic sourcing of lithic artifacts helps to reconstruct exchange patterns, illuminate cultural interactions, and map trade routes of prehistoric peoples. During Bleichroth’s final year at USI, she learned of some obsidian artifacts archived at the university that had been uncovered at a nearby archeological site. Obsidian sourcing has proven particularly useful due to the limited geography of obsidian outcrops and the homogeneity of the rock itself. Obsidian artifacts are found throughout prehistoric Hopewell sites along rivers in the Midwestern United States (Davis et al. 1995). However, the closest surface outcrop of obsidian is at least 1,800 kilometers (1,100 mi) away from the sites where these obsidian artifacts occur.

Together, Bleichroth and I developed a project that would use geochemical analyses to identify the origin of obsidian used in artifacts recovered from the Mann site in Posey County, Indiana. This project tested the hypothesis that the obsidian artifacts found in Indiana originated in the Yellowstone Plateau, even though Yellowstone National Park is nearly 2,500 kilometers (1,600 mi) from Posey County, Indiana, and Bear Gulch, Idaho, is 2,700 kilometers (1,700 mi) distant. The experimental design helped formulate the objective: to apply obsidian sourcing by specific geochemical analytical techniques in order to identify the origin of obsidian for artifacts recovered from the Mann site. This project showed the applicability of geological forensics in furthering our understanding of the direct linkage among widely separated cultures thousands of years before the present. It applied concepts of historical geology, stratigraphy, mineralogy, petrology, and archeology, in a single, integrated study.

The Mann Site

The Mann site in Posey County, Indiana, is one of the largest and most complex Hopewell tradition sites known in the Midwest. It served as an important ceremonial center during the Middle Woodland Period (200 BC to AD 500). The site extends over 1.5 kilometers (1 mi) along a high terrace bordering the floodplain of the Ohio River, about 15 kilometers (9.4 mi) upstream from its confluence with the Wabash River (fig. 1). The Mann site is remarkable for the quantity and diversity of exotic materials, the tremendous investment in mound and earthwork construction, and the range of activities evident on the site. It is distinguished from other Hopewell sites by its size, intensity of occupation, and complexity (Ruby 2006). The diversity of artifacts tells us that people of different cultural and social affiliations were attracted here and traded a large variety of exotic goods from sources far outside the region.

Figure 1. Map of the Mann site in southern Indiana. Numbers identify the constructed earthen structures, including notable mounds. Modified from J. Kellar (1979).
Methods

Part of the capstone project was to guide the student through the administrative elements of professional research as well. I guided Bleichroth through the preparation of a grant proposal to USI’s Endeavor Program, a program designed to assist undergraduate scholars in pursuit of their research. It is a competitive program, and not all students receive funding, but she was successful in obtaining financial support to contract geochemical analyses of obsidian. Five obsidian artifacts (three blades, one biface tip, and one sherd) of unknown origin, from the extensive collection of artifacts uncovered at the Mann site in Indiana, were submitted to the Northwest Research Obsidian Studies Laboratory for nondestructive x-ray fluorescence analysis (fig. 2). XRF can accurately measure trace element concentrations in any fine-grained solid, and is well suited to analysis of obsidian and fine-grained volcanic rocks such as basalt. Analyses were also generated for some other known and unknown artifacts so that we had a greater breadth of geochemical results to ponder. Two obsidian artifacts (one basal-notched stunner or blunt, and one sherd) known to originate from the Yellowstone Plateau and two fine-grained volcanic artifacts (basalt biface points) from West Virginia were used for reference and comparison.

Just like with DNA “fingerprinting,” trace element concentrations of obsidian sources form a catalogue of known “geochemical fingerprints.” The diagnostic trace element ratios that characterize the unknown samples are then compared directly to the catalogue of known obsidian sources. Specific and diagnostic trace element ratios such as zirconium versus strontium (Zr/Sr) or rubidium (Zr/Rb) allow researchers to match sample concentrations with known obsidian source concentrations. Ultimately these matched geochemical fingerprints to indicate, with a very high degree of certainty, the geologic sources for the obsidian used to manufacture the artifacts.

Results

XRF analyses identified two distinct geochemical signatures among the five obsidian artifacts from the Mann site, both of which were correlated with known obsidian sources in Wyoming and Idaho (Table 1). Four Mann site samples, three blades and single sherd (Mann 61b–61e) were traced to the Bear Gulch source in eastern Idaho. The Bear Gulch site in the Centennial Mountains (also known as the Camas/Dry Creek source) lies within the uplifted terrane of the Yellowstone Hotspot track, and its obsidian is often found paired with artifacts traced to Obsidian Cliff in Yellowstone National Park, Wyoming. The single biface tip sample from the Mann site (Mann 61a) was traced directly to Obsidian Cliff. Trace element concentrations of the four samples sourced to Bear Gulch (Mann 61b–Mann 61e) and the Obsidian Cliff sample (Mann61a) exhibit marked differences in rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Strontium and zirconium, which show the most diagnostic trace element signatures, served

![Figure 2. (A) Samples from the Mann site. Geochemical signatures indicate origins from the Obsidian Cliff flow and the Bear Gulch, Idaho, site in the Centennial Mountains. (B) Samples from the Obsidian Cliff flow on the Yellowstone Plateau. (C) Basalt artifacts found in West Virginia, lithic source unknown.]

<table>
<thead>
<tr>
<th>Sample</th>
<th>Artifact Type</th>
<th>Strontium</th>
<th>Zirconium</th>
<th>Obsidian Source</th>
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<tbody>
<tr>
<td>Mann 61a</td>
<td>Blade</td>
<td>9 ± 9 ppm</td>
<td>167 ± 7 ppm</td>
<td>Obsidian Cliff-YNP</td>
</tr>
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<td>Mann 61b</td>
<td>Blade</td>
<td>48 ± 9 ppm</td>
<td>301 ± 7 ppm</td>
<td>Bear Gulch, ID</td>
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<tr>
<td>Mann 61c</td>
<td>Blade</td>
<td>50 ± 9 ppm</td>
<td>306 ± 7 ppm</td>
<td>Bear Gulch, ID</td>
</tr>
<tr>
<td>Mann 61d</td>
<td>Sherd</td>
<td>45 ± 9 ppm</td>
<td>291 ± 7 ppm</td>
<td>Bear Gulch, ID</td>
</tr>
<tr>
<td>Mann 61e</td>
<td>Biface tip</td>
<td>46 ± 9 ppm</td>
<td>290 ± 7 ppm</td>
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<td>YELL 1</td>
<td>Sherd</td>
<td>8 ± 9 ppm</td>
<td>175 ± 7 ppm</td>
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<tr>
<td>WV 2</td>
<td>Basalt biface point</td>
<td>62 ± 9 ppm</td>
<td>58 ± 7 ppm</td>
<td>Unknown</td>
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</table>
as the primary “signature” linking the Indiana artifacts to known sources on the Yellowstone Plateau.

The Bear Gulch samples (Mann 6b-61e) have average strontrium concentrations of 47+9 ppm, and average zirconium concentrations of 297+7 ppm. The Obsidian Cliff sample has a strontrium concentration of 9+9 ppm and a zirconium concentration of 167+7 ppm. The two analyzed obsidian artifacts that were known to originate from the Yellowstone Plateau were also traced to Obsidian Cliff in Yellowstone National Park with strontrium concentrations of 8+9 ppm and a zirconium concentration of 175 and 180+7 ppm. These trace element concentrations correlate with known concentrations of the Obsidian Cliff Lava Flow (Davis et al. 1995). As expected, the two fine-grained volcanic artifacts from West Virginia had significantly, and distinctly, different trace element signatures, and likely originate from a geologic source in the eastern US, as yet to be determined.

Conclusions and Implications

Bleichroth’s project included a review of previous work on sourcing Midwestern artifacts. Our geologic source determinations for obsidian artifacts from Posey County, Indiana, correlate with results of previous lithic sourcing studies done on Hopewell obsidian artifacts in the Midwest (Griffin et al. 1969, Hatch et al. 1990, and Hughes 2006). Geochemical characteristics of the various artifacts are distinct, and we were able to conclude that the five obsidian artifacts from the Mann site do originate from the Yellowstone Plateau. Though we cannot determine with complete certainty the events that brought this obsidian to prehistoric people in the Midwest, Early Hopewell obsidian studies have hypothesized that the obsidian could have been obtained in a single acquisition event. However, multiple Hopewell obsidian artifact occurrences have since been identified, and could indicate that repeated procurement expeditions or “down-the-line trade” provided the obsidian found in these sites (Davis et al. 1995). Because our study identified obsidian sources that correlate to Hopewell obsidian artifacts from other archeological sites in Ohio, Illinois, and Indiana, it is reasonable to assume that inhabitants of the Mann site were involved in the same trade or lithic procurement activities as the rest of the Hopewell culture in the Midwest during the Middle Woodland Period.

This project serves as a valuable example of integrated research for an undergraduate geology major being mentored through the classic steps of the scientific method. Bleichroth made an observation—“obsidian artifacts were found at a Hopewell archeological site in southern Indiana, but there are no nearby sources of obsidian.” From that observation we formulated a hypothesis—“the obsidian used for those artifacts originated on the Yellowstone Plateau.” We designed an experiment to analyze trace-element concentrations by nondestructive XRF analyses for comparison to known obsidian sources. Finally, we interpreted the results to conclude that our hypothesis was correct. The fact that earlier scientific literature showed other Hopewell obsidian had been traced to Yellowstone demonstrated a certain “surrogate” reproducibility to the work. Bleichroth disseminated the research in a professional presentation at a meeting of the Geological Society of America.

In addition to the incredibly valuable educational experience gained by Bleichroth, this project also contributed to the scientific knowledge base for both geology and archeology. We now know with certainty that an important cultural site, the Mann site, was engaged in some form of transportation and/or commerce over 2,000 years ago; acquiring and bringing natural resources more than 2,500 kilometers (1,600 mi) from the Yellowstone Plateau into what is now southern Indiana.

Acknowledgements

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Paul K. Doss is a professor of geology at the University of Southern Indiana.

Amy Bleichroth graduated from the university of Southern Indiana in 2012.

Literature Cited