International Association for Obsidian Studies Newsletter

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Assembled and edited by R. J. Jackson

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Introduction

This is the first in what I hope will be a long series of newsletters from the International Association for Obsidian Studies (IAOS). The purpose of the newsletter is the dissemination of news and information regarding obsidian studies throughout the world. We make no pretense at comprehensive coverage as yet. As you will see, the majority of the news and information derives from obsidian studies in Californnia. This simply demonstrates the need for a wide network for information-sharing. We anticipate that the scope of coverage will increase greatly with membership and participation. The success and frequency of this newsletter will depend on the interest and demand of IAOS members.

Background

So what is the IAOS? For those of you who are unfamiliar with the IAOS, let me briefly describe its short history, goals, and benefits of membership.

The IAOS is an outgrowth of a 1988 meeting of obsidian hydration specialists who met in Reno, Nevada during the Materials Research Conference to discuss a wide variety of common problems. All participants at the meeting agreed that greater standardization of procedures, interaction, and information exchange was necessary to address problems of data comparability and quality. The concept of an organization of obsidian hydration laboratories was discussed, and the group agreed to develop a set of obsidian hydration thin section slides for circulation and examination to begin assessing the degree of comparability in measurements as well as define the variables appropriate for further examination. The results of the informal comparison are reported in this newsletter.

I pursued the idea of an organization by corresponding with a number of obsidian researchers, proposing the formation of an organization. A number of questions regarding the need to develop standard data categories, centralized data collection, and the establishment of laboratory standards were discussed. The response to this initial mailing was positive, resulting in an organizational meeting at the 1989 Society for California Archaeology Annual Meeting in Los Angeles.

Numerous interested obsidian researchers attended the meeting. In discussing the scope and audience for such an organization, all agreed that archaeological applications of obsidian hydration analysis cannot be effective if divorced from other kinds of glass studies, such as geochemical analysis and lithic technology. Furthermore, we discussed the common problems and potential solutions shared by obsidian researchers worldwide. Hence, the formation of the International Association of Obsidian Studies. The meeting is documented by a detailed transcript.

The IAOS now has by-laws, officers, and a growing membership (not to mention recognition by the IRS). The IAOS is operating as a special-interest group under the umbrella of the Society for Archaeological Sciences (SAS).

Goals

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 sourcing results;

3) provide technical support 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.

The IAOS hopes to assist users of obsidian hydration and geochemical data as well. Reporting standards will facilitate computerized data retrieval and dissemination for regional research. We will distribute information on laboratory services, including analytic services, applications, research perspectives, and geographic areas of interest of member labs. Finally, we are developing an extensive bibliography of pertinent references and shall distribute information concerning newly identified obsidian sources and geochemical studies, sampling and analytic strategies, and hydration rate developments.

Membership

The activities described above require modest financing. Initial mailings were performed largely at personal expense, but as we grow this cannot continue. We need 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
- Institutional Member $50.00/year

Regular members are individuals or institutions who are interested in obsidian studies, and wish to support the goals of the IAOS. Regular members will automatically be subscribed to the Society for Archaeological Sciences (SAS) Bulletin, issued quarterly. If you already subscribe to the SAS Bulletin, deduct $10.00 from the membership dues. The SAS Bulletin shall be the regular forum for meeting announcements and developments of the IAOS. Regular members will also receive any general mailings; announcements of meetings, conferences, and symposia; newsletters; and papers distributed by the IAOS during the year. Regular members are entitled to attend and vote in Annual Meetings.

Institutional members are those individuals, facilities, and institutions who are active in obsidian studies and wish to participate in inter-laboratory comparisons and standardization. If an institution joins, all members of that institution are listed as IAOS members, although they will receive only one mailing per institution. Institutional members will receive assistance from, or be able to collaborate with, other institutional members. Institutional members are automatically on the Executive Board, and as such have greater influence on the goals and activities of the IAOS. In addition, Institutional members will automatically receive the SAS Bulletin and all other mailings sent to Regular members. If you wish to become an institutional member and already subscribe to the SAS Bulletin, deduct $15.00 from the membership dues.

