NOTES ON MESOAMERICAN OBSIDIANS AND THEIR SIGNIFICANCE IN ARCHAEOLOGICAL STUDIES

Robert F. Heizer, Howel Williams and John A. Graham

Prehistorians are interested in obsidian as a material from which artifacts were fashioned partly because the natural occurrence of this volcanic glass is rare and these few source localities have constituted a supply of trade material (Bosanquet 1904; Sarasin 1936). Archaeologists who have studied obsidian trade have been hopeful that chemical differences in obsidians from various sources might enable them to identify with certainty the original place from which imported obsidian found in archaeological sites was obtained. Unfortunately, however, ordinary chemical analyses of different obsidians are so much alike that this method of identification does not appear to be very promising. In certain instances obsidians contain significantly larger or smaller amounts of some specific element which enables one to identify the source (cf. Washington 1921, tables 1, 2), but these cases are the exception rather than the rule as one can tell from casual inspection of tables of chemical analyses. For illustration we provide here such a table drawn from published information provided by Williams, McBirney and Dengo (1964:43), Washington (1921), and unpublished data provided by Carl Fries, Jr., Instituto de Geología, University of Mexico. The analyses forwarded to us by Dr. Fries were made for him by Ing. Alberto Obregon-Perez, chemist of the Instituto de Geología. Ordoñez (1892) characterized six different obsidians of Mexico by identifying different forms of microlites in them. This approach to identification may be a useful one and perhaps deserves more attention than it has received. Washington (1921:482, 484) provides the refractive indices as determined by the immersion method for obsidian from Copán and Chichén Itzá. The two are sufficiently different to suggest that this characteristic might also be useful in distinguishing different obsidians.

In January, 1965, the authors spent two weeks in Guatemala visiting archaeological sites and conducting a site survey in the area of the volcano of Ixtepeque, Department of Jutiapa. We encountered widespread evidence of ancient obsidian-working in and near the village of Papalhuapa which lies near the base of Ixtepeque. This obsidian locality has been described by Williams, McBirney and Dengo (1964:38-42). It is obvious that the Ixtepeque source was extensively exploited and that the obsidian was collected for export purposes.

On our return to Berkeley we approached Mr. J. R. Weaver and Dr.

F. H. Stross for their suggestions on a method which could be employed to distinguish individual or local obsidian types. They proposed the use of x-ray fluorescence which has been known for some time as useful in mineralogical determination (Ashby 1961; Anon. 1958) and archaeological analysis (Hall 1960), and we submitted to them a limited series of samples which were selected to test the applicability of the method. The results of their examination are given in the preceding paper. While we were engaged in this laboratory work we received a copy of the paper by Cann and Renfrew (1964) which approached the same problem by a different method. The results of our method and of the Cann-Renfrew method are similar, and it is clear that by using either one it is possible to identify a piece of obsidian as coming from a specific source locality. There are thus available at least two means of determining how far in space obsidian from a given locality was diffused. We intend to continue our investigation of Mesoamerican obsidians along this line, and have begun to collect samples for testing.

We provide here a map showing the location of presently known obsidian localities in Mexico and Guatemala. There are, possibly, additional occurrences which are not indicated here, but at the same time it is probable that most of the important localities which were known and exploited in prehistoric times are indicated on Map 5.

Presented below are a few comments on the possible significance of the analyses provided by Weaver and Stross in Table 2 of the preceding paper.

Sample No. 1 comes from the obsidian locality called Glass Mountain which is near St. Helena, Napa County, California. This site has been described earlier (Heizer and Treganza 1944:303-306, map 1, figs. 5A, 5B, 7; Heizer, ed., 1953:248, site 31). It has always been assumed that the Glass Mountain obsidian was traded south and east to San Francisco Bay and the lower Sacramento Valley areas. To test this assumption Sample No. 2, from a Late Horizon site (Sol-2) was submitted for analysis, and in our opinion the results support the belief that the obsidian from site Sol-2 did in fact come from the Glass Mountain locality.

