International Association for Obsidian Studies
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Assembled by B. Hamusek

CONTENTS

NEWS AND INFORMATION

AUSTRALASIAN ARCHAEOMETRY: RETROSPECTIVES FOR THE NEW MILLENNIUM: CALL FOR PAPERS

The Sixth Australasian Archaeometry Conference will be held at the Australian Museum, Sydney from 10-13 February 1997. As this will be the last official meeting on Australasian archaeometry this millennium, the Conference will present an overview of the current status of archaeometry, major achievements, recent advances, and applications. For this purpose, archaeometry is defined in the broadest context and contributions are sought from as wide a field as possible. We expect that as at previous conferences, there will be a major session devoted to obsidian studies including dating, characterization, use-wear and residues.

At this early stage of planning, the organizing committee invites contributions in the form of major reviews of techniques and applications as well as suggestions for paper and poster session on significant thematic issues that place importance on interdisciplinary studies.

Suggested themes to date include:

1. Human colonization of Australasia and Oceania.

2. Extinction: its causes and timing.

3. Natural resources, production, trade and exchange in a worldwide perspective.

Academic sessions will be held at The Australian Museum and there will be a one day visit to the AMS and other facilities at ANSTO including a BBQ and business meeting to consider the organization of the archaeometry community in Australasia, national

facilties, etc. As with previous conferences distinguished overseas visitors will present public lectures in association with the conference.

To receive the Second circular and registration materials, please send your name and address to:

Secretariat
Sixth Australasian
Archaeometry Conference
AINSE
PMB 1
Menai NSW 2234
Australia

Send ideas for sessions, review papers, or paper abstracts to the Academic program chairmen:
Dr. Claudio Tuniz, AINSE (as above); Tel (61-2-7173493); Fax (61-2-7179256); e-mail: tuniz@atom.ansto.gov.au

or

Dr. Richard Fullagar, Division of Anthropology, The Australian Museum, 6 College Street, Sydney South NSW 2000, Australia. Tel (61-2-3206147); Fax (61-2-3206058); e-mail: richardf@amsg.austmus.oz.au

IAOS NEWS AND INFORMATION

The proposed changes to the IAOS By-laws which Steve Shackley and others worked on during the past year were approved in December 1995. The amendments to the By-laws received more than the two-thirds votes of votes casts which were required of the mail ballot. For copies of the amended By-laws please contact the Secretary-Treasurer.

In other news, candidates for IAOS officers were selected by the membership for the offices of President Elect/Vice-President and Secretary-Treasurer. The nominations for President Elect are Robert Tycot, Harvard University and Dr. Jonathon Ericson of University of California, Irvine. For the position of Secretary-Treasurer, Jeff Hamilton of Redwood Valley, California, was nominated. Position statements for all three candidates will be sent by separate mail along with a voting ballot.

The next IAOS meeting will take place during the SAA meeting in New Orleans from April 10-14, 1996. Results of the elections will be announced at this time.

RECENT RESEARCH ON OBSIDIAN SOURCES IN THE SOUTHERN SIERRA MADRE OCCIDENTAL, MEXICO

by J. Andrew Darling

Museum of Anthropology, University of Michigan, Ann Arbor, Michigan

In spite of recent advances in obsidian studies in the American Southwest and even more work on the sources of the Central Highlands and the Neovolcanic Chain of Mexico, almost nothing is known of the obsidian resources found in the intervening zone in the Sierra Madre Occidental. This immense Tertiary volcanic

field or physiographic province extends more than 1200 km from north to south encompassing a wide variety of potential deposits of volcanic glass yet to be identified and explored. In our recent investigations of obsidian extraction and distribution in the southern Sierra Madre Occidental and the western Neovolcanic chain, conducted as part of an archaeological, settlement pattern survey in the Tlaltenango Valley, Zacatecas, we have identified and chemically characterized at least five new obsidian sources as well as 10 to 15 unknown compositional groups based on artifact data representing still unlocated obsidian deposits.

Compositional analysis to date has included 130 samples from five volcanic glass sources and 93 obsidian artifacts from sites throughout the north-central Mesoamerican frontier in the states of Durango, Zacatecas, and Jalisco. Known sources include Huitzila, La Lobera, and Nochistlán, located at the southern extreme of the Sierra Madre Occidental in Zacatecas and Jalisco, Llano Grande in the state of Durango to the north, and Ixtepete, which is a gravel source associated with the neovolcanic Sierra La Primavera found to the west of Guadalajara. An additional 61 artifacts from southern Zacatecas are currently being analyzed and will complete the present study later this year. Compositional analysis using neutron activation is being conducted at the laboratories of the Missouri University Research Reactor Center (MURR) under the direction of Michael Glascock and all results are integrated into the Missouri obsidian database. A comparative set of 100 geologic samples from Huitzila, La Lobera, and Llano Grande were also studied at the University of Michigan, Ford Nuclear Reactor/Phoenix Memorial Laboratory for the purpose of interlaboratory comparison.

Preliminary results of compositional analysis indicate a separation of Sierra Madre-related obsidian sources from those sources located in the Mexican neovolcanic province. Huitzila and La Lobera, located just north of the Rio Santiago, show greater similarities to neovolcanic sources including Ixtepete, as well as the La Joya and La Mora-Teuchitlán sources of Jalisco which have been described by Phil Weigand and Michael Glascock. Nochistlán and Llano Grande clearly associate with the Sierra Madre Occidental (Figure 1).

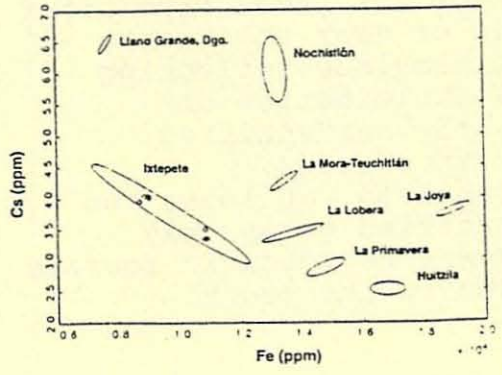

Figure 1: Bivariate plot illustrating separation of sources considered in this study. Ellipses are at the 95% level of confidence.

Comparative studies of archaeological artifacts have identified many source matches based on composition as well as an abundance of unidentified compositional groups. As shown in Figure 2, there is a clear north-south division indicated by the two ellipses representing the combined samples for known sources found in the Sierra Madre Occidental and Neovolcanic provinces examined during this study.

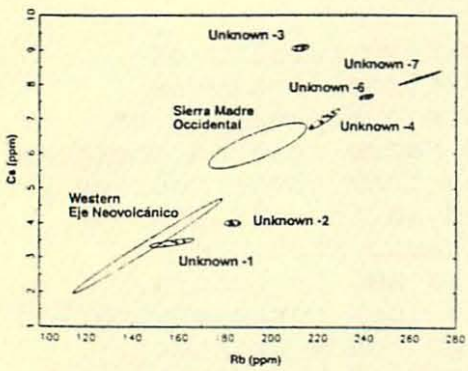

Figure 2: Bivariate plot illustrating the relationship of unknown compositional groups represented by artifacts and 95% confidence ellipses to ellipses representing the combined geologic samples of known sources.

The distribution of most of the unknown groups shown suggests an association with the Sierra Madre Occidental formation. This is attributable to our artifact sample which comes from sites within or near the Sierra Madre province reflecting local exploitation of currently unidentified northern sources. Nevertheless, at least two unidentified groups may represent neovolcanic sources located in the south.

These results provide evidence for prehispanic, local obsidian extraction and utilization as well as long-distance distribution or exchange particularly from high quality neovolcanic sources to populations in the north. The variety of obsidian sources utilized and the paucity of data currently available to identify the many, as yet unidentified, compositional groups underlines the current need for continued obsidian research in North and West Mexico. This is especially true for the Sierra Madre Occidental about which very little is known and for which few sources have been recorded.

Note: This article is a summary of a paper by J. A. Darling and M. D. Glascock presented last summer at the III Coloquio Pedro Bosch Gimpera, sponsored by the Universidad Autónoma de México.

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TRACE ELEMENT CHARACTERISTICS OF CENTRAL ANATOLIAN OBSIDIAN FLOWS AND THEIR RELEVENCE TO PRE-HISTORY

by Joseph Yellin

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INTRODUCTION

The occurrence of obsidian artifacts in prehistoric archaeological sites in Israel, and in the Mediteranean and the Near East, in general, is very important evidence bearing on the movements of people, and prehistoric trade patterns and exchange networks. The quantity of obsidian artifacts or flakes found in Israel is too small to suggest a brisk trade or major production centers. Cores and flakes have been found suggesting that raw material may have been an object of trade and that there was some local industry. The total absence of obsidian sources in Israel makes obsidian artifact finds an especially important material for tracing the movements of people into this region. Netiv Hagdud is the earliest site in Israel (about 8000 BCE)[1] from which obsidian has been available for analysis. For this material to be useful as a tracer of movements of people and trade or exchange it is necessary to relate the obsidian artifacts to their sources. For this, one must obtain the characteristics of obsidian specimens collected from all possible sources which could relate to the archaeological material. The best way to charcterize obsidian in terms of precision and accuracy is by its trace elements employing neutron activation analysis. We point out, however, that there are other methods which are currently employed, e.g., X-ray fluorescence,[2,3] plasma emission spectrometry,[4] fast neutron activation,[5] and fission-track dating (FT).[6] The nearest potential sources of obsidian artifacts recovered from sites within Israel that can be reached overland are in central Anatolia about 1000 km north of the southernmost site in Israel where obsidian artifacts have been found. These are the most logical sources to characterize first.

Other sources are shown in Fig. 1 along with the central Anatolian sources.[7]

Results of analysis of 188 samples collected at a number of obsidian flows within central Anatolia (Fig. 2) are reported here. A considerable body of information has already been obtained from archaeological obsidians from sites in Israel which relate to these sources.[8-12]

The obsidian specimens analyzed represent a random selection from a larger collection made by S. Payne with M. Charlesworth of the British School of Archaeology at Ankara and S. Ozkuzey and I. Uyfue of the Maden Tetkik ve Arama Enstitüsü (Mineral Research and Exploration Institute of Turkey), Ankara. The collection was made during a five-day field trip in the iller of Niğde and Nevşehir in November of 1973. The collection by no means represents a full sampling of obsidian in the area. The collection focused on localities where obsidian was known to occur and with the object of collecting as wide a range of samples as time permitted. There were some localities where obsidian was known to occur but which could not be sampled for lack of time. For example, Karakapu, recorded by Renfrew et al.,[13] was not sampled. It is also likely that obsidian will be found in other localities in the general sampling area. Samples were chipped from obsidian flow outcrops where possible, and if no flow outcrop was found, samples were taken of pieces of obsidian included within tuff or ignimbrites, or from surface scatters. In the latter case the samples are designated "loose" in the field notes. Generally, 4-6 pieces of obsidian were collected in each locus; each piece from which samples were taken for analysis was given an identifying letter in addition to the field number. Transcribed field notes, together with maps and photographs,[14] have been deposited with the Maden Tetkik ve Arama Enstitüsü, Ankara, and with the British Institute of Archaeology at Ankara. One copy of the field notes is with the author.

Time did not permit a detailed examination of the geological occurrence of each sample. There has been substantial volcanic activity in central Anatolia at least since the Upper Miocene.[15] All the obsidian flows reported in this paper fall within the area mapped by Innocenti et al.[15] as "quaternary volcanics (lava domes, flows of cinder deposits of Acigöl, Göllü Dağ, and Hasan Dağ; central volcanoes of Erciyes Dağ and Hasan Dağ)" (Fig. 2). Some of these flows appear to be of relatively recent date: Innocenti et al. report a fission-track age determination of 15,000 to 25,000 years, based on an obsidian sample from Acigöl,[15] and there are historical reports of volcanic activity

International Association for Obsidian Studies

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February 2, 1996

Dear Member,

Enclosed you will find a pre-stamped (where possible) card with the nominees for the offices of President-Elect and Secretary-Treasurer for the International Association for Obsidian Studies. Please vote for only one person for each office. The cards must be received no later than the end of March, 1996. The results will be announced in at the Annual Meeting and in the next edition of the *Newsletter*. Your prompt attention to this matter is much appreciated.

Also enclosed are brief summaries of the backgrounds of the nominees for the office of President-Elect. The nominee for the office of Secretary-Treasurer is Jeffrey A. Hamilton, of California. This office now has a two year term.

The result of the voting for the changes to the Association's bylaws is that they were passed by the majority.

This year's Annual meeting will be held in conjunction with the 61st Annual Meeting of the Society for American Archaeology Meetings, on Friday, April 12th, 1996, at 4:30 PM, at the Marriot Hotel in New Orleans, Louisiana. Room assignment has not yet been finalized. We hope you are able to attend.

Also please remember that your 1996 membership fees are due by the end March.

If we can be of any further assistance in any matter, please do not hesitate to get in touch with me.

Warmest regards

V. Bellifemine

Viviana Inés Bellifemine
Secretary-Treasurer, IAOS

Robert H. Tykot, Ph.D.