This first newsletter is sent to everyone who has expressed an interest in the IAOS, current members and non-members alike. **If you do not join the IAOS, you will not receive future mailings.** While preparation of newsletters, mailings, the development of standards, and bibliographies is performed on a volunteer basis, reproduction and mailing costs cannot be supported without your help. If you wish to join us, mail a check or money order to the IAOS:

Ms. Kathleen Hull, Secretary-Treasurer
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NEWS AND INFORMATION

Obsidian Hydration Laboratories Forming

Several new obsidian hydration laboratories are forming in Northern California. These much-needed facilities will result in more comprehensive examinations of obsidian from regional sites, as well as increased sample sizes for many projects. Comparability of results and standardization of procedures will be ensured through the cooperation and collaboration of the IAOS! IAOS members are actively working with these fledgling labs to assemble the appropriate equipment. In addition, IAOS institutional members Tom Origer and Rob Jackson have been working with these prospective labs to develop proper techniques for specimen preparation and examination. Brief profiles of the new laboratories and technicians are offered below.

San Jose State University

The Department of Cybernetics and Anthropology, San Jose State University (SJSU) has assembled the equipment necessary to perform obsidian hydration analysis. Under the watchful eye of Dr. Tom Layton, SJSU has consulted with IAOS members to purchase an Olympus BHT microscope with strain-free polarizing capabilities. SJSU is also in the process of training student technicians in the preparation and examination of thin sections. As institutional members of the IAOS, SJSU is consulting with other IAOS members in this learning process. Dr. Layton has a long-standing record of interest in, and use of, obsidian hydration data in the Great Basin. SJSU anticipates that its primary and principle activity in obsidian hydration analysis will be in-house projects rather than commercial analyses.

California State University, Chico

The Department of Anthropology, California State University, Chico (CSUC) conducts archaeological research in north-central, northeastern, and northern Sierra archaeology. Each of these research areas witnessed the extensive prehistoric use of obsidian, each characterized by the use or import of different obsidian sources. Northeastern California, alone, is one of the most obsidian-rich and complex regions in North America. CSUC, also an IAOS Institutional member, is in the process of assembling the proper equipment to conduct hydration analysis in consultation with other IAOS Institutional members. There is no shortage of research experience at CSUC, as the new laboratory will be operated under the supervision of Dr. Mark Kowta, Dr. Frank Bayham, and Mr. Bill Dreyer. Ms. Lisa Swillinger will play an important role in organizing the laboratory and conducting analyses. CSUC also plans to conduct obsidian hydration studies primarily for in-house archaeological projects.

Yosemite National Park

Yosemite National Park encompasses two of the major prehistoric obsidian distribution routes in central California; the Tuolomne and Merced River drainages. These east-west drainages served as important geomorphological conduits for the transport/exchange of obsidian from primarily the central-eastern Bodie Hills and Casa Diablo obsidian sources to prehistoric populations of the western Sierra Nevada and Central Valley of California. Obsidian studies have become a central focus of Yosemite research in the last decade. Yosemite National Park has the largest and most active research and cultural resource management program of any National Park in California, and YNP archaeological studies unfailingly include obsidian source and hydration analyses. The Yosemite Archaeological Research Program, under the supervision of Mr. Scott Carpenter, is organizing an obsidian hydration laboratory. Yosemite National Park is an IAOS Institutional member. As you will note, Kathleen Hull, an archaeologist with the Yosemite Research Center, is our Secretary-Treasurer and has volunteered her own P.O. Box as the business mailing address for 1989, demonstrating the Park's interest and commitment in developing this capability in collaboration with the IAOS. The Yosemite laboratory anticipates conducting obsidian hydration research initially and primarily on its own projects and collections, but may eventually explore the possibility of conducting hydration analyses for other Sierran projects.