Sample No. 3 was collected by W. H. Holmes (1919:214-226) at Pachuca, State of Hidalgo, Mexico. We are indebted to Dr. Clifford Evans of the U.S. National Museum for providing us with this specimen from the well known obsidian locality which is also referred to as "Cerro de las Navajas" and "Mountain of the Knives." This obsidian is characteristically green in color, and it has been generally assumed whenever implements of this green obsidian occurred in Mexican sites that their source was the Pachuca flow. We provided Weaver and Stross with two additional samples of green obsidian, one an exhausted nucleus from Teotihuacán (Sample No. 6) and the other a small blade ("razor") from the site of La Venta, Tabasco (Sample No. 7), in the hope that we could discover whether all three were, as expected, so similar as to be considered derived from the same locality. Samples Nos. 3, 6, and 7 are sufficiently close in their trace element composition to indicate the strong probability, if not certainty, that this is a fact. Since the La Venta site is three hundred miles distant from Pachuca we have clear evidence of long range trade. The La Venta sample is not, unfortunately, accompanied with archaeological context, and we cannot say whether it dates from the period of the La Venta ceremonial site of about 800-400 B.C. or from after the abandonment of the ceremonial center, in which case the sample would be younger than about 2300 B.P. At the moment, therefore, we must be satisfied simply to know that Pachuca obsidian was traded as far away as La Venta.

Sample No. 4 is from the Guatemalan Ixtepeque obsidian deposit mentioned above, and the reason for determining its trace element characteristics is to learn whether it is distinctively different from Sample No. 9 which is from the extensive, though very much smaller, deposit at El Chayal in Guatemala which was mentioned by Holmes (1919:227) and described in greater detail by Coe and Flannery (1964). We also submitted a second Ixtepeque obsidian sample, Sample No. 8, which was red obsidian. By comparing the analyses of Samples Nos. 4 and 8 we can see that the two are very similar, and from this conclude that color variations such as red and black in the same obsidian deposit are visual rather than chemical differences. Sample No. 9, from El Chayal, appears to differ sufficiently from Samples Nos. 4 and 8 that it is possible to distinguish them.

Sample No. 5, a thin blade of black obsidian, came from Copán, and was made available through the kindness of Dr. H. Pollock from the collections of the Peabody Museum, Harvard University. Since it is fairly obvious that a great deal of worked obsidian in the form of implements, and perhaps raw material chunks or blanks, was exported from the Ixtepeque locality, we considered it possible that Copán might have secured obsidian from Ixtepeque. Washington (1921:481) suggests that obsidian occurs naturally in the immediate vicinity of Copán, but this is very much to be doubted; in any case no geologist has ever observed either obsidian flows or nodules imbedded in the ignimbrites in the Copán vicinity. The question cannot be answered on the basis of the very limited number of samples analyzed by Weaver and Stross; it is only possible to say that the Copán implement may have been derived from Ixtepeque, and that it was almost certainly not derived from the El Chayal locality.

Nothing offered here can be considered more than suggestion. It is, as Weaver and Stross point out, only after numbers of samples from each source locality are analyzed that we can know for certain what range of trace element characteristics for different obsidians exists. Cann and Renfrew (1964) have analyzed a very much larger series of obsidian samples from the Mediterranean region and were able to establish six major groups of obsidians. They have also been able, as we hope ultimately to do, to draw important culture-historical conclusions from their data. For our part, at this time we can only say that we believe x-ray fluorescence analysis will provide us with the same sort of useful data.

EXPLANATION OF MAP 5

Principal Obsidian Localities of Mexico and Guatemala
(Numbers refer to localities indicated on map)

No. 1 On highway from Guadalajara to Tepic; near town of Tequila. This locality is called Sierra de la Venta, near Magdalena, Jalisco, by West (1964:47).