Dr. Robert H. Tykot received the MA and Ph.D. degrees in Anthropology from Harvard University, with concentrations in Old World Archaeology and Archaeological Science. His dissertation, "Prehistoric Trade in the Western Mediterranean: The Sources and Distribution of Sardinian Obsidian," included a field survey and chemical characterization of the geological sources in Sardinia, and the analysis, source attribution, and interpretation of 2700 obsidian artifacts from Neolithic and Bronze Age sites in Italy, France, and North Africa. Dr. Tykot has managed the Arcaeometry Laboratories at Harvard since 1990, and has worked extensively with stable isotope analysis of bone for dietary purposes, and of marble for source tracing, in addition to projects on metallurgy and ceramics. His most recent publications include: "Mediterranean Islands and Multiple Flows : The Sources and Exploitation of Sardinian Obsidian," in M.S. Shackley (ed.), *Method and Theory in Archaeological Obsidian Studies*, Advances in Archaeological and Museum Science Series (New York: Plenum, in press);"Stable Isotope Analysis of Bone Collagen and Apatite in the Reconstruction of Human Diet: A Case Study from Cuello, Belize" (R.H. Tykot, N.J. van der Merwe & N. Hammond), and "Archaeological Applications of ICP-Mass Spectrometry" (R.H. Tykot & S.M.M Young) both in M.V. Orna (ed.), *Archaeological Chemistry V: Organic Inorganic and Biochemical Analysis* (Washington, DC: American Chemical Society, Spring 1996); and "Radiocarbon Dating in Sardinia and Corsica," in R Skeates & R. Whitehouse (eds.), *Radiocarbon Dating and Italian Prehistory* (London, 1994) 115-145.

Jonathon E. Ericson, Ph.D.

Jonathon E. Ericson, Ph.D. is currently Professor of Environmental Analysis and Design as well as Anthropology at the University of California, at Irvine, California. His background is in Exploration Geophysics and Anthropology. Approximately half of his research has focused on obsidian to elucidate the chemical and physical mechanisms of obsidian hydration, to develop laboratory-induced hydration protocols, and to measure hydration by linear accelerator nuclear reaction techniques. In addition, research has been conducted to characterize obsidian by trace element and multivariate statistical analysis with regards to prehistoric exchange, direct access, and quarrying activities as well as to explore for, and survey obsidian sources in the Western U.S. and Mexico.

Current research continues on flow-specific trace element characterization of obsidian and the mechanisms of obsidian hydration. Research has been extended from obsidian to understand the hydration of tektites and crystalline quartz.

"If elected president of IAOS, I will make every effort to identify a research agenda common to all researchers and survey the membership to identify a set of common (shared) research objectives. These will be forwarded to federal program offices, in Pacific Rim countries and Europe. Hopefully these efforts will stimulate new research support on obsidian and hydration dating."

in the area. More recent fission-track age determinations by Bigazzi et al.[6] reveals two main age groups for central Anatolian obsidians: Acigöl area obsidians and Göllü Dağ area obsidians. Ercan et al.[16] divide the former group into two stratigraphic subgroups: Boğazköy obsidians which were formed before the caldera collapse and Taskesiktepe obsidians extruded after the caldera formation. The Boğazköy obsidians have ages in the range of 150,000 to 180,000 years, while the postcaldera obsidians have ages in the range 20,000 to 80,000 years. Biggazi et al.[6] also point out that the age of obsidians on the east side of the Acigöl caldera have an age of about 20,000 years. The Göllü Dağ area obsidians have ages in the range 1 to 1.3 million years. These observations by Bigazzi et al.[6] are potentially of great importance in understanding some compositional variations detailed below.

Earlier studies of this same problem concerning obsidian in the Near East have been carried out by Renfrew et al.,[13,17] Wright and Gordus,[18] and Wright.[19] Renfrew et al. employed optical spectrography as the analytical tool, whereas Wright and Gordus used neutron activation analysis. Both of these earlier studies were of much wider scope than the present one in terms of the coverage of sources, but the intensity of sampling within a source area was not nearly so thorough.

Analytical data reported in these earlier studies are poor by modern standards. For example, where we have overlap in the locations analyzed by us and by Wright and Gordus we find that the spread in the mean values of elemental abundances of obsidian groups is as much as an order of magnitude smaller than those reported by Wright. When the observed compositional range from a source is more confined, it is much easier to distinguish one source from another and a match with an archaeological specimen is more meaningful. We find also that some elemental abundances measured by us are different from earlier work by as much as a factor of 2. We measure a much larger array of elements than those reported in earlier works. It might be argued that this is unnecessary for determining obsidian provenience but, objectively, one cannot know which element to dispense with until all sources have been shown to be distinguishable on the basis of a more restricted list. Our samplings from each source are extensive and lay a firmer foundation for future obsidian provenience studies. For example, we find that distinctly different compositions can be found in a limited sampling area and if specimens of only one of these were taken as representative, errors in assigning provenience could result.

The system for neutron activation analysis used here is based on one previously described by Perlman and Asaro,[20] and by Yellin et al.[21] The latter report compares results on paired samples analyzed in two different laboratories, and shows that the data are compatible within narrow limits. Since both laboratories use the same multielement standard for computing elemental abundance, the question of the reliability of the absolute values hinges upon how well the composition of the standard is known. This issue will not be discussed here other than to assert that the values in the present report for the respective elements cannot be seriously in error. Additional information about the standards employed and manner of analysis is given by Yellin. [22] Table 1 lists the isotopes on which the measurements are based, their half-lives, and gamma-rays measured. The analyses reported here were carried out over a long period of time and involved many neutron iradiations. There were no more than 20 samples in any given batch of obsidians. The study of Yellin et al.[21] showed the system of analysis to be extremely stable and the measurements reproducible to within very narrow limits.

RESULTS

For economy of space, the analytical results are not presented for the individual specimens which were analyzed, but are grouped according to the headings for the data columns (Tables 2-6). It will be seen that in most of the sampling areas more than a single composition was encountered. For each element in one of these groups the number shown is the mean value (M) and the spread (S), the root-mean-square deviation among the samples.

The spread, S, is a compounding of the dispersion introduced by the natural variations in the material and the dispersion from the error of measurement. In most cases the measuring errors are minor compared with the natural spreads; in others, the measuring error makes up the dominant factor. In all cases, it will be noted that the spreads are not very great. A discussion as to why the data from a single sampling area were divided into compositional groups appears in the description of the results.

Not all of the elements which are routinely measured in some other materials, e.g., pottery, are shown in the tables. Elements which have been measured but are not shown have relatively large measuring errors which may mask real differences in composition. The missing elements are therefore of dubious values in defining the compositions. Errors of measurement vary greatly between elements, and in obsidians the levels of certain elements are such that

the percentage errors are quite large; therefore, the results do little to distinguish one obsidian flow from another. For example, the elements not shown for this reason in the case of the Göllü Dağ source are K, Co, Ni, Ca, and Ti.

In conjunction with Figs. 3-6, which show the sampling loci for the ara, there will be found designations such as 14/11 around which a group of numbers cluster. The designation 14/11 refers to the day the samples were taken, in this case 14 November, and the other numbers point out the exact places.

A few words are in order about how the groups discussed below were arrived at. When the analyses, say from Göllü Dağ, are laid out on paper it is evident by "eye-balling" that they form a tight group and this is confirmed by calculating the mean values and root-mean-square deviations. However, a few elements, e.g., Ba and Eu, have dispersions which are significantly larger than the dispersions exhibited by other elements. These larger dispersions cannot be accounted for by measuring errors. They either are real or indicate that we may have more than one group on our hands. In fact, inspection of the analyses shows that the dispersion in Ba and Eu (in the case of Göllü Dağ) is not due to a broader distribution in composition but rather to three narrow distributions. Keller and Seifried[2] also discerned a distribution based on barium which they measured by X-ray fluorescence. When the samples are grouped according to Ba values, we obtain three groups that differ significantly only in the values of Ba and Eu. The dispersion in these elements is not in line with the dispersion of the other elements. These results were checked using univariate statistical procedures of SAS. When multivariate procedures were employed with all elements that are useful for characterizing the obsidian the division of the Göllü Dağ composition into three subgroups was less certain. This is apparently due to the fact that the groups differ significantly in only a few out of many elements.

GÖLLÜ DAĞ SOURCE

Göllü Dağ is a large volcanoe mountain over 2150 m high. As seen in Fig. 2, the Göllü Dağ flow is centered about 20 km west of Golcuk, a small town on the main road between Neveşehir and Niğde (bottom right corner), and about 40 km southwest of Nevşehir. Obsidian flow outcrops were found at various places around Göllü Dağ. The location of this flow conforms with that called Location 6 by Wright.[19] Obsidians were collected on all sides of Göllü Dağ, but some of the sampling loci were not represented among the specimens sent for analysis. These are loci 17-15 to 17-22

to the west. In all, 63 samples have been analyzed to date. Some comments about the loci follow.

Loci 17/11.12-18: To the north of the mountain, samples were collected in a valley running up towards Kabak Tepe, to the east of the village of Kayirli. Banded obsidian flows were found in the stream bed and on its east side; some of the flows were up to 50 cm thick and of good workable quality. Loci 16/11.1-20: To the northeast of the mountain, samples were collected in several localities in and around the village of Kormurcu. Banded obsidian flows were found and also thicker perlitic flows with obsidian blocks; again some of the obsidian was of good workable quality. This is in the same general area as Wright's Locality 6;[19] the obsidian deposits ca. 2 km northeast of Kormuca described by Todd[23] (also ref 13) are probably those sampled as loci 16/11.11-20.

Loci 16/11.21-31: To the south of the mountain, samples were collected in a valley running up towards Boztepe. Banded obsidian flows were again found; some of the obsidian was of workable quality, but of small size, larger pieces tending either to be sperulitic or full of microfractures. This is the same general area as the source called "Sirca Deresi" by Todd[23] (also ref 13). Todd[23] suggests that this may also have been the source of the samples reported by Renfrew et al.[17] as coming from ca. 10 km south of Çiftlik, generally referred to as the Çiftlik source.

Loci 17/11.19-22: Finally, to the west of the mountain, samples were collected in a valley leading north from the village of Bozkoy. Obsidian flow outcrops were found again, along with larger pieces of loose obsidian of workable size and quality.

Most of the elements showed no perceptible difference between the three subgroups of Göllü Dağ (abbreviated GLD) in Table 2. The data were separated into three subgroups to show the substantial variation for the two elements Ba and Eu. For Ba it is seen that the differences between the mean values in the groups are several times as large as the spreads encountered in each of them (see also refs 2,24). Other elements, such as Cs, showed smaller, but nonetheless significant differences. The last column in Table 2 gives the values for all 63 samples taken as a group.

Analyses of archaeological obsidians from sites in Israel show that of those that can be assigned to the Göllü Dağ source, the majority match the composition of GLD-C.

Although the division of obsidians from a source into compositional subgroups may have little archaeological significance, it might have

some importance for the geological history of an area, provided that this division would be correlated with other geological features. Unfortunately, we do not have the necessary ancillary information to permit such speculation. Nevertheless, we record the loci where obsidians comprising these groups were found: The large group GLD-C came largely from loci 16/11.1 to 16/11.20 which stretch northeasterly from Göllü Dağ, but also includes 2 pieces from 16/11.27 and 7 from 16/11.29 to 16/11.31 which lie to the south. Most of the specimens in GLD-A came from the southern sample area from 16/11.21 to 16/11.31, and especially from flows on the north side of the same valley, but two are from a loose sample from the northern area from locus 17/11.13, and another specimen came from the northeastern area, locus 16/11.8. The 6 samples in GLD-B are from 16/11.21, 16/11.27, 17/11.12, 17/11.14, and 16/11.2. The three specimens 16/11.21, 26 and 27 are from the southern area, the two specimens 17/11.12 and 14 are from the northern area, and the remaining specimen, 16/11.2, is from a loose sample from the northeastern area. No specimens from the western area were included among the samples made available for analysis.

Archaeological obsidian reported by Yellin and Garfinkel[9] suggest that there may be yet other subgroups of the Göllü Dağ source. The fission-track work of Bigazzi et al.[6] clearly demonstrates that there were multiple obsidian-forming events in the Göllü Dağ Acigöl areas. These events may be related to the subgroups observed at Göllü Dağ.

NENEZI DAĞ SOURCE

This source, a smaller isolated volcanic peak, lies to the northwest of Göllü Dağ about 23 km west of Derinkuy, which is situated on the Nevşehir-Niğde road about 26 km southwest of Nevşehir (Fig. 2). This source was previously reported.[24,25] The flow is just 3 km east of Bekarlar. The obsidian occurrences are all on the west side of Nenezi Dağ and sampling was carried out within a north-south band about 1.5 km in length (see Fig. 4). Flow outcrops were found in stream beds on the west side of the mountain, and rich surface scatters of obsidian of good quality and workable size were also sampled. The specimens analyzed are from loci 17/11.1-11.

From this collection 26 samples were analyzed, including specimens from outcrops and some which were loose. Such compositional variations as were discerned did not correlate with the loci where found. The data are shown in Table 3, where this flow is abbreviated NNZD.

