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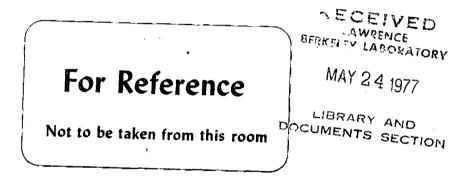**Permalink**
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HIGH-PRECISION CHEMICAL CHARACTERIZATION
OF
MAJOR OBSIDIAN SOURCES IN GUATEMALA

F. Asaro, H.V. Michel, R. Sidrys, F. Stross

Elemental analysis of obsidian has been shown to be useful
in reconstructing ancient trade routes. A sizable amount of
work has been done on Mesoamerican sites and sources (Cobean
et al 1972, Hammond 1972, Heizer et al 1965, Stross et al 1976a)
In this paper we propose to deal with two problems that have
naturally arisen in these studies, and to contribute to their
solution: 1. it has often been difficult or impossible to
compare results of the different studies and thus, to make
them universally useful, because different elements are usually
reported, the number of elements may vary, and the reliability
of the results have tended to differ from author to author;
2. the cost of reliable analysis and sampling is perhaps far
higher than necessary.

Previous research has shown that in some cases a correlation
of an artifact with its source can be made by analysis of only
two or three elements, but that in other instances a far greater
number of elements must be determined to reach a firm conclusion
with regard to the source of the glass. This is not only for
the obvious reason that the chance of overlapping patterns

increases with increasing number of supply sources and archaeo-
logical sites, but also for another reason. A priori state-
ments on the chemical composition pattern of an unanalyzed
obsidian source are impossible to make. An obsidian source
or supply area may have several outcrops, which may or may not
be chemically similar. However, even an individual outcrop
may show a systematic variation within its own boundaries
(Bowman et al 1973). A source thus has to be adequately sampled
so that its homogeneity may be demonstrated, or, if it is found
to be heterogeneous, that the character of the variation of its
composition may be defined by analysis.

It thus becomes desirable to develop libraries of composi-
tion patterns for all sources of archaeological obsidian of a
given region. These composition records should be as complete,
accurate, and precise as possible. They should be published in
units and in a form that makes it convenient to compare them,
and thus be of use to all interested in identifying artifacts
according to source. It is also desirable that the data be
published in journals that are generally known and accessible
to those working on the subject.

Comparison of the composition patterns of the obsidian of
a given cultural area often reveals that determination of the
abundances of a limited number of elements is sufficient to

distinguish the sources of the region in question. The determination of these few elements in the artifacts collected within this area should be sufficient to assign provenience to these artifacts, and would be far less expensive than a complete analysis of the samples. When a generally applicable, detailed catalogue of composition patterns is available, it is not too difficult to determine the most economical method for matching artifacts with their respective sources. Existence of reliable and complete source composition records for a particular region would also eliminate the need for expensive, repetitive expeditions to collect source samples to correlate with excavated artifacts.

To facilitate comparison of results, and also of equipment calibrations, it would also be highly desirable to make available a well-defined standard obsidian source sample, and it is hoped that sufficient quantities of such material may be collected and analyzed, for distribution at nominal cost to interested individuals or institutions.

The majority of known obsidian sources in eastern Mesoamerica recently have been systematically sampled and discussed (Sidrys et al 1976). As a start toward a complete library of obsidian source data of the area, these samples have been

analyzed by what we believe to be the most accurate and exten-
sive methods employed to date on Mesoamerican sources. We
hope that other research institutions with suitable facilities
will similarly contribute to this enterprise.

The analyses reported in this study were carried out by
neutron activation, by procedures previously described (Perlman
et al 1969; see also Stross et al 1976a).

Tables 1 - 4 characterize each of the four largest Maya
obsidian sources by 21 elements. Eleven obsidian sources are
recognized in the Maya sphere, but present archaeological
evidence indicates utilization of only four of these by the
ancient Maya and their precursors. Two of these sources,
El Chayal and Ixtepeque, are known to have been used from the
Early Preclassic (1800 - 800 B.C.) to the Late Postclassic
(1200 - 1450 A.D.) periods (Cobean et al 1971; Sidrys et al
1976; Sheets 1975). The San Martin Jilotepeque (Rio Pixcaya)
source (Nelson et al n.d., b) and the Tajumulco source (Stross
et al n.d.) appear to have been primarily exploited during
the Preclassic and Archaic periods, respectively.