No. 2 On highway from Zinapecuaro to Ciudad Hidalgo; just south of Zinapecuaro, Michoacan. This locality is called Sierra de San Andrés, near Ucareo, N.E. Michoacan, by West (1964:47).

No. 3 Near Cadareyto de Montes, Queretaro.

No. 4 Small cut with abundant material on road from Pachuca to Zacualcipan, Hidalgo; at the turnoff to Huayacocotla to the east.

No. 5 Las Minillas, Cerro de las Navajas; north of Cuyamaloya and east of Pachuca. Locality described by Holmes (1919:214-226) and Breton (1902).

No. 6 Obsidian exposed in cut on highway from Tulancingo to Posa Rica, Veracruz; between 145 and 146 km. markers.

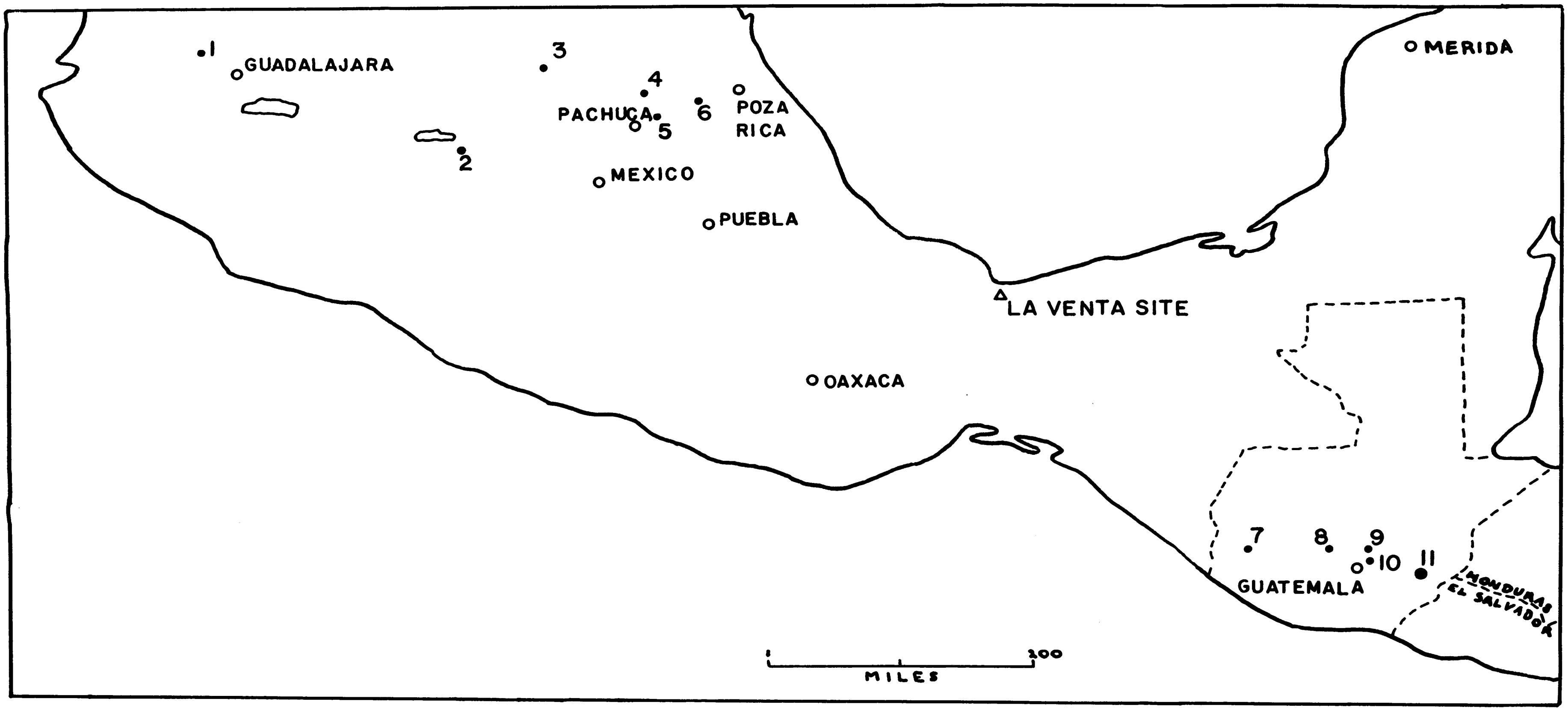
No. 7 Four miles southeast of town of San Pedro and approximately five miles east-southeast of San Marcos. Information taken from map in McBryde (1947).