Biosystems Analysis, Inc.

Biosystems Analysis, located in Santa Cruz, California, has recently established a cultural resources management section headed by Dr. Thomas Jackson Those of you who know Tom will realize that, under his leadership, Biosystems' cultural resource management program is bound to be successful and highly professional. Mr. Brian Wickstrom, an archaeologist working with Biosystems, will be the primary obsidian hydration laboratory technician. Brian has years of experience working with obsidian hydration data and his several years at Sonoma State University has acquainted him with the method. Brian recently worked with Rob Jackson, assisting him in the preparation of several dozen specimens to better learn the process of specimen preparation and measurement. Biosystems is currently processing obsidan specimens for both in-house projects and contracted work.

IAOS Obsidian Studies Bibliography

An extensive bibliography of articles and publications relating to obsidian studies is nearing completion and will be available to IAOS members for the cost of reproduction and mailing ($5.00). Non-members can purchase the bibliography for $10.00. The bibliography was developed and graciously donated by Ms. Kim Tremaine at Sonoma State University and Ms. Janet Scalise at the University of California, Los Angeles. We anticipate that the bibliography will also be available to members on either 5 1/4" or 3 1/2" diskette for an additional charge.

Inyo National Forest Obsidian Research

The Inyo National Forest in central-eastern California encompasses a number of obsidian sources, many which were intensively used by prehistoric peoples. Of these, Casa Diablo obsidian was one of the major sources of stone tool material for prehistoric central California. Many Casa Diablo obsidian exposures and quarry areas are covered with marketable trees, creating conflicts between the protection and preservation of prehistoric quarry areas and timber harvest--along with a number of other multiple-use activities including geothermal development, grazing, and recreation. In an effort to develop thoughtful, well-supported, and defensible long-term management approaches to these prehistoric resources, the Inyo National Forest has launched a comprehensive, multi-year, multi-phase approach to the study of the Casa Diablo obsidian source. This effort should prove instrumental in developing a thematic study and treatment plan that can be applied to other obsidian sources as well.

Aboriginal Quarries Bibliography

The first phase of this study involved an extensive literature review. An annotated bibliography of works relating to aboriginal quarries for flaked-stone, primarily in the western United States, has been prepared by Ms. Elena Nilsson of Mountain Anthropological Research, Incorporated, for the Inyo National Forest. The bibliography has over 200 references that include publications, research reports, and cultural resource management documents.

Geochemistry and Intra-source Variability of Casa Diablo Obsidian

The second phase of research will explore the geochemical variability of the Casa Diablo source by obtaining and analyzing samples from at least 20 geographically separated outcrop locations within the source area. Mapped samples will be subjected to quantitative X-ray fluorescence spectroscopy. The Inyo National Forest has contracted with Dr. Richard Hughes to perform the sample collections and the geochemical study. Dr. Hughes is interested in identifying the similarities and differences both within and between outcrop locations. The results of this study have important implications for the archaeological examination of archaeological sites containing Casa Diablo obsidian, with the potential to address topics such as: 1) prehistoric access to, and regularity of use of, and/or control of specific quarries within the source area; 2) patterns of exchange and distribution by quarry area within the source; 3) raw material preferences practiced by prehistoric craftsmen; and 4) the potential for variation in obsidian hydration rates within and between outcrop areas resulting from geochemical differences.

Source Boundary Verification

Although the area of the Casa Diablo source has been more or less completely surveyed for archaeological sites, the reports on file are of varying quality and accuracy.

Some of the previous surveyors did not have the training to recognize quarry and workshop remains so that new sites need to be recorded and added to the inventory. An additional problem in using the reports is lack of comparability. Such seemingly basic concepts as "site" and "quarry" need to be operationalized and records updated accordingly. This phase of the project is being conducted by Inyo National Forest personnel and will be completed this fall. A comprehensive report of the Casa Diablo source as an archaeological entity will be prepared by Mr. Nicholas Faust of the Mono Lake Ranger District.

