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# High-Precision Chemical Characterization of Major Obsidian Sources in Guatemala

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# HIGH-PRECISION CHEMICAL CHARACTERIZATION
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# MAJOR OBSIDIAN SOURCES IN GUATEMALA

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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 archaeological sites, but also for another reason. A priori statements 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 composition patterns for all <u>sources</u> 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 extensive 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 outcrops 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 characterization 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 Archaeological 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 Preclassic 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 toolmakers.

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 deviation 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 corresponding 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