No. 8 On road between San Martín Jilotepeque and Chimaltenango; 14 km. south of S.M. Jilotepeque and 17 km. north of Chimaltenango.

No. 9 El Chayal, near El Fiscal. Atlantic Highway from Puerto Barrios to Guatemala City cuts through exposures of obsidian. Area mentioned by Holmes (1919:227) and more fully described by Coe and Flannery (1964).

No. 10 On old highway to Sanarato, north of the Agua Caliente bridge.

No. 11 Ixtepeque volcano, Laguna de Obrajuelo and Agua Blanca area, southeast Guatemala. This is the largest of all obsidian areas in Middle America and probably the largest locality in the world. Described by Williams, McBirney and Dengo (1964).



Map 5

Principal Obsidian Localities of Mexico and Guatemala

EXPLANATION OF TABLE 3

Sample 1	Mexico: Site 6, Map 5. Analyses 1 through 6 were made by Ing. Alberto Obregon-Perez, Instituto de Geología, University of Mexico.
Sample 2	Mexico: Site 5, Map 5.
Sample 3	Mexico: Site 4, Map 5.
Sample 4	Mexico: Site 1, Map 5.
Sample 5	Mexico: Site 2, Map 5.
Sample 6	Obsidian knife from Teotihuacán, identical in color and luster with obsidian from Site 5, Map 5.
Sample 7	Nearly colorless obsidian from flakes of broken knives collected near Petlalcingo, Puebla, and north of Telixtlahuaca, Oaxaca, Mexico.
Sample 8	Obsidian implement from Copán, Honduras. After Washington 1921, Table 1.
Sample 9	Obsidian from Corinto, Nicaragua. After Washington 1921, Table 1.
Sample 10	Cerro de las Navajas, Mexico (same as Sample 2), Site 5 on Map 5. Compare with Sample 2, this table.
Sample 11	Cerro de las Navajas, Mexico (same as Samples 2 and 10 this table), Site 5, Map 5.
Sample 12	Ixtepeque volcano, Guatemala. After Williams, McBirney and Dengo 1964, table on p. 42, col. 1.
Sample 13	Crater of Laguna de Obrajuelo, Guatemala. After Williams, McBirney and Dengo 1964, table on p. 42, col. 2.
Sample 14	Obsidian bead from cenote at Chichén Itzá. After Washington 1921, Table 2, col. 1.