For more information on the draft bibliography, the geochemical study, or subsequent phases of research, contact:

Ms. Linda Reynolds,
Forest Cultural Resources Manager,
Inyo National Forest
873 North Main Street
(619) 873 5841

Induced Hydration Research at Sonoma State University

Sonoma State University is currently conducting research on induced hydration, participating in selected research projects. Research on a number of California obsidian sources is ongoing, and an examination of eastern California obsidians, including Bodie Hills and Casa Diablo, is planned. For more information, contact:

Ms. Kim Tremaine
Cultural Resources Facility
Sonoma State University
1801 E. Cotati Avenue
Rohnert Park, California 94928.

Cultural Resource Management and Research Within the Coso Geothermal Field

The Coso volcanic field was a major source of obsidian for prehistoric stone tool manufacture in southern California. Coso obsidian was exchanged hundreds of miles and dominates archaeological assemblages in the Coso region. The Coso volcanic field is situated in the Coso Known Geothermal Area (KGRA), controlled primarily by the China Lake Naval Weapons Center. Geothermal exploration and development has resulted in a substantial amount of archaeological attention in recent years. Under the careful stewardship and supervision of Ms. Carolyn Shepherd of the Naval Weapons Center, a number of researchers have conducted archaeological inventory, evaluation, and data recovery at archaeological sites within the Coso KGRA. Ms. Shepherd is also credited with navigating the maze of bureacracy to arrange for the development of a management plan for archaeological studies within the KGRA. This management plan will provide specific guidance to researchers conducting work in the KGRA, ensuring that minimum standards for data collection, analysis, and report preparation are maintained. The management plan will also ensure that comparable data are gathered and incorporated into a standard data base. Dr. Jamie Cleland, Dames and Moore, Inc., prepared the draft management plan, with assistance from Dr. William Hildebrandt and Ms. Amy Gilreath of Far Western Anthropological Research Group, Inc. These firms have conducted the most extensive archaeological studies within the KGRA to date, and they were asked to provide brief descriptions of their work.

Dames and Moore Investigations

by Dr. Jamie Cleland

Dames and Moore, Incorporated has conducted a series of archaeological investigations on and around Sugarloaf Mountain in the Coso obsidian source area. One thrust of the research has been to test the validity of induced hydration rate determinations as an archaeological dating tool. Artificially induced hydration experiments have been conducted for the Sugarloaf Mountain and West Sugarloaf geochemical groups. Effective hydration temperatures have been established for four sites at Sugarloaf Mountain. Additionally, soil relative humidity has been determined for one site. Approximately 500 artifacts have been measured for hydration rind width, and approximately 260 of these have been ascribed to source using XRF. These results are currently being compared to other dating techniques, including radiocarbon assay, typological cross-dating, and typological analysis. The final report is expected in May 1990.

Far Western Anthropological Research Group Coso Investigations

by Ms. Amy Gilreath

Over the past three years Far Western Anthropological Research Group, Incorporated has conducted considerable archaeological survey, testing, and data recovery investigations in the Coso Known Geothermal Area (KGRA), China Lake Naval Weapons Center. This work is necessitated by geothermal development and funded by geothermal developers. To date, detailed inventory has been completed for all, or portions of, 17 sections, totalling some 8000 acres. Approximately 200 prehistoric loci (125 sites) have been identified. Data gathered from each locus result from: surface assemblage inventory; technological analysis of a sample of surface debitage; shovel testing; and obsidian hydration and sourcing samples. Tool assemblages and debitage analysis indicate a variety of resource types, dominated by quarry and quarry-related loci, and limited habitation loci. The cumulative data base results in approximately 1100 hydration samples. The lion's share of the hydration values range from 2.0 to 17.0 microns, with the major peak between 5.2 and 8.5 microns. This peak is thought to correspond roughly with the Newberry Period (Elko age). Over half of the hydration specimens have also been geochemically sourced by XRF ($n = 630$). Of these, 37% are identified as West Sugarloaf glass, 32% as Sugarloaf, and 26% as Joshua Ridge. Primary and secondary quarries of these three Coso subgroups occur within the area surveyed. The fourth subgroup identified by Hughes (1988) (see Reports and Publications), West Cactus Peak, occurs approximately 2.5 miles to the north, and only 10 specimens are recognized in the data base. Non-Coso obsidian is extremely rare -- only five projectile points have been identified as such.