A reasonable level of homogeneity in composition was found for this assemblage of

26 samples. The largest spread in values for any element was less than 5% after removing the dispersion introduced by the error of measurement. Nevertheless, in Table 3, the data are divided into 3 subgroups, a separation which gave even greater homogeneity for a few elements. The last column shows the mean values and spreads for all 26 samples taken as a group.

A comparision of the Nenezi Dağ composition with that for Göllü Dağ shows that they are vastly different.

HOTAMIŞ DAĞ SOURCE

Hotamiş Dağ is a prominent volcanic mountain 12 km southwest of Nevşehir (Fig. 2). Flow outcrops were found at various places around the mountain. The collection area for this source is shown on Fig. 5 and it is seen to cover a wide expanse. Hotamiş Dağ lies just south of the Nevşehir-Acigöl road about midway between the two towns, and Boğazköy rests on its flank. From the description of source materials given by Renfrew et al.,[7] our collection area includes that which they call "Acigöl-Topada". It also includes locations 2 and 3 described by Wright.[19] Some comments about the sampling loci follow.

Loci 14/11.22-23: To the north, obsidian outcrops of moderate quality were found north of the road, at Kartalkayasis Tepe. This area is the source called Acigöl-Topada by Renfrew et al.,[17] and Wright's Localities 3 and 3A.[19] Todd[23] refers to it as "Kocatepe-Acigöl"; this is potentially misleading, because the summit of Hotamiş Dağ is called Kocadağ Tepesi. The name Acigöl has also been used for obsidian occurences just north of Guneydağ, which belong to a different analytical group (KRUD: see next section, loci 15/11.22-23).

Loci 14/11.1-6 and 15/11.1-2: East of the mountain, further obsidian flow outcrops were found in a small valley above and to the south of the village of Boğazköy. Some of the flows were thick, but the obsidian were sperulitic and full of microfractures.

Loci 14/11.17-21: West of the mountain, more coarse spherulitic flows were found in valleys above the village of Karacaoren. Sources in this general area are described by Todd: "The most important source in this area is the north face of Hotamiş Dağ; large quantities of obsidian are to be found in the streams near the villages of Karacaviran and Boğazhöy, and there is a general scatter all around the lower parts of the north face of the mountain"[13] (note that the statement that Hotamiş Dağ is north of the main road is in error).

Loci 14/11.7-12, 13-16, and 15/11.3-13: Further southeast, flows were found in various

localities around Tulce Tepe. Again, much of the obsidian was spherulitic and full of microfractures, but some was of better quality. These localities are in the same general area as Wright's Localities 1 and 2.[19]

Most of the samples we attribute to this source were collected within a band lying along a northwest axis about 5 km in length and over a band width of about 2 km. It will be noted in Fig. 5 that samples were also collected along an arc about 6 km from Hotamiş Dağ to the west and south. The composition of materials from this arc was vastly different from that of Hotamiş Dağ and will be discussed separately as the Köru Dağ source. The Hotamiş Dağ materials themselves divided into three distinct chemical groups, but these seem to be genetically related. Because of these complexities and others to be mentioned, the sampling loci will be discussed in some detail. The data concerning the Hotamiş Dağ groups are shown in Table 4 and those from Köru Dağ (also in Fig. 5) will be discussed in the next section.

Sixty-one samples from the Fig. 5 collection clearly belong to the Hotamiş Dağ flow or flows. The chemical group in Table 4 termed HTMS-A is made up of 18 samples: 16 from loci 14/11.1 to 14/11.6 which lie in a cluster on the northeast slope of Hotamiş Dağ. All of these were taken from outcrops, and hence are in situ specimens. A single sample from 15/11.2 (about 1 km east of south) was taken from a layer embedded in tuff, and another was a loose sample from 15/11.14 which is well-removed to the south (Loci 14/11.1-6 and 15/11.2 are from the flow outcrop area just above and south of Boğazköy.) It seems clear that the flow represented by HTMS-A composition is centered upon the northeast slope of Hotamiş Dağ.

The source for the 11 specimens in HTMS-B centers on the low outcrops on the west side of the mountain, above Karacaoren. Seven of these were from flow outcrops at loci 14/11.17, 14/11.18, 14/11.19, and 14/11.21, of which 14/.18 is described as large. Three specimens were loose samples in a stream bed at locus 14/11.11 on the opposite side of Hotamiş Dağ. How they arrived there is not clear since the many other samples on this side were not of HTMS-B composition. The last specimen in Hotamiş Dağ-B was a loose sample from 15/11.14 which lies some distance to the south and also provided one member of HTMS-A which is also far displaced from the outcrops of its group.

The largest number of specimens analyzed from Hotamiş Dağ (32) fell into group HTMD-C. Twenty-six of these fall within a circle of about 1.2 km in diameter, 3 km southeast of Hotamiş Dağ, the

flow outcrop area around Tuluce Tepe, southeast of the mountain. The specimens are from loci 14/11.8 to 14/11.16 and 15/11.3 to 15/11.13. Another outcrop about 5 km northwest of Hotamiş Dağ, at Kartalkayasi Tepe (loci 14/11.22, 14.11.23), furnished 5 other samples belonging to this group. The last piece was a loose sample taken far to the south at 15/11.14, the same locus in which transported samples belonging to HTMS-A and B were found.

An examination of the Hotamiş Dağ data in Table 4 shows that they form 3 distinct subgroups which seen to be genetically related. If we take Fe as an example, it is seen that the mean values decrease progressively from HTMS-A to HTMS-C, but that differences between successive groups are about 10 times the spread encountered in each group. This division into three groups is therefore real and not an arbitrary separation of a continuum of Fe values into three ranges. It will also be noted that such elements as La, Ba, Hf, and Co show the same trend as Fe, albeit with differing slopes. On the other hand, Ta, U, Th, and Cs have slopes of the opposite sign. Still other elements show no significant differences between the groups.

Such behavior suggests that the magmas responsible for these materials had some common origin. Without examining and analyzing other rocks of the region it is not possible to arrive at a definite explanation. One possibility is that following the first eruption, a period of time ensued during which a mineral phase separated from the magma depleting it in certain elements and enhancing the relative levels of these in which the separated phase was poor. A second eruption would then produce an obsidian of different composition, and a third eruption could then have produced another such phase separation in the magma. Dating of the obsidian at Hotami Dağ may help clarify the differences in composition.

The present study was undertaken to characterize obsidian sources in order to learn about obsidian trade in the ancient world. With this objective, questions of how three or more obsidian compositions arose are not of concern. What is important is than an obsidian artifact or flake found elsewhere came from this source it if matches any of the groups. The findings of three compositions from one place also emphasize the importance of a thorough sampling rather than relying upon just a few samples which may have been taken from one locus. In the latter case one might find that archaeological obsidians which actually came from this place do not match one's source material.

Finally, mention should be made of the curious fact that not one piece of obsidian from

34 other specimens of this chemical composition from locus 15/11.1 on the eastern flank of Hotamiş Dağ. These were described as small pieces of obsidian embedded in tuff and could conceivably have been transported as a "bomb" from Köru Dağ.

Of the 26 pieces analyzed, 23 were placed in a chemical group shown in Table 5 under the heading KRUD. The data from the group HTMS-C are shown beside the KRUD group to illustrate the contrast. It is seen that not only are the levels of many elements greatly different between these groups but the patterns also show that these flows cannot be related.

It will be noted from an examination of the values for the Köru Dağ flow that it is considerably less uniform in composition than are the other groups, such as HTMS-A, B, and C. In contrast to the Hotamiş Dağ material which could be divided into three distinct groups, the variations in the Köru Dağ material were chaotic. That is, any grouping which would make one element more homogeneous did not necessarily help another.

This dispersion in composition was so great for three pieces that their data were not combined with the others which appear in the group of 23. For two of these, data are shown under the heading KRUD-a and KRUD-b. Note particularly the values for U, Th, Cs, and Hf; otherwise these pieces analyzed much like the large group. The data for the third piece(not shown) were much like those for KRUD-a. The numbers shown for these odd pieces are set in parentheses to emphasize that the "error limits" have no relation to (S) for a group but represent the precisions of measurement for the individual pieces. We have no explanation for the exotic composition of KRUD-a and KRUD-b and are merely reporting an observation. These compositions probably have nothing to do with the Köru Dağ source and may represent intrusions from another source or contaminated samples.

ÇATKÖY SOURCE

The material from this collection area presented a puzzle for which it is necessary to note its position relative to Hotamiş Dağ and Köru Dağ. From Figs. 1 and 5, it is seen that Orta Kepizi, which lies within the collection loci, is situated 15 km north of Hotamiş Dağ and 19 km from Köru Dağ. This is the same general area as Renfrew et al.'s source at Karinyarik Kepez, judging by their location of the source as "12 kilometers west-northwest of Nevşehir."[17]

Loose obsidian was fairly commonly encountered in stream beds southwest of Çatköy, a village about 10 km northwest of Nevşehir, and small pieces of obsidian were also found in ignimbrite cliffs along the streams. No flow outcrops

archaological sites in Israel, among the approximately 100 specimens analyzed, came from Hotamiş Dağ. This aspect of the obsidian trade pattern had already been noted by Renfrew et al.[17] who stated that this flow, which they call Acigöl-Topoda, did not furnish material to the Levant although it was well represented in other regions.

KÖRU DAĞ SOURCE

In the preceding section on the Hotamiş Dağ source, shown in Fig. 5, it was mentioned that an unrelated flow also appeared in the collection area of this map. This flow seems to center upon Köru Dağ and obsidians of its composition lie on an arc to the west and south of Hotamiş Dağ at a distance of about 6 km. Köru Dağ is an outlier of the Erdas Dağ massif, about 20 km southwest of Nevşehir (Fig. 5). Some comments about the sampling loci follow.

Locus 15/11.25: Southwest of Hotamiş Dağ, massive flows were found on the northeast side of Köru Dağ (Fig. 5); the obsidian was of moderate quality, with some small spherulites. This is in the same area as (and may in fact be the same as) Wright's locality 5.[19]

Loci 15/11.14-24 and 26: Loose samples of obsidian incorporated in tuffs were collected over a long arc streching north and east from Köru Dağ. Some of this obsidian was of large size and good workable quality, especially on the west side of Köru Dağ (loci 15/11.18-21) and on a small hill just to the east of a lake near the main road, north of GuneyDağ (Gol Dağ) and about 4 km east of the small town of Acigöl. This last locality is in the same general location as the source reported by Todd as "Acigöl and GuneyDağ"[23] (also see ref 12 where GuneyDag is called Gol Dağ), and Wright's Locality 4.[19]

The focal point for this chemical group whic we abbreviate KRUD seems to be on the north side of Köru Dağ at locus 15/11.25 which is described as a "massive outcrop". Below this at 15/11.26 were abundant loose pieces. On the west side of Köru Dağ is locus 15/11.20 having large pieces embedded in tuff and loose pieces at 15/11.18, 15/11.19, and 15/11.21. To the south and west of Köru Dağ, extending almost 4 km, were three sampling loci (15/11.17, 15/11.16, and 15/11.15) from which samples were either loose or found in tuff. Somewhat west of Köru Dağ and extending northward up to 4 km were three loci from which loose pieces were taken (15/11.24, 15/11.23, 15/11.22).

From the above-mentioned loci, 23 samples were analyzed and it is not difficult to visualize the distribution pattern emanating from Köru Dağ. More difficult to visualize is the appearance of

were found.

Fifteen samples were analyzed: 3 from loci 13/11.1 and 13/11.2, and 12 from loci 13/11.3 to 13/11.6. The group which we term CTKY-A has the same composition as the group HTMS-C, and the group of 3 (CTKY-B) matches the KRUD group. All of the elements have been listed in Table 6 so that one may see, element by element, how good these matches are. There can be no doubt that we are dealing with identical materials in each of these sets.

The distances between which identical compositions are found are rather large for materials to be transported by erosion and, more importantly, the field notes indicate that some of the obsidians were taken from flow outcrops in which materials waere embedded in ignimbrite. In the absence of a more detailed geological examination of the area it is not profitable to speculate as to how this occurence came about. The data are recorded here mainly for those who may be concerned with the geology of this area and with the dispersions of obsidians in general.

DISCUSSION

The data shown in this report represent obsidians collected in a restricted region within central Anatolia. Over a period of time, it is expected that this study will be supplemented by similar surveys of all other Anatolian obsidian sources from the general region of this collection and from sources of the Lake Van region and beyond.

Notably missing from the region of central and southcentral Anatolia are the flows in the region of Çiftlik and others recorded by Renfrew et al.[17] Although some data have been taken on obsidians from the Lake Van region, the specimens which came to us are too meager in number to provide an understanding comparable to that form sources recorded in this paper. Some discussion of these will be found in Yellin and Perlman where they were needed to explain the origins of archaeological obsidians found in Israel.

The other objective of the present report is to lend some perspective to what can be encountered even within a limited area. An obvious conclusion is that one must collect source specimens in considerable numbers and that it is advisable to record the loci of meticulous sampling. The results also imply that there need be no ambiguities as to where archaeological obsidians came from if the analytical technique provides precise abundances for an array of elements representing much of the periodic table.