TABLE 3

Chemical Composition of Some Mesoamerican Obsidians

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SiO_2	73.65	74.63	73.72	74.56	75.43	74.78	75.50	74.46	76.68	75.23	75.64	73.08	72.67	75.58
TiO_2	0.29	0.28	0.31	0.25	0.12	0.29	0.16	0.45	-	-	-	0.26	0.21	0.10
Al_2O_3	12.80	11.43	13.32	13.15	13.04	11.46	13.60	13.13	14.49	12.36	12.68	12.99	13.20	9.67
Fe_2O_3	0.60	1.70	0.85	0.51	0.51	2.13	0.12	0.49	-	0.96	1.07	1.20	0.43	2.23
FeO	1.76	0.61	0.76	1.00	0.76	0.46	0.45	1.03	1.09	1.24	-	1.62	0.56	0.83
MnO	0.02	0.01	0.02	0.02	0.02	0.06	0.05	0.05	trace	-	-	0.06	0.01	trace
MgO	0.25	0.36	0.22	0.25	0.15	0.25	0.19	0.29	0.84	0.01	trace	0.43	0.23	0.21
CaO	0.63	0.00	0.66	0.66	0.43	0.00	0.45	1.25	1.53	1.00	0.83	1.22	0.78	0.72
Na_2O	4.28	5.43	3.13	4.10	4.73	5.73	4.48	4.52	3.92	4.00	4.98	3.84	2.99	5.13
K_2O	5.15	5.17	6.60	5.44	4.57	4.42	4.62	4.37	1.20	4.62	3.51	4.06	4.51	4.56
H_2O+	0.23	0.38	0.22	0.25	0.51	0.39	0.26	0.10	{ 0.36	{ 0.73	{ 1.58	0.89	4.22	0.38
H_2O-	0.01	0.03	0.03	0.06	0.00	0.05	0.09	0.03				0.36	0.27	
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.04	-	-
P_2O_5	0.08	0.08	0.09	0.08	0.06	0.06	0.02	0.09	-	-	-	0.13	0.01	-

- = no determination made

BIBLIOGRAPHY

Anonymous
1958 Spectrographic Analysis of Minerals and Rocks. California State Division of Mines, Mineral Information Service, Vol. 11, No. 8.

Ashby, G. E.
1961 Index to the Literature on X-Ray Spectographic Analysis: Part I, 1913-1957. American Society of Testing Materials, Special Technical Publication No. 292.

Bosanquet, R. C.
1904 The Obsidian Trade. In Excavations at Phylakopi in Melos. Society for the Promotion of Hellenic Studies, Supplementary Paper IV. London.

Breton, A.
1902 Some Obsidian Workings in Mexico. Proceedings of the International Congress of Americanists, XIII Session, pp. 265-268. New York.

Cann, J. R. and Colin Renfrew
1964 The Characterization of Obsidian and Its Application to the Mediterranean Region. Proceedings of the Prehistoric Society, Vol. 30:111-133. Cambridge, England.

Coe, M. D. and K. V. Flannery
1964 The Pre-Columbian Obsidian Industry of El Chayal, Guatemala. American Antiquity, Vol. 30:43-49.

Hall, E. T.
1960 X-ray Fluorescent Analysis Applied to Archaeology. Archaeometry, Vol. 3:29-35. Oxford University Press.

Heizer, Robert F. (ed.)
1953 The Archaeology of the Napa Region. University of California Anthropological Records, Vol. 12, No. 6.

Heizer, Robert F. and A. E. Treganza
1944 Mines and Quarries of the Indians of California. California Journal of Mines and Geology, Vol. 40:291-359.

Holmes, W. H.
1919 Handbook of Aboriginal American Antiquities: Vol. 1, Introductory; The Lithic Industries. Bureau of American Ethnology, Bulletin 60. Washington.

McBryde, F. W.
1947 Cultural and Historical Geography of Southwest Guatemala. Smithsonian Institution, Institute of Social Anthropology, Publication No. 4.

Ordoñez, E.
1892 Algunas Obsidianas de México. Memorias de la Sociedad Científica "Antonio Alzate," Vol. 6:33-35. México.

Sarasin, F.
1936 Über die Rolle des Obsidians in Prähistorie und Volkerkunde. Verhandlungen der Naturforschenden Gesellschaft in Basel, Vol. 47:146-169. Basel.

Washington, H. S.
1921 Obsidian from Copán and Chichén Itzá. Journal of the Washington Academy of Sciences, Vol. 11:481-487. Washington, D.C.

West, R. C.
1964 Surface Configuration and Associated Geology of Middle America. In Handbook of Middle American Indians, R. Wauchope, ed., Vol. 1:33-83. University of Texas Press, Austin.

Williams, H., A. R. McBirney and G. Dengo
1964 Geologic Reconnaissance of Southeastern Guatemala. University of California Publications in Geological Sciences, Vol. 50.