Archaeologists' understanding of the rate of Coso obsidian hydration continues to be problematic, although we are making headway. Data recovery excavations have been completed at 30 of the above-mentioned loci. Features unearthed at some of these loci produced radiocarbon samples. Radiocarbon and hydration pairings are forthcoming that should document Coso obsidian hydration rate(s).

In addition to the data recovery excavations, Far Western is in the report preparation phase for an additonal 9000-acre survey at Coso. This survey is expected to provide a substantial sample of West Cactus Peak obsidian, thus rounding out the spatial distribution of primary and secondary quarries for each of the four Coso subgroups identified by Hughes (ibid).

NSF Grant Proposal

Drs. Jonathon Ericson and Christopher C. Stevenson have submitted an NSF grant proposal for a 2-year study of obsidian from the Coso obsidian source area. A primary focus of the study, if funded, will be an identification of the trace elements that best discriminate between geographically different obsidian exposures within the Coso volcanic field. Ericson hopes to reduce or eliminate the overlap in trace element composition between exposures by identifying the elements or combination of elements that produce highest discrimination frequency. Ericson will be employing neutron activation analysis to examine a suite of 28 trace elements, building upon work he is currently conducting, involving the examination of 225 samples collected from various locations within the volcanic field. Jon also anticipates that the work he proposes will complement the recent work of Dr. Richard Hughes, which has demonstrated the efficacy of intra-source discrimination. The objective of the study is to develop data that are independent of technique, useful for a variety of geochemical analytic methods. Chris Stevenson will be examining the differences in hydration rate between the discriminated exposures by the induced hydration method. This work also seeks to refine obsidian hydration rates he has proposed for Coso, based on work that he has performed for Dames and Moore, Incorporated.

REPORTS AND PUBLICATIONS

The volume of so-called "gray literature" in archaeology is staggering, making it difficult for researchers who are not "plugged-in" to contract or research archaeology of a certain region to hear of and gain access to reports. Some of the most innovative, thoughtful, and best-funded research is presented in unpublished CRM reports, professional meeting papers, master's theses, and doctoral dissertations. The IAOS Newsletter will bring some of this information to its readers by reproducing abstracts and summarizing both new and old literature that may be of particular interest to our readers. In addition, we will announce current and upcoming publications relevant to obsidian studies.

Jackson, Thomas L.

1986 *Late Prehistoric Obsidian Exchange in Central California.* Ph.D dissertation, Department of Anthropology, Stanford University.

Dr. Thomas Jackson's Ph.D. Dissertation provides one of the most interesting archaeological applications of geochemistry (X-ray Fluorescence Spectroscopy) seen in recent years. Jackson examined late prehistoric projectile points from 43 archaeological sites in central California and the North Coast Range of California within different ethnolinguistic group and tribelet/village areas. His goal was to determine if there is evidence of any effect of ethnographic territorial boundaries on the distribution of obsidian artifacts. Jackson extensively reviewed the ethnographic literature, discussing the evidence of non-egalitarian social organization in late prehistoric central California. He found that "...(1) obsidian was directly exchanged across some ethnic and tribelet boundaries but not others; (2) proportions of represented obsidian sources changed across some ethnic and tribelet boundaries but not across others; (3) obsidian projectile points and raw material were imported by groups who otherwise had suitable lithic raw materials; (4) obsidian exchange reflects at least two different modes of production--one characterized by tribelets who imported obsidian although they controlled their own productive obsidian sources (e.g., Gualomi Pomo); another mode of production is distinguished by groups who did not import "coals to Newcastle" (e.g., Napa Valley Wappo); (5) obsidian was produced as a surplus beyond the needs of the primary group; (6) inter-tribelet obsidian exchange was apparently coincidental with marriage ties between tribelet elites; (7) commodities recognized as wealth items (e.g., clam disk beads) penetrated all territorial boundaries, but were used principally by the elite, while obsidian raw material and artifacts were impeded by some territorial boundaries, and were used by all classes (Stockton curves are an exception); (8) obsidian was exchanged in a variety of forms, but only among certain groups was it transformed into non-utilitarian artifacts (e.g., Stockton curves)" (Jackson 1986:122).

Tremaine, Kimberly Jo

1989 *Obsidian As a Time Keeper: An Investigation In Absolute and Relative Dating.* M.A. thesis, Department of Anthropology, Sonoma State University.

Ms. Kim Tremaine recently completed her Masters thesis and is currently conducting research at Sonoma State University. Tremaine's thesis offers an objective examination of the experimental approach to the development of absolute obsidian hydration rates. Tremaine has conducted the most thorough compilation and synthesis of the extensive and scattered literature regarding both obsidian hydration and glass alteration studies to date. The abstract from her thesis is reproduced below.

Abstract

Purpose of the Study:

Over the last 30 years, obsidian has served archaeologists by providing a means to estimate age in one capacity or another. An ultimate objective of this thesis was to reexamine both absolute and relative dating approaches.

Procedure:

Two lines of action were pursued in this endeavor. First, an extensive review of studies on glass surface reactions was undertaken, with the intent to synthesize the information gathered, and assess both its pertinence to the obsidian hydration process and its implications regarding dating issues. Secondly, accelerated hydration experiments were conducted, reacting California North Coast Ranges obsidians, with the intent to evaluate the applications of the experimental method for both absolute and relative dating purposes.

Findings:

From the review of studies on glass surface reactions, it was found that glass scientists have made considerable advances recently in their understanding of glass weathering kinetics. Many factors, working synergistically, have been shown to affect both mechanisms and rates of reaction, reflecting the complexity of glass weathering processes. As the literature search indicates, such factors as solution pH, solution composition, glass surface area-to-solution volume (SA/V), relative humidity, and temperature, all affect experimentally determined rates of reaction. The extent of their significance to naturally hydrating obsidian, in archaeological site contexts, needs to be assessed to fully evaluate implications to obsidian dating in its absolute chronometric capacity.

From accelerated hydration experiments, designed primarily to investigate the replicability of test results, it was found that some variability between results occurred. This variability was attributed to small differences in condition such as non-standardized flake sizes (affecting SA/V ratios), and differences in solution composition (deionized water vs. silica saturated solutions). Although it was determined that test results appear to be reproducible if all factors are held constant, the appropriateness of applying condition-specific rate constants (derived from these high-temperature essentially closed-system experiments) to field conditions was questioned.

Weisler, Marshall

1990 Sources and Sourcing of Volcanic Glass in Hawai'i: Implications for Exchange Studies. In press. Archaeology in Oceania.

Mr. Marshall Weisler, University of California, Berkeley, has been conducting archaeological research in Hawai'i for over ten years. Much of his fieldwork has focused on the island of Moloka'i and includes both extensive survey and excavation. The results of this work includes the identification of volcanic glass sources. These resources were exploited by ancient Hawaiians for stone tools (in the form of small flakes), and volcanic glass appears in archaeological deposits in small quantities. Weisler is one of the first to explore the potential for geochemical examination of volcanic glass with the goal of analyzing regional prehistoric exchange and distribution patterns. Work on source identification and geochemical study is ongoing. Mr. Weisler's article is summarized below.

Prehistoric Hawaiian society was one of the most stratified in Oceania, yet the role of exchange in Hawaiian prehistory has received little attention. Weisler's paper demonstrates the potential of volcanic glass