There is no discussion in this report of how our results relate to those of other investigators who analyzed materials from sources which

are almost identical with some covered here. There is some discussion of this issue in Yellin and Perlman[24] in conjunction with the attribution of the provenance of those archaeological obsidians which are common to the different studies. Correlation between results of different investigators is discussed by Blackman.[25] Blackman also discusses correlations with some of the data reported here on the basis of unpublished data communicated to him by this author. A comprehensive report on archaeological obsidian from sites in Israel is in preparation and it is planned that it will also include all the individual source obsidian analyses as well as a more detailed description of the obsidian collection whose characterization by neutron activation was presented above. A preliminary report dealing with both source obsidian and obsidian artifacts was presented (JY) at the Obsidian Workshop held at the National Bureau of Standards, Gaithersburg, Maryland in 1978 (unpublished). For the conference Yellin and Perlman[24] prepared a paper which, unfortunately, was not published. Renewed interest in Middle Eastern obsidians (see refs 3, 26-35) has prompted me to re-examine and complete this research.

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Table 1. Isotopes, gamma-rays, half-lives, and standard com position

Isotope	Gamma-ray (keV)	Half-life (days)	Standard (ppm)	Elemen
As-76	559.30	1.10	30.80	As
Ba-131	123.73	12.00	712.00	Ba
Ba-131	496.30	12.00	712.00	Ba
Ca-47	1297.00	4.54	2800.00	Ca
Ce-141	145.43	32.50	80.30	Ce
Co-58	810.50	71.30	279.00	Ni
Co-60	1332.48	1921.00	14.06	Co
Co-60	1173.23	1921.00	14.06	Co
Cr-51	319.80	27.80	115.10	Cr
Cs-134	795.80	748.25	8.31	Cs
Cs-134	604.60	748.25	8.31	Cs
Eu-152	121.79	4636.00	1.29	Eu
Eu-152	1408.00	4635.50	1.29	Eu
Fe-59	192.20	44.90	1.02	Fe
Fe-59	1292.00	44.90	1.02	Fe
Fe-59	1099.20	44.90	1.02	Fe
Hf-181	133.02	42.50	6.23	Hf
Hf-181	482.00	42.50	6.23	Hf
K-42	1524.00	0.52	13500.00	K
La-140	329.00	1.68	44.90	La
La-140	486.70	1.68	44.90	La
La-140	1596.00	1.68	44.90	La
La-140	329.00	1.68	44.90	La
Lu-177	208.36	6.74	0.43	Lu
Na-24	1368.53	0.62	0.26	Na
Na-24	1731.00	0.62	0.26	Na
Nd-147	91.06	11.06	32.40	Nd
Np-239	106.14	2.35	4.82	U
Pa-233	311.90	27.00	13.96	Th
Rb-86	1077.00	18.66	70.00	Rb
Sb-122	563.90	2.80	1.71	Sb
Sb-124	1692.00	60.40	1.71	Sb
Sc-46	889.60	83.90	20.55	Sc
Sc-46	1120.60	83.90	20.55	Sc
Sm-153	103.19	1.95	5.78	Sm
Ta-182	67.75	115.10	1.55	Ta
Tb-160	298.50	72.10	73.00	Tb
Tb-160	1178.10	72.10	73.00	Tb
Tb-160	86.79	72.10	0.73	Tb
Yb-169	63.12	31.80	2.80	Yb
Yb-175	396.30	4.21	2.80	Yb

Table 2. The composition of Göllü Dağ obsidians

Element	GLD-A M	GLD-A S (11 samples)	GLD-A S(%)	GLD-B M	GLD-B S (6 samples)	GLD-B S(%)	GLD-C M	GLD-C S (46 samples)	GLD-C S(%)	GLD-all M	GLD-all S (63 samples)	GLD-all S(%)
As	7.5	0.7	9.3	6.6	0.7	10.6	6.9	0.9	13.0	6.9	0.8	11.6
Ba	77	8	10	110	13	12	160	10	6	143	35	25
Ce	45.1	1.3	2.9	45.4	1.0	2.2	45.9	0.8	1.7	45.8	1.1	2.4
Cs	8.57	0.19	2.20	8.23	0.19	2.30	7.98	0.13	1.60	8.09	0.27	3.30
Eu	0.124	0.008	6.4	0.139	0.011	7.9	0.160	0.010	6.20	0.152	0.018	11.8
Fe(%)	0.599	0.017	2.8	0.614	0.017	2.8	0.611	0.010	1.6	0.610	0.021	3.4
Hf	3.26	0.14	4.30	3.32	0.20	6.00	3.22	0.17	5.30	3.24	0.17	5.20
La	21.9	0.8	3.6	22.7	0.8	3.5	22.8	0.6	2.6	22.7	0.7	3.1
Lu	0.357	0.012	3.4	0.348	0.013	3.7	0.338	0.013	3.8	0.342	0.015	4.4
Na(%)	3.01	0.26	8.60	2.89	0.26	9.00	2.97	0.15	5.00	2.97	0.18	6.10
Nd	13.8	0.6	4.4	14.2	1.0	7.0	14.4	0.8	5.4	14.3	0.8	5.6
Rb	223	23	10	213	14	7	209	10	5	211	14	7
Sb	0.94	0.07	7.40	0.86	0.07	8.10	0.89	0.09	10.10	0.88	0.08	9.10
Sc	2.040	0.060	2.9	2.010	0.080	4.0	1.920	0.040	2.1	1.950	0.070	3.6
Sm	2.82	0.07	2.50	2.82	0.04	1.40	2.75	0.06	2.20	2.77	0.06	2.20
Ta	2.11	0.04	1.90	2.04	0.05	2.40	1.97	0.04	2.00	2.00	0.06	3.00
Tb	0.45	0.04	8.90	0.41	0.04	9.80	0.44	0.04	9.10	0.43	0.04	9.30
Th	22.60	0.50	2.20	22.94	0.46	2.00	22.95	0.37	1.60	22.89	0.42	1.80
U	8.25	0.23	2.80	8.20	0.17	48.00	7.77	0.22	2.80	7.89	0.29	3.70
Yb	2.46	0.05	2.00	2.43	0.04	1.60	2.32	0.08	3.40	2.34	0.09	3.80

Values are in parts per million unless expressed in percent. M = mean; S (spread) = root-mean-square deviation, and S(%) is S expressed in percent.

Table 3. The composition of Nenezi Dağ obsidians

Element	NNZD-A M	NNZD-A S (9 samples)	NNZD-A S(%)	NNZD-B M	NNZD-B S (9 samples)	NNZD-B S(%)	NNZD-C M	NNZD-C S (8 samples)	NNZD-C S(%)	NNZD-all M	NNZD-all S (26 samples)	NNZD-all S(%)
As	5.8	0.8	13.8	5.4	1.5	28.0	5.8	1.0	17.0	5.7	1.0	17.5
Ba	556	16	2.9	555	18	3.2	558	15	2.7	556	16	2.9
Ca(%)	0.96	0.12	12.5	1.01	0.08	7.9	0.98	0.06	6.1	0.98	0.09	9.2
Ce	68.3	1.0	1.5	71.2	1.1	1.5	73.5	1.3	1.8	70.9	2.4	3.4
Co	0.66	0.04	6.1	0.75	0.05	6.7	0.81	0.07	8.6	0.74	0.08	10.8
Cs	6.95	0.10	1.4	6.90	0.10	1.4	7.00	0.10	1.4	6.95	0.10	1.4
Eu	0.547	0.013	2.4	0.558	0.010	1.8	0.59	0.01	1.7	0.563	0.019	3.4
Fe(%)	0.887	0.011	1.2	0.926	0.011	1.2	0.994	0.012	1.2	0.933	0.045	4.8
Hf	4.22	0.07	1.7	4.20	0.09	2.1	4.25	0.07	1.6	4.22	0.07	1.7
La	38.5	0.5	1.3	40.2	0.5	1.2	41.3	0.5	1.2	40.0	1.3	3.2
Lu	0.353	0.012	3.4	0.363	0.010	2.8	0.351	0.014	4.0	0.354	0.012	3.4
Na(%)	3.21	0.14	4.4	3.35	0.25	7.5	3.44	0.09	2.6	3.33	0.19	5.7
Nd	19.8	0.7	3.5	20.3	0.7	3.4	21.1	1.0	4.7	0.9	0.9	4.4
Rb	188	7	3.7	169	11	6.5	199	7	3.5	185	14	7.6
Sb	0.75	0.07	9.3	0.74	0.06	8.1	0.74	0.12	16.0	0.74	0.08	10.8
Sc	1.50	0.05	3.2	1.58	0.03	1.6	1.65	0.01	0.4	1.58	0.07	4.3
Sm	3.09	0.05	1.6	3.18	0.02	0.6	3.23	0.02	0.6	3.13	0.05	1.6
Ta	1.576	0.021	1.3	1.545	0.018	1.2	1.556	0.027	1.7	1.559	0.024	1.5
Tb	0.41	0.04	9.8	0.42	0.03	7.1	0.42	0.03	7.1	0.42	0.03	7.1
Th	27.55	0.43	1.6	28.66	0.23	0.8	30.25	0.16	0.5	28.78	1.15	4.0
U	6.88	0.19	2.8	7.16	0.08	1.1	7.42	0.09	1.2	7.13	0.26	3.6
Yb	2.31	0.06	2.6	2.31	0.09	3.9	2.39	0.05	2.1	2.33	0.07	3.0

Values are in parts per million unless expressed in percent. M = mean; S (spread) = root-mean-square deviation, and S(%) is S expressed in percent.

Table 4. The composition of Hotamiş Dağ obsidians

Element	HTMS-A M (18 samples)	HTMS-A S	HTMS-A S(%)	HTMS-B M (11 samples)	HTMS-B S	HTMS-B S(%)	HTMS-C M (32 samples)	HTMS-C S	HTMS-C S(%)
As	5.5	0.8	14.6	5.3	0.7	13.2	5.6	0.7	12.5
Ba	450	19	4	385	16	4	318	20	6
Ce	62.4	0.8	1.3	58.6	1.0	1.7	52.4	1.3	2.5
Cs	7.23	1.20	1.2	8.05	0.13	1.6	8.55	0.21	2.5
Eu	0.546	0.019	3.5	0.425	0.017	4.0	0.321	0.019	5.9
Fe(%)	1.266	1.300	1.3	1.026	0.013	1.3	0.817	0.025	3.1
Hf	5.39	1.50	1.5	4.78	0.09	1.9	4.15	0.10	2.4
La	33.4	0.7	2.1	30.4	0.1	3.0	27.6	0.1	2.5
Lu	0.437	4.800	4.8	0.439	0.018	4.1	0.420	0.017	4.0
Na(%)	3.35	0.15	4.5	3.32	0.13	3.9	3.05	0.12	3.9
Nd	19.8	0.9	4.6	18.7	0.7	3.7	16.8	0.8	4.8
Rb	179	11	11	200	13	7	206	12	6
Sc	1.55	5.20	5.2	1.42	0.07	4.9	1.24	0.06	4.8
Sm	3.42	2.00	2.0	3.21	0.08	2.9	2.94	0.07	2.4
Ta	1.789	1.400	1.4	1.947	0.019	1.0	2.052	0.038	1.8
Tb	0.47	4.30	4.3	0.46	0.03	6.5	0.41	0.03	7.3
Th	25.25	3.60	3.6	26.99	1.10	4.1	28.96	0.83	2.9
U	6.46	2.50	2.5	6.99	0.22	3.2	7.63	0.21	2.8
Yb	2.93	2.40	2.4	2.95	0.09	3.0	2.86	0.072.4	

Values are in parts per million unless expressed in percent. M = mean; S (spread) = root-mean-square deviation, and S(%) is S expressed in percent.

Table 5. The composition of Köru Dağ obsidians

Element	HTMS-A M (32 samples)	HTMS-A S	HTMS-A S(%)	KRUD M (23 samples)	KRUD S	KRUD S(%)	KRUD-a v (1 sample)	KRUD-a e	KRUD-a S(%)	KRUD-b v (1 sample)	KRUD-b e	KRUD-b S(%)
As	5.6	0.7	12.5	10.3	0.9	8.7	9.2	1.0	10.9	9.9	1.0	10.1
Ba	318	20	6.3	0	13		0.00	9.00		0.00	16.00	
Ce	52.4	1.3	2.5	33.3	1.4	4.2	32.9	0.4	1.2	34.3	0.8	2.3
Cs	8.55	0.21	25.0	14.09	0.64	4.5	14.86	0.19	1.30	14.80	0.34	0.01
Eu	0.321	0.019	5.9	0.033	0.011	3.3	0.018	0.006	33	0.022	0.013	59
Fe(%)	0.817	0.025	3.1	0.630	0.015	2.4	0.621	0.006	1.0	0.617	0.010	1.6
Hf	4.15	0.10	2.4	4.34	0.25	5.8	4.86	0.07	1.40	5.51	0.14	2.50
La	27.6	0.7	2.5	12.6	1.2	9.5	12.6	0.3	2.4	10.7	0.4	3.7
Lu	0.420	0.017	4.0	0.601	0.025	4.2	0.647	0.013	2.0	0.638	0.022	3.4
Na(%)	3.05	0.12	3.9	3.15	0.19	6.0	3.30	0.12	3.60	3.07	0.05	1.60
Nd	16.80	0.80	4.8	14.80	1.20	8.1	14.90	0.50	3.30	17.90	1.00	5.60
Rb	206	12	5.8	292	17	5.8	278	9	3.2	313	25	8.0
Sc	1.24	0.06	4.8	2.30	0.15	6.5	2.32	0.01	0.43	2.30	0.01	0.43
Sm	2.94	0.07	2.4	3.61	0.12	3.3	3.76	0.01	0.30	3.81	0.02	0.52
Ta	2.052	0.038	1.8	3.282	0.144	4.4	3.442	0.027	0.800	3.291	0.046	1.400
Tb	0.41	0.03	7.3	0.68	0.04	5.9	0.83	0.05	6.00	0.61	0.05	8.20
Th	28.96	0.83	2.9	33.82	1.70	5.0	41.29	0.14	0.34	75.11	0.48	0.64
U	7.63	0.21	2.8	10.86	0.50	4.6	12.42	0.10	0.80	16.15	0.19	1.20
Yb	2.86	0.07	2.4	4.19	0.16	3.8	4.29	0.06	1.40	4.71	0.122.60	

Values are in parts per million unless expressed in percent. M = mean; S (spread) = root-mean-square deviation, and S(%) is S expressed in percent.

Table 6. The composition of Çatköy obsidian samples (CTKY) compared with samples from Hotamiş Dağ (HTMS) and Köru Dağ (KRUD)

	CTKY-A			HTMS-C			CTKY-B			KRUD		
	M	S	S(%)	M	S	S(%)	v	e	S(%)	v	e	S(%)
Element	(12 samples)			(32 samples)			(3 samples)			(23 samples)		
As	5.8	0.8	13.8	5.6	0.7	12.5	9.8	1.9	19.4	10.3	0.9	8.7
Ba	319	15	5	318	20	6	0	10	0	0	13	0
Ce	52.1	0.7	1.3	52.4	1.3	2.5	33.2	2.2	6.6	33.3	1.4	4.2
Cs	8.58	0.15	1.8	8.55	0.21	2.5	14.44	0.86	6.0	14.09	0.64	4.5
Eu	0.326	0.027	8.3	0.321	0.019	5.9	0.033	0.008	24	0.033	0.011	33
Fe(%)	0.804	0.010	1.2	0.817	0.025	3.1	0.621	0.010	1.6	0.630	0.015	2.4
Hf	4.13	0.16	3.9	4.15	0.10	2.4	4.38	0.22	5.0	4.34	0.25	5.8
La	27.7	0.4	1.4	27.6	0.7	2.5	13.4	0.8	6.0	12.6	1.2	9.5
Lu	0.425	0.019	4.5	0.420	0.017	4.0	0.613	0.025	4.1	0.601	0.025	4.2
Na(%)	3.00	0.17	5.7	3.05	0.12	3.9	3.25	0.15	4.6	3.15	0.19	6.0
Nd	16.6	0.8	4.8	16.8	0.8	4.8	15.2	0.9	5.9	14.8	1.2	8.1
Rb	204	12	6	206	12	6	285	12	4	292	17	6
Sc	1.26	0.07	5.6	1.24	0.06	4.8	2.26	0.04	1.8	2.30	0.15	6.5
Sm	2.92	0.05	1.7	2.94	0.07	2.4	3.65	0.04	1.1	3.61	0.12	3.3
Ta	2.062	0.039	1.9	2.052	0.038	1.8	3.334	0.199	6.0	3.282	0.144	4.4
Tb	0.43	0.05	11.6	0.41	0.03	7.3	0.68	0.05	7.4	0.68	0.04	5.9
Th	29.09	0.50	1.7	28.96	0.83	2.9	33.27	0.54	1.6	33.82	1.70	5.0
U	7.58	0.10	1.3	7.63	0.21	2.8	11.13	0.20	1.8	10.86	0.50	4.6
Yb	2.84	0.07	2.5	2.86	0.07	2.4	4.21	0.27	6.4	4.19	0.16	3.8

Values are in parts per million unless expressed in percent. M = mean; S (spread) = root-mean-square deviation, and S(%) is S expressed in percent.

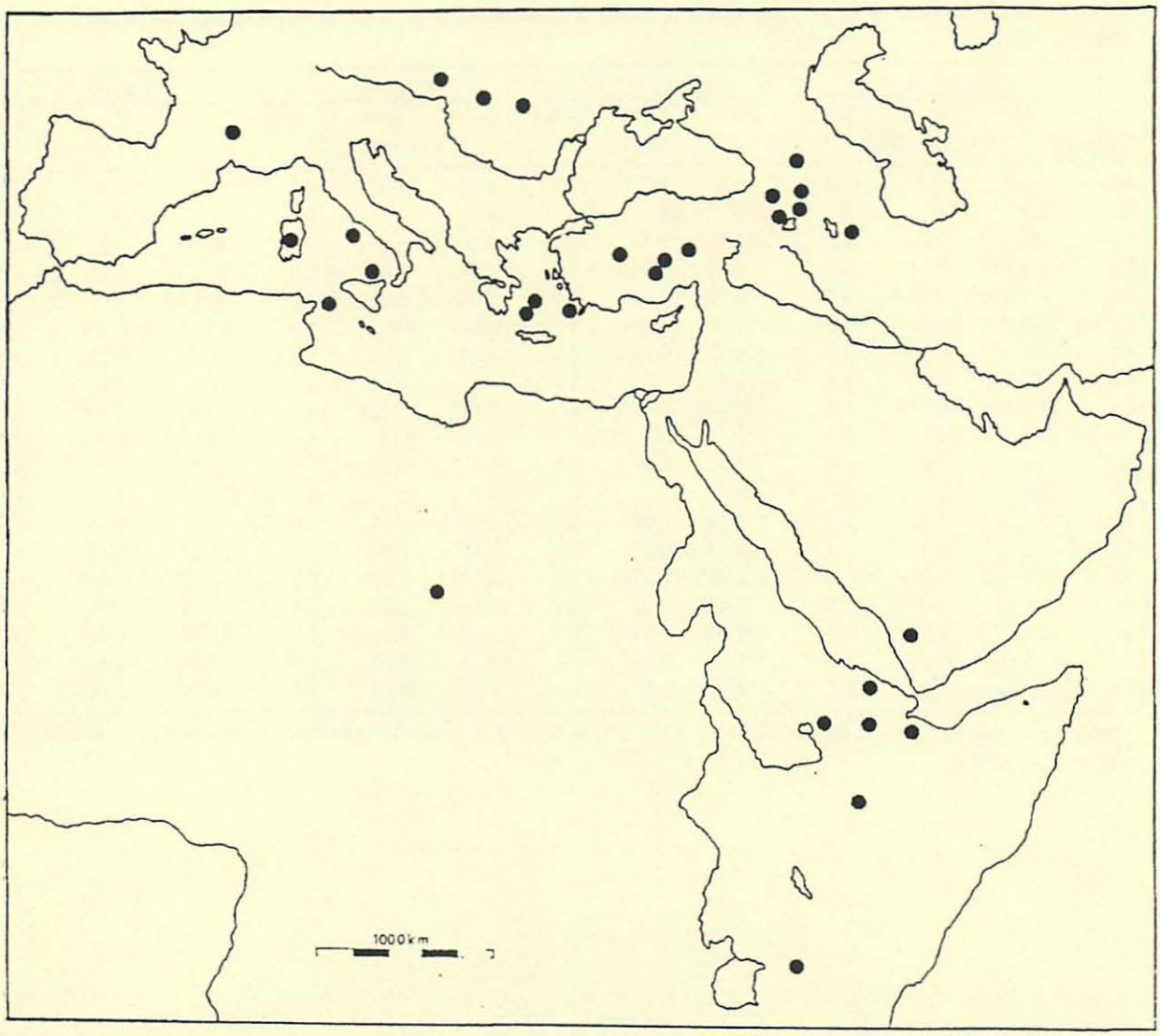

Fig. 1. General map of obsidian sources.

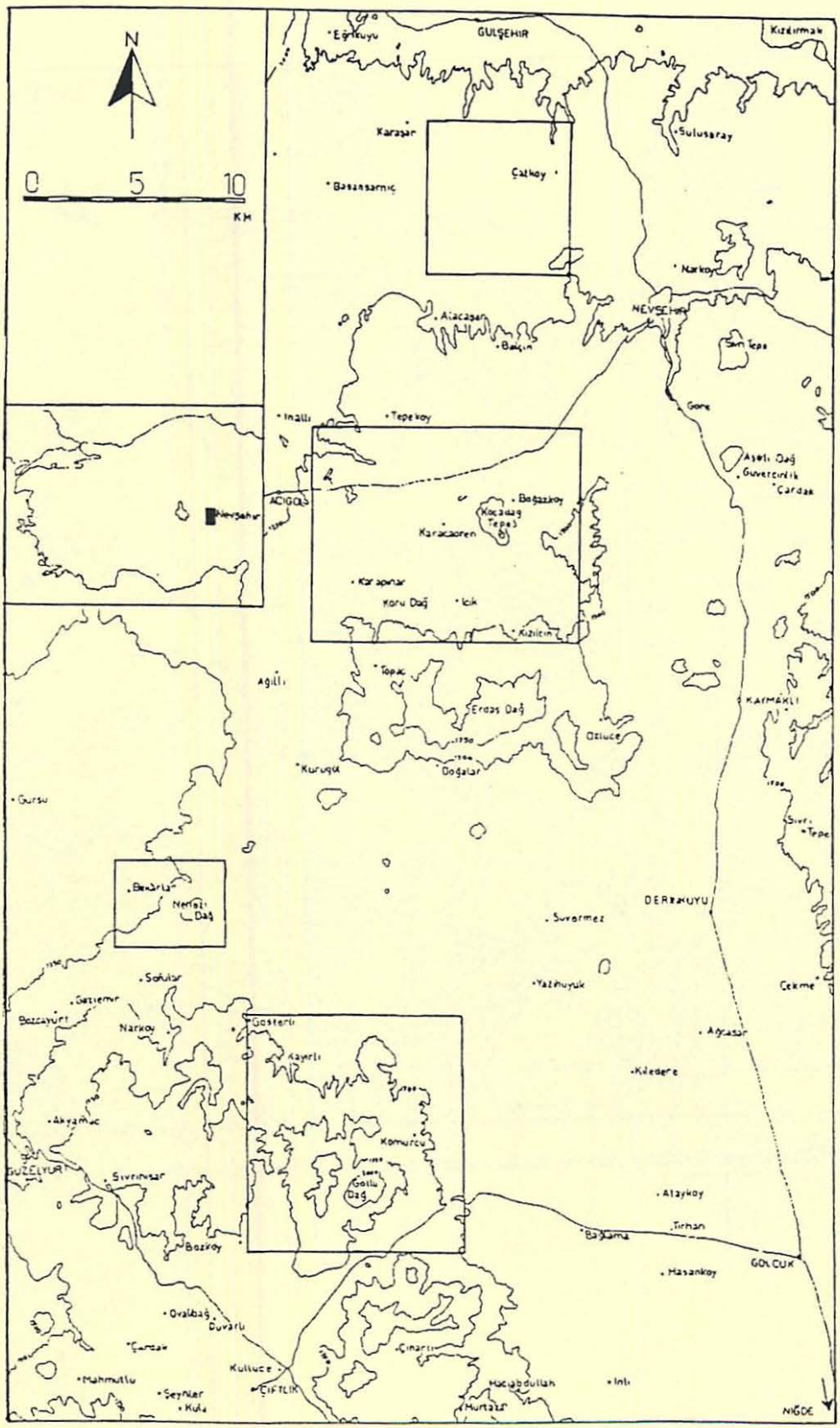

Fig. 2. The region of Anatolia from which obsidians were collected.[14]

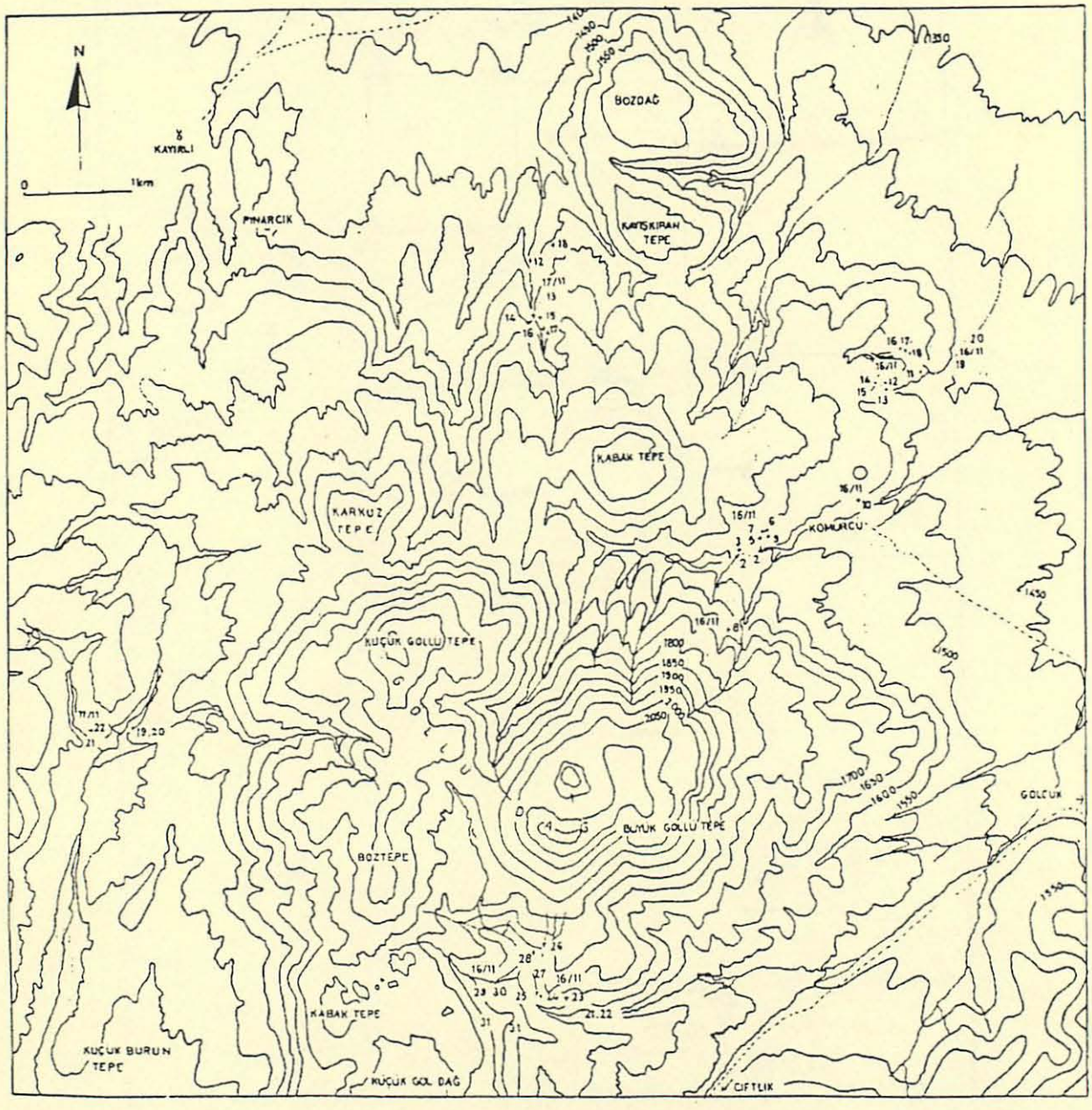

Fig. 3. Map of Göllü Dağ and vicinity showing the locations from which obsidians were collected.[14]

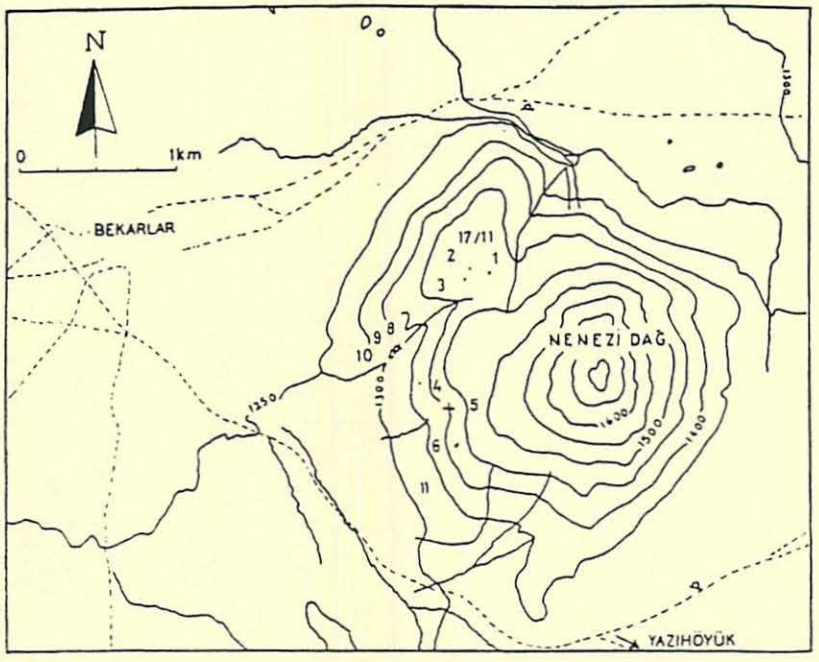

Fig. 4. Map of the Nenezi Dağ obsidian source showing the locations from which obsidians were collected.[14]

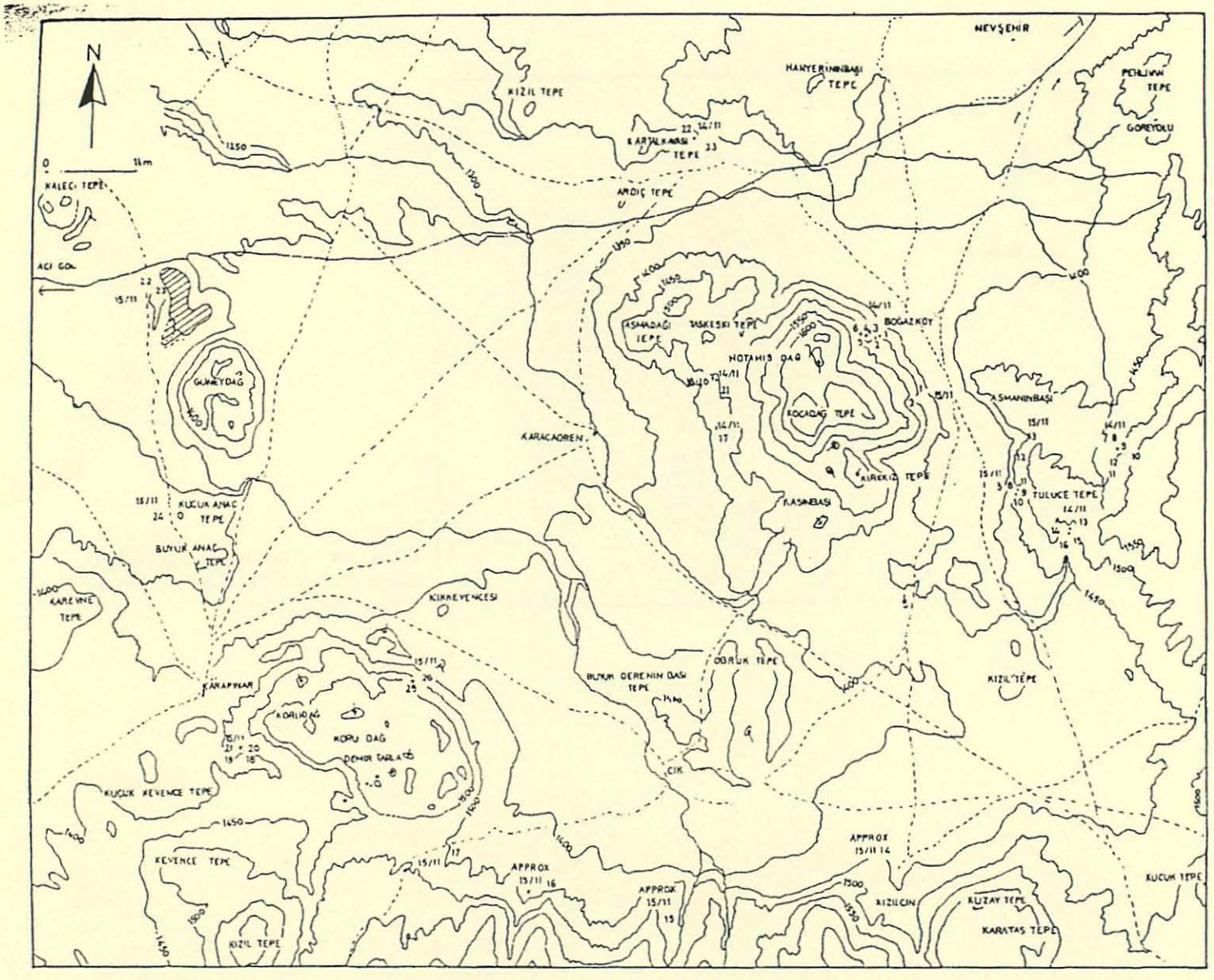

Fig. 5. Map of Hotamiş Dağ and Köru Dağ showing the locations from which obsidians were collected.[14]

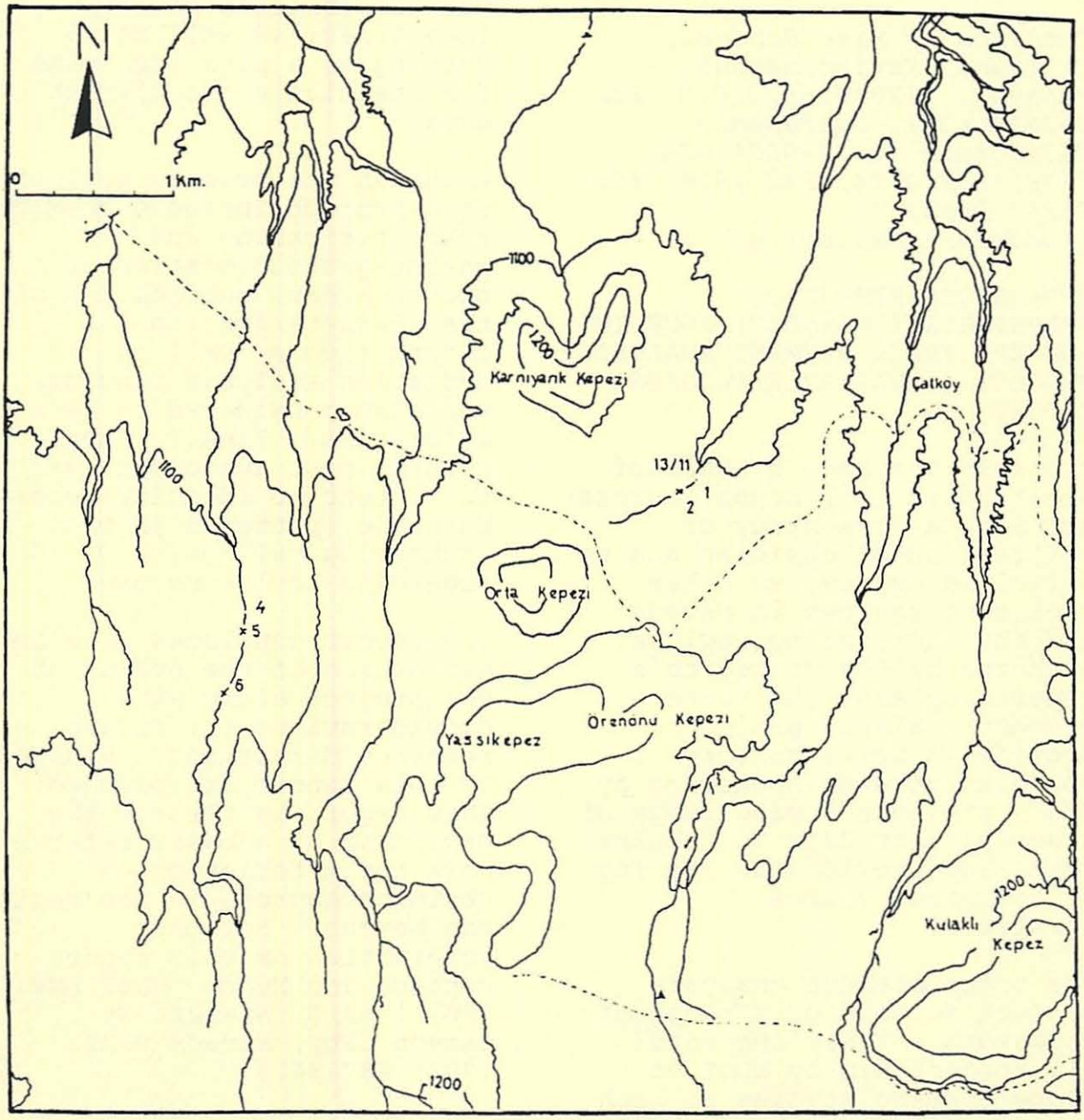

Fig. 6. Map of Çatköy showing the locations from which obsidians were collected.[14]

SHORT REPORTS AND REVIEWS

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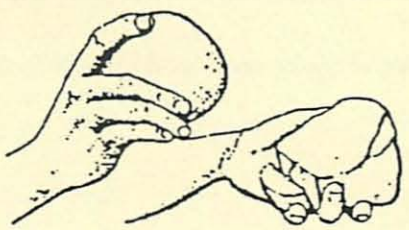
NEVADA DEPARTMENT OF TRANSPORTATION (NDOT) SOURCING AND XRF TRACE ELEMENT ANALYSIS PROJECT: AVAILABLE PROGRESS REPORT

The 1995 issuance by NDOT of Great Basin Tool-Stone Sources provides a wide array of information on obsidian and to a limited degree, on other toolstone sources in Nevada and the surrounding regions. Authored by Joe Moore, this report explains the trace element analysis project, provides a brief history of obsidian studies sponsored by NDOT, presents a wide range of trace element data in tabular form, and provides an listing of toolstone source localities.

The trace element analysis project focused on a range of endeavors. These included: (1) sponsorship by NDOT of trace element studies of both artifacts and geochemical source samples; (2) hydration analysis of artifacts; (3) induced hydration experiments for specific obsidian geochemical source groups; (4) placement, maintenance, and recovery of instrumentation providing essential environmental information; (5) locating and sampling of various obsidian source localities; as well as (6) serving as a clearing house for obsidian trace element data.

Although the primary goal of this project included chemical characterization and on-the-ground location of source areas, publication of the characterization information as well as hydration analysis findings was also considered to be a major goal. Finally, and perhaps most ambitious, was the intent to identify, where possible, patterns in the archaeological record regarding toolstone use.

The report concludes with an evaluation of the status of the project along with considerations for future research directions. Updates to this report are planned. This report is clearly the beginning of a basic reference work for information on obsidian sources in the region and beyond. For more information on this report contact Joe Moore, NDOT ENV CRS, 1263 S. Stewart St., Carson City, Nevada 89712 (702) 687-5479.



TECHNO-HYDRATION ANALYSIS REVEALS ARCHAIC PERIOD REWORKING OF CALIFORNIA OBSIDIAN: STUDY IN PROGRESS

Limited archaeological excavations by Caltrans in 1994 and 1995 at the Glory Hole site (CA-Cal-S461) in Calaveras County, California has afforded an opportunity to address a test hypothesis advanced by Skinner (1988). Skinner's hypothesis advanced the idea that a major source of obsidian utilized during the late prehistoric period on the western slopes of the Sierra Nevadas might have consisted of the scavenging and reuse of obsidian from older, hence, prior prehistoric occupations.

This hypothesis was offered by Skinner in order to account for the identified reworking of Archaic dart points and other artifacts in late period prehistoric archaeological site assemblages. Analysis of the artifacts from these assemblages revealed that bipolar percussion and other techniques were used to manufacture usable tools. Further, it was recognized that such scavenging might also account for the late prehistoric decline of the trans-Sierran obsidian exchange which had been observed by other areal researchers. The presentation of Skinner's hypothesis was accompanied by a set of methods by which obsidian hydration studies could be used to test the timing of that reuse.

A total of 100 specimens from the Glory Hole site collection were subjected to obsidian hydration rim analysis. Fifty of these specimens derived from the artifact assemblage which was recovered during an earlier excavation project that focused on the northern portions of the site area (Moratto et al. 1984). The remaining 50 specimens were selected from the current testing program which focused entirely on the easternmost portion of the site.

Cuts were made at preselected locations based on the technological attributes diagnostic of the flaking techniques that produced them. These specimens were visually identified as Bodie Hills (designated throughout remainder of article as BH) by this author and submitted to Tom Origer for hydration band width measurements.

Of the 100 specimens submitted for analysis, 92 returned useful measurements. Of those, 71 specimens (77.2%) possessed hydration rim measurements of 3.5 microns BH or greater. Based on previous studies conducted by the author (Rondeau 1992), it was suspected that hydration rim measurements of 3.5 microns or greater on artifacts recovered from this elevation level in the Sierra region can be dated no earlier than the Sierra Phase (1000 B.C.-A.D. 500). This temporal placement is commensurate with the most common projectile point assignment for these

site assemblages, that being the Elko Corner-notched type, as well as the predominance of the groundstone deriving from the milling slab/handstone technology.

Reworking was indicated on ten specimens. Eight were diagnostic of reworked bifaces (4.0-8.8 microns BH). Four were reworked by radial break percussion, three by bipolar percussion, and one by an unidentified percussion technique. None showed a difference in hydration band width between the originally worked surface and the "younger" reworked surface. Likewise, two reworked flakes, one each by bipolar and radial break percussion, also possessed Archaic era band widths (5.7 and 6.6 microns BH).

The 20 flakes identified as ventral flakes (e.g. retaining a remnant of the ventral surface of the original flake blank) all lacked double hydration bands that could have indicated the later working of an older flake blank. Likewise, neither the biface thinning pieces (n=37) nor the other bipolar specimens (n=13), the latter often associated with reworking, showed double hydration band widths.

Only the 2.0 micron (BH) reading on the rejuvenated blade element of an Elko Corner-notched point suggested the possibility of later reuse of older obsidian. However, the practice of obsidian reworking for reuse, at least at CA-Cal-S461, appears to have been practiced prior to the late prehistoric. The total lack of double hydration band pieces in this collection indicates obsidian reworking during the Archaic period. Thus, direction for refinement of the Skinner hypothesis into a working model is indicated.

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1984 *New Melones Archeological Project, California:Indian Sites 04-Cal-S-286, 04-Cal-S-347, and 04-Cal-S-461.* Final Report of the New Melones Archeological Project, IV(1, 2 and 3). National Park Service, Washington, D.C.

Rondeau, Michael F.

1992 *The Archaeology of the Kelly Site. A Phase II Report for the Archaeological Excavation of CA-Tuo-2642, for the East Sonora Bypass Project, Tuolumne County, California.* California Department of Transportation, Sacramento, California.

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1988 *Scavenging and Reuse: An Alternative to Models of Late Prehistoric Trans-Sierran Exchange in Central California.* Paper presented at the 22nd Annual Meeting of the Society for

California Archaeology,
Redding, California.

ABSTRACTS AND ANNOTATIONS ON REPORTS AND PUBLICATIONS

** Please note the following corrections on IAOS Bulletin No. 14. The Society for American Archaeologists should have read Society for American Archaeology.*

Asaro, Frank, Ernesto Salazar, Helen V. Michel, Richard L. Burger, and Fred H. Stross.

1994 Ecuadorian obsidian sources used for artifact production and methods for provenience assignments. Latin American Antiquity, 5: 257-277.

Abstract

A study by neutron activation analysis and X-ray flourescence measurements of 116 Ecuadorian obsidian artifacts as well as primary and secondary source samples has shown that the material originated from two Andean sources in north-central Ecuador, a flow in the valley of Mullumica, and deposits found on Yanaurco Chico and the nearby Quiscatola crest. The Yanaurco-Quiscatola deposit complex, homogeneous within our ability to measure, is represented by 18 percent of the artifacts. The Mullumica source has variable, apparently linearly related element abundances that may have resulted from the incomplete mixing of two magmas within a magma chamber. Seventy-eight percent of the samples studied are deduced to have originated from that source. Five artifacts from La Chimba cannot be assigned an origin, but four of them have the same provenience. To test the validity of the mixed-magma theory, we present equations to calculate the abundance of any measured element from that of iron. On the average, agreement within about 3 percent is obtained for artifacts.

Bayman, J.M.

1995 Rethinking "Redistribution" in the Archaeological Record: Obsidian Exchange at the Marana Platform Mound. *Journal of Anthropological Research* 51:37-55.

Abstract

Economic concepts of redistribution and reciprocity (e.g., Service 1962; Sahlins 1972; Earle 1977) often play important roles in models of exchange, even though prehistorians are poorly equipped to discriminate between these processes in the archaeological record. Spatial analyses and geochemical characterization (X-ray fluorescence) of obsidian from the Classic period (A.D. 1100-1300) Hohokam multi-site community of Marana in the American Southwest reveal patterns that do not match idealized archaeological expectations of redistribution. These data

support an interpretation of restricted obsidian consumption at communal ceremonial gatherings that centered on the platform mound. However, households in the platform mound settlement (the largest site in the community) had roughly *equivalent* amounts of obsidian, whereas households in settlements away from the mound had highly limited access. This unexpected pattern indicates that normative models of exchange are inadequate for characterizing prehistoric economy in prestate societies like the Hohokam.

G. Bigazzi, M. Coltelli, N.J.C.Hadler, A.M. Orsorio Araya, M. Oddone, and E. Salazar.

1992 Obsidian-bearing lava flows and pre-Columbian artifacts from the Ecuadorian Andes: First New Multi-disciplinary Data. *Journal of South American Earth Sciences* 6(1/2):21-32.

Abstract

All known outcrops of obsidian flows in the Cordillera Real (Ecuador) have been mapped and sampled to reconstruct their eruptive history using geological observations, age determinations, and trace element data. Our results bear also on the recognition of the sources of obsidian artifacts, used in Pre-Columbian tools, and on the reconstruction of ancient trading patterns in Ecuador. Three obsidian flow groups were identified on the basis of flow structures and state of preservation. The groups are further defined by differences in radiometric age, fission-track measurements made at two laboratories (Pisa, Italy, and Campinas, Brazil), and different trace element patterns, determined by neutron activation analysis (Pavia, Italy). The oldest obsidian flows form the upper part of the Basal Volcanic Complex (BVC), the basement of Quaternary Ecuadorian stratovolcanoes. Their ages fix the upper limit of the BVC at 1.5Ma, in the central Cordillera Real. The two more recent episodes of obsidian rhyolitic volcanism are dated at 0-.85 Ma and slightly less than 0.2Ma, corresponding in age to the present volcanic arc.

Burger, Richard L.,Frank Asaro, Helen V. Michel, Fred H. Stross, and Ernesto Salazar.

1994 An Initial Consideration of Obsidian Procurement and Exchange in Prehispanic Ecuador. *Latin American Antiquity* 5:228-255.

Abstract

We have examined the role of long-distance trade in Prehispanic Ecuador using X-ray flourescence (XRF) and neutron-activation analysis (NAA) of obsidian artifacts from the archaeological sites of El Inga, Chobshi Cave and Site OGSE-46 on the Santa

Elena Peninsula. Results indicate that two geological sources east of Quito, Yanaurco-Quiscatola and Mullumica, were the principal source of raw obsidian at these sites. We situate our findings within a broader archaeological context through a review of the literature and a discussion of an earlier provenience study undertaken by us. We express concerns about recent attempts to apply ethnohistoric models to early periods of Ecuadorian prehistory, and argue that despite early exploitation of the principal obsidian sources, long-distance trade in obsidian was initiated at a relatively late date and remained at a surprisingly low level in southern Ecuador during most of prehistory.

Darling, J. Andrew and Michael D. Glascock

1995 Acquisition and Distribution of Obsidian in the North-Central Frontier of Mesoamerica. In *III Coloquio Pedro Bosch Gimpera: Rutas De Intercambio en Mesoamerica*, June 5-9, 1995, Universidad Autonoma de Mexico, Mexico City.

Annotation

Compositional analysis of 130 obsidian samples from five volcanic sources and 93 obsidian artifacts from sites throughout the north central frontier in Durango, Zacatecas and Jalisco are reported. All analyses were performed by NAA at the Missouri University Research Reactor and were integrated into the Missouri databank for Mesoamerican obsidians. The study indicates that an unexpected diversity of obsidian sources were utilized at various times during the history and prehistory of the northern frontier. With the expansion and growth of Mesoamerican culture into what is today northern Mexico, diversity may have increased as the desire for certain kinds of obsidian objects such as fine blades exceeded the limitations of local technologies and available raw material. This may have lead, in turn, to the development of new routes or the elaboration of pre-existing routes of interaction and trade on both sides of the Sierra Madre Occidental.

Darling, J. Andrew and Frances M. Hayashida

1995 Compositional analysis of the Huitzila and La Lobera obsidian sources in the southern Sierra Madre Occidental, Mexico. *Journal of Radioanalytical and Nuclear Chemistry, Articles* 192(2):245-254.

Abstract

Results of neutron activation analysis of 100 obsidian specimens from the southern Sierra Madre Occidental are discussed. Two separate perkaline sources are identified, Huitzila and La Lobera, which are chemically and spatially distinct. Subsequent subdivision of each

source into spatial and compositional subgroups suggest separate flows or subsources. Identification of archaeological artifacts which match these sources compositionally suggests that Huitzila and La Lobera were important sources of high quality obsidian which was distributed widely in northern Mesoamerica.

Friedman, Irving, Fred W. Trembour, Franklin L. Smith, and George I. Smith

1994 Is Obsidian Hydration Dating Affected by Relative Humidity? *Quaternary Research* 41:185-190.

Abstract

Experiments carried out under temperatures and relative humidities that approximate ambient conditions show that the rate of hydration of obsidian is a funciton of the relative humidity, as well as of previously established variables of temperature and obsidian chemical composition. Measurements of the relative humidity of soil at 25 sites and at depths of between 0.01 and 2 m below ground show that in most soil environments at depths below about 0.25 m, the relative humidity is constant at 100%. We have found that the thickness of the hydrated layer developed on obsidian outcrops exposed to the sun and to relative humidities of 30-90% is similar to that formed on other portions of the outcrop that were shielded from the sun and exposed to a relative humidity of approximately 100%. Surface samples of obsidian exposed to solar heating should hydrate more rapidly than samples buried in the ground. However, the effect of the lower mean relative humidity experiences by surface samples tends to compensate for the elevated temperature, which may explain why obsidian hydration ages of surface samples usually approximate those derived from buried samples.

Glascock, Michael D., Hector Neff, Katherine S. Stryker, and Taryn N. Johnson

1994 Sourcing Archaeological Obsidian by an Abbreviated NAA Procedure. *Journal of Radioanalytical and Nuclear Chemistry, Articles* 180:29-35.

Abstract

An abbreviated NAA procedure has been developed to fingerprint obsidian artifacts in the Mesoamerican region. Despite the large number of available sources, an NAA procedure, which relies on producing short-lived isotopes, has been applied witha success rate greater than 90 percent. The abbreviated NAA procedure is rapid and cost competitive with the XRF technique more often applied to obsidian sourcing. Results from the analysis of over 1,200 obsidian artifacts from throughout Mesoamerica are presented.

Gomez, Basil, Michael D. Glascock, M. James Blackman, and Ian A. Todd
1995 Neutron activation analysis of obsidian from Kalavasos-*Tenta*. *Journal of Field Archaeology* 22:503-508.

Abstract

The small quantity of obsidian used by the Aceramic Neolithic occupants of Cyprus was imported since there is no source on the island. The chemical composition, determined by neutron activation analysis, of six samples of obsidian from Kalavasos-*Tenta* indicates that they were derived from the central Anatolian, Göllü Dağ (Çiftlik: Group 2b), source. Thus, on the basis of chemical composition, obsidian from five Cypriot Aceramic Neolithic sites has the same provenance. Our data suggest that the fragments we analyzed were not derived from a single core and, because obsidian occurs throughout the Aceramic period of occupation of Kalavasos-*Tenta*, it appears unlikely that the 36 artifacts recovered from the site represent a one-time transfer of material. This suggests an enduring supply, and implies to us that the inhabitants of Kalavasos-*Tenta* were never completely estranged from the mainland.

Hall, Mark E. and Steven Shackley

1994 An Energy Dispersive X-ray Fluorescence Study of Some Near Eastern Obsidians. *Al-Rafidan* XV:25-32. (Institute for Cultural Studies of Ancient Iraq, Kokushkan University, Tokyo).

Annotation

Twenty four obsidian artifacts from three sites in the Habur River basin in northeastern Syria and northern Iraq were characterized by energy-dispersive XRF spectrometry. Twenty two of the artifacts came one of the four subsources at Nemrut Dağ, Turkey. Due to the lack of XRF data on these subsources, the specific subsource could not be identified. One of the two remaining artifacts came from source B at Bingöl, Turkey and the other came from an unknown source.

Harbottle, Garman, Hector Neff and Ronald L. Bishop
1994 The Sources of Copan Valley Obsidian. In *Ceramics and Artifacts from Excavations in the Copan Residential Zone*, edit ed by Gordon R. Willey, Richard M. Leventhal, Arthur A. Demarest and William L. Fash, pp. 445-457, Cambridge.

Annotation

One hundred thirty-nine obsidian artifacts from the Copan Valley were subjected to neutron activation analysis at Brookhaven National Laboratory. As anticipated, the overwhelming majority (132 specimens) of obsidian recovered in the Copan Valley comes from the closest source, Ixtepeque. The seven remaining specimens pertain to

the source at El Chayal. These data provide no evidence of a difference between the two localities in external obsidian exchange relations. Thus, we find no grounds for questioning the assumption that the minor quantities of El Chayal obsidian that reached the Copan Valley were distributed through the same channels responsible for distribution of the more common Ixtepeque obsidian.

Mitchell, Douglas R., and M. Steven Shackley

1995 Classic Period Hohokam Obsidian Studies in Southern Arizona. *Journal of Field Archaeology* 22(3):291-304.

Abstract

During the last decade a number of obsidian studies have been conducted on Classic-period Hohokam artifacts from sites in southern Arizona. The geological and cultural settings of this region make it an ideal area for the study of raw material acquistion and distribution networks. The technique of X-ray fluorescence (XRF) spectometry has been used an inexpensive means to characterize sources and artifacts. This paper discusses the results of obsidian studies conducted on nine sites or site complexes within the Hohokam area. The dominant pattern of raw material procurement appears to be one of proximity, where the most commonly found obsidian on the site was usually obtained from the closest source. Procurement strategies indicate that obsidian procurement may have been secondary or parallel to the acquisition of other primary resources.

Neff, Hector, Frederick J. Bove, Taryn N. Johnson, and Barbara Arroyo

1993 Fechamiento a Traves de Hidratacion de Obsidiana en la Costa Sur de Guatemala. *Apuntes Arqueológicos* 2:55-79.

Annotation

Obsidian hydration dating has been in use in Pacific coastal Guatemala since Friedman and Smith reported rim readings from La Victoria over 30 years ago. Subsequent obsidian dating efforts in the region for the most part have adhered to the "empirical" approach advocated by Meighan. In recent applications of the technique to assemblages from the Pacific coastal department of Escuintla, we have coupled source determination via neutron activation analysis with hydration rim readings and have evaluated the readings from each source separately. We consider both "empirical" dates obtained by correlation with independent chronological evidence and dates by calculating source-specific hydration rates on the basis of induced hydration experiments and estimates of effective hydration temperature.

Shackley, M. Steven

1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantatitive Analysis. *American Antiquity* 60(3):531-551.

Abstract

Obsidian studies in the greater American Southwest have come of age. No longer does the region lag behind other adjoining regions both in the understanding of source provenance and the integration of obsidian source studies into regional designs. Most of the archaeological obsidian sources discussed here were originally presented in semi-quantitative form in this journal in 1988 (Shackley 1988a). The purpose here is to present that same data in broadly useable quantitative calibrated to international standards, update the source descriptions when appropriate, and, finally, present data on a few new sources recently located. This is a necessary step to continue the momentum of obsidian studies in the region and make the information available to all. Finally, some discussion is directed toward the archaeological utility of obsidian studies in the region.

Torrence, R., and K.L. Victor

The relativity of density. *Archaeology of Oceania* 30:121-131.

Abstract

In an attempt to overcome biases resulting from small sample size, we examine the potential of relative density, which Ambrose (n.d.;1994) and Green (1987) have proposed is a non-destructive, inexpensive, and each technique for characterizing the chemical composition of obsidian from different sources in Melanesia. Our results demonstrate considerable overlap in relative density for the chemical subgroups in West New Britain, but also show that reasonable discrimination between obsidian samples from the West New Britain and Lou Island regional groups can be obtained. Weathered surfaces and inclusions are found to have inconsequential effects. It is argued that when used within its limitations, relative density could have an important role in future studies of prehistoric obsidian procurement and exchange.

Yellin, Joseph

1995 Trace element characteristics of Central Anatolian obsidian flows and their relevance to pre-history. *Israel Journal of Chemistry* 35:175-190.

Abstract

This report concerns the chemical characterization of obsidian sources from Central Anatolia by neutron activation analysis. The sources covered

in this study were Göllü Dağ, Hotamiş Dağ, Köru Dağ, Nenezi Dağ, and Çatköy. The study reported here was undertaken with the object of obtaining an accurate "fingerprint" of the compositions of obsidian sources that would permit tracing the origin of archaeological obsidian artifacts to their sources, and in particular, archaeological obsidian recovered from prehistoric sites in Israel. The extent of the sampling within the sources was more thorough than hitherto reported and the results are of high precision and accuracy.

MEETINGS AND EVENTS

1996

February 22-23. State of Jefferson Meeting. Southern Oregon State College. Ashland, Oregon. USA.

February 24-25. Sacramento River Ecosystem Prehistory. Central California Archaeological Foundation. California State University, Chico, California. USA.

April 3-7. Society for California Archaeology Meeting. Red Lion Hotel, Bakersfield, California. USA.

April 10-14. The 61st Annual Meeting of the Society for American Archaeology. Marriott Hotel, New Orleans, Louisiana, USA.

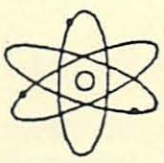
May 20-24. International Symposium on Archaeometry. Urbana-Champaign, Illinois. Sarah Wisseman, ATAM Program, University of Illinois, 116 Observatory, 901 S. Mathews, Urbana, Il 61801, USA; tel:217-333-6629; fax: 217-244-0466; email: wisarc@uxl.cso.uiuc.edu

1997

February 10-13. Sixth Australasian Archaeometry Conference. Australian Museum, Syndey, Australia. Austalian Institute of Nuclear Science and Engineering, Australian Nuclear Science and Technology Organization, Australian Museum. Dr. Claudio Tuniz, Sixth Australian Archaeometry Conference, AINSE, PMB 1, Menai, NSW 2234, Australia; tel: (02) 717-3493; fax: (02) 717-9265; email: tuniz@atom.ansto.gov.au.

ARCHAEOMETRY WORKSHOPS

On February 24-25, 1996 *WORKSHOPS IN ARCHAEOMETRY* will be held at the 7th Annual International Conference at the University of Buffalo. For more information, contact Patrick S. Miller, email: psmiller@buffalo.edu, or Ezra Zubrow, tel: (716) 645-2511.



ABOUT THE IAOS

The IAOS was established to:

(1) develop standards for analytic procedures and ensure inter-laboratory comparability;

(2) develop standards for recording and reporting obsidian hydration and characterization results;

(3) provide technical suport in the form of training and workshops for those wanting to develop their expertise in the field.

(4) provide a central source of information regarding advances in obsidian studies and the analytic capabilities of various laboratories and institutions.

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The IAOS needs membership to ensure the success of the organization. To be included as a member and receive all of the benefits thereof, you may apply for membership in one of the following categories:

· Regular member $20.00/year
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CALL FOR ARTICLES AND INFORMATION

Submissions for articles, short reports, abstracts, or announcements for inclusion in the next newsletter should be received by March 15, 1996. We accept electronic media on IBM compatible 3.5" or 5.25" diskettes in a variety of word processing formats, but Wordperfect (5.n) is preferred. A hard copy of the text and any figures should accompany diskettes. Send to Blossom Hamusek, 2874 Camulos Way, Redding, California, 96002, USA; tel: (916) 221-7852;

Short Reports and Reviews: If you are interested in briefly reporting on research findings (e.g., one column in length), contact Mike Rondeau at Caltrans Environmental Program, 1120 N St., P.O. Box 942874 MS 27, Sacramento, California, 94274-0001, USA; tel: (916) 653-0974; fax: (916) 653-6126; email: mrondeau@trmx3.dot.gov.ca

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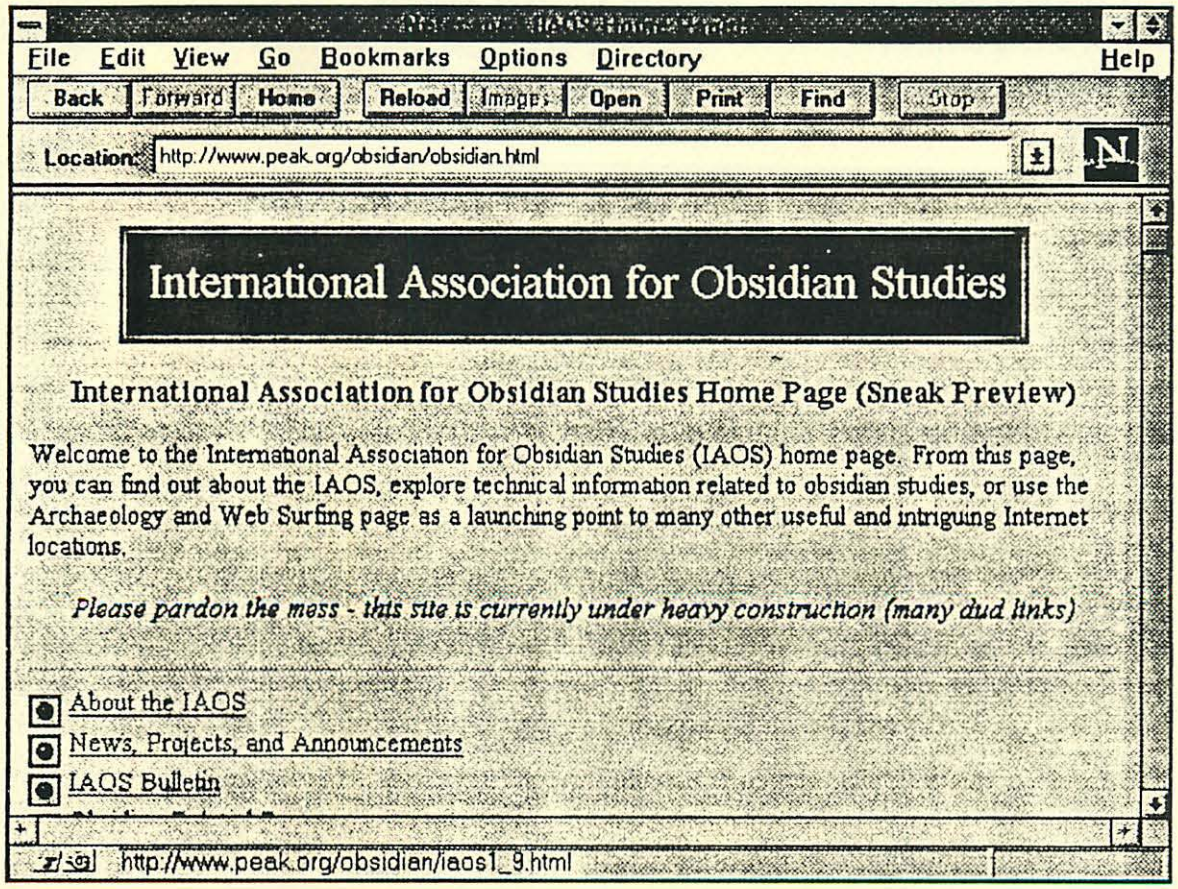

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