Source Identification of Mesoamerican Obsidian Using X-ray Fluorescence Spectrometry

Emily Hamilton and Dr. Jeffrey Ferguson

ABSTRACT

Obsidian is a naturally formed volcanic rock that was an important part of the various material cultures of Mesoamerica. It breaks in controlled ways through conchoidal fracturing and can be worked by knapping, grinding, and carving. Mesoamericans utilized its sharp edges in tools for hunting, warfare, and agriculture. They also used obsidian objects as burial goods, personal adornments, and components of ritual activities.

The Saint Louis Art Museum holds 99 objects identified as Mesoamerican obsidian in its collection, largely given to the museum in the 1980s by the collector Morton May. This group was examined using x-ray fluorescence spectrometry (XRF) as well as visual study by Dr. Jeffrey Ferguson of the University of Missouri Research Reactor Archaeometry Laboratory. The goal of analysis was to identify source information through trace element identification and physical attributes.

COLLECTION

Of the 99 pieces, 58 are reportedly from a single cache of objects in Teotihuacan (ca. 300-550 AD). The cache includes 21 human effigies, 14 animal effigies, and 23 bifacial knives or projectile points. In addition to the cache, 39 other obsidian objects were analyzed including 2 blade fragments, 1 ear spool, 8 labrets, and 28 various bifacial knives/projectile points. Of these objects, 9 are understood to be from the Mixtec, Aztec, or Tarascan cultures and 32 have no known contextual information.

Labret, Mixtec, ca. 1250-1450 AD, obsidian with turquoise, 1 x 1 5/8 x ¾ in. Saint Louis Art Museum, 140:1980.

Cache of Projectile Points, Blades, Eccentrics, and Figurines, Teotihuacan, Early Classic Period, ca. 300-550 AD, obsidian, largest figure: 5 7/8 x 2 5/16 x 1/2 in. Saint Louis Art Museum, 135:1980.1-.58.

The arrangement here is based on objects found in one of Teotihuacan's main pyramids, where larger blades and serpents surrounded a central figure in what seems to be a sacrificial tableau.

ANALYTICAL METHOD

The University of Missouri Archaeometry Laboratory holds one of the most extensive reference collections for obsidian sources in the world. Obsidian source identification utilizes a set of 37 very well-characterized samples with data from previous XRF, inductively coupled plasma-mass spectrometry (ICP-MS), and neutron activation analysis (NAA) measurements. Analysis of the SLAM obsidian was performed using a Bruker Tracer III-V XRF, a portable unit with a rhodium-based X-ray tube operated at 40 kV and a thermoelectrically-cooled silicon detector. All of the objects analyzed here were large and thick enough to allow for relatively short count times ranging from 90-120 seconds.

The main goal of data analysis was to identify distinct homogeneous groups within the SLAM objects and match these groups to the chemical signatures of known geologic sources. The key signature elements in these sources include rubidium (Rb), strontium (SR), yttrium (Y), zirconium (Zr), and niobium (Nb). Groups within the SLAM objects were identified by the unique relationships between the elements. Statistical analysis was carried out on base-10 logarithms of concentrations to compensate for differences in magnitude between major and trace elements. Decisions about whether to assign a specimen to a particular compositional group were based on the overall probability of a match.

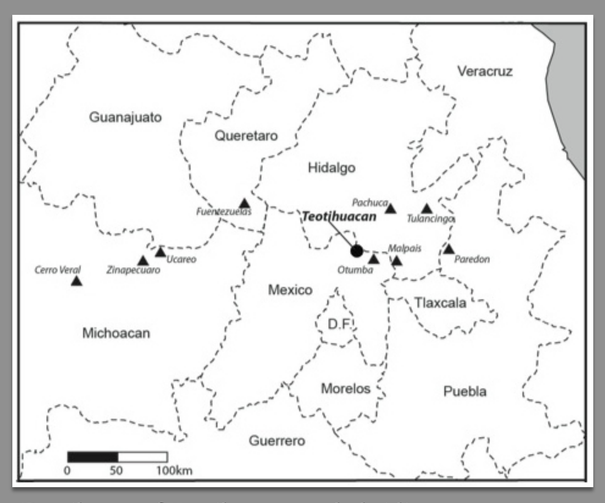
Obsidian objects from different sources also have key visual differences including color, opacity, inclusions, and surface texture. Observations about these attributes were made in tandem with trace element analysis.

RESULTS

The data was compared to obsidian source samples from all known sources in central and east-central Mesoamerica. The sources identified include Fuentezuelas, Pachuca, Paredon, Tulancingo, Ucareo, Zinapecuaro, Cerro Veral, Malpais, Otumba, and San Antonio Enchisi-2. The artifacts in the large cache are almost entirely from the major sources nearest Teotihuacan, supporting the understanding that this cache is from that region and may represent a collection of objects made nearby. The artifacts other than the cache reveal greater source diversity, including more sources to the west of Teotihuacan. The human and animal effigies reveal slightly greater source diversity than the points. There is some question about the five artifacts assigned to the San Antonio Enchisi-2 source as these could also be Otumba. Only one obsidian artifact was not assigned to a known Mesoamerican source. Two objects were found to be materials other than obsidian.

	Malpais	Not Obsidian	Otumba	Pachuca-1	Paredon	San Antonio Enchisi-2	Tulancingo	Ucareo	Cerro Varal	Fuentezuelas	Zinapecuaro	Unassigned	Total
Cache													
Animal	1		10	3									14
Human	1		13	7									21
Leaf			6	2									8
Projectile Point			13						2				15
Other													
Blade			1	1									2
Ear Spool					1								1
Labret				1		2		2	2			1	8
Projectile Point		2	9	3	2	1	1	7		1	4		30
Total	2	2	52	17	3	3	1	9	4	1	4	1	99
	<100km of Teotihuacan							>100km from Teo.					

Table of Results, organized by source and object type



Detail map of Teotihuacan and obsidian sources identified in this analysis, in central Mexico

CONCLUSION

Compositional data from XRF analysis provides clear source identification for 96 of 99 artifacts analyzed in this study. The data for these artifacts is consistent with 10 compositionally distinct sources in Mesoamerica, which supports SLAM's attribution and understanding of these works. This kind of analysis provides insightful information for artifacts where the context is irrevocably lost, though further contextual knowledge would greatly increase the historic and scientific value of these works.

Emily Hamilton
Associate Conservator, San Francisco Museum of Modern Art
Assistant Conservator, Saint Louis Art Museum 2012-2014
ehamilton@sfmoma.org

Dr. Jeffrey Ferguson
Research Assistant Professor, University of Missouri
fergusonje@missouri.edu

Special thanks to:

Michael Glascock assisted in the interpretation of this data. Partial funding for this project was provided by a National Science Foundation Grant to the MURR Archaeometry Laboratory (BCS1110793). Additional funding was provided by the Saint Louis Art Museum.

SAINT LOUIS ART MUSEUM