The El Chayal source area (see Table 1) is one of the
largest sources in Guatemala. It includes at least two major

quarries (La Joya and El Chayal proper), each with many
workshops, and five other outcrops that are contained within
an area that ranges over some 100 km^2 (Sidrys et al 1976).
Table 1 presents chemical data for four of the seven out-
crops that have been surveyed in the El Chayal source area.
The outcrop designations used in Table 1 correspond to the
maps and text of the earlier survey (Sidrys et al 1976).
Likewise the terms "quarry" and "workshop" are used as
defined there.

In general, the El Chayal area is very homogeneous.
The samples designated "Roadcut 22-23 km from Guatemala
City" (listed under Outcrop 1-1), however, show small but
significant departures from the other road cut locations
of outcrops 1-1, and from the other El Chayal outcrops,
specifically in the elements Ce, Cs, Fe, La, Sc, Sm, U,
and Yb.

The Ixtepeque source has at least four large outcrops
and possibly more. Table 2 gives the chemical characteri-
zation of six samples of Ixtepeque obsidian. Two of these
are known to have come from Outcrop 2-1, the major quarry
area. The other four are from the collection of the Archaeo-
logical Research Facility at the University of California at

Berkeley; their more specific provenience is uncertain.
In the future we hope to publish further analyses of the
other Ixtepeque outcrops.

San Martin Jilotepeque is another of the large supply
sources in the Maya area. At least four outcrops have been
reported a short distance south of the town of San Martin
Jilotepeque and east of Comalapa (Sidrys et al 1976). No
quarries have been found as yet, although one has been
mentioned in a colonial document (Feldman 1973, p.93).
Obsidian from this source has been identified in the Pre-
classic levels at Edzna and Dzibilnocac, Campeche, Mexico
(Nelson et al, n.d., b). Table 3 gives the chemical data
for two samples from Outcrop 3-4. This designation was
given to the unknown source of obsidian found along or in
the nearby Rio Pixcaya river. We hope in the future to
analyze more samples from this important source.

Tajumulco is the westernmost obsidian source in the
Maya sphere. Three outcrops may exist in the area. The
first evidence that this deposit was used in antiquity has
come to light only recently (Stross et al n.d.). This was
a small flake fragment excavated at a site dated at 11,700
radiocarbon years B.P. (Gruhn et al n.d.). Tajumulco
volcano is only 45 km from Izapa, Mexico and is the site

of a Late Preclassic "proto-Mayan" culture. It would not
be surprising to identify Tajumulco obsidian in Late Pre-
classic lowland Maya sites in future studies of trace
elements.

The Tajumulco outcrops show more chemical variation
(Table 4) than do the other three Maya source areas. Three
samples collected from Outcrop 4-4, a roadcut in Tajumulco
village, are not really obsidian, but are more silicic in
composition, although they superficially resemble obsidian
and therefore might well have been used by the ancient tool-
makers.

If the measurements have a high degree of precision
and internal coherence, it is possible to gain substantial
insight into the homogeneity of a source area, or a devia-
tion from homogeneity. It is also possible sometimes to
pinpoint or to exclude from consideration certain outcrops
of a particular area. These points are illustrated in
Tables 5 and 6, in which are presented the detailed results
obtained on obsidian artifacts found at Maya sites in
Belize by N. Hammond (Stross et al 1976a). The agreement
of the averages of 21 samples from Lubaantun and 4 samples
from Wild Cane Cay (Table 5) with the various groups from
El Chayal is excellent, with the exception of the roadcut

samples particularly those "22-23 km from Guatemala City"
mentioned above. In Table 6 are shown the Hammond samples
identified with the Ixtepeque source on the basis of the
analyses. Sixteen samples from Wild Cane Cay, one sample
from Frenchman's Cay, and two samples from Moho Cay fall
in this group.

The average differences between the average values of
the 16 best measured elements of the 27 El Chayal samples
(with the exception of the roadcut samples) and the four
Wild Cane Cay samples identified with El Chayal is 1.1%.
The average standard deviation of the 16 elements in the
27 El Chayal samples is 2.3%. The average deviation in the
means for this group and the four Wild Cane Cay samples would
be expected to be $\sim 2.3 \times \sqrt{1/4 + 1/27}/6253 = 1.0\%$ which is
very close indeed to the 1.1% found.

Similarly the average difference between the corres-
ponding values of the Ixtepeque samples found at Wild Cane
Cay and the Ixtepeque source samples is 1.0%, while the
average standard deviation of the same (15) elements in
the Ixtepeque source is 2.7%. The average deviation in
the means for the Wild Cane Cay and the six Ixtepeque source
samples should be $\sim 2.7 = \sqrt{1/6 + 1/19}/1.253 = 1.0\%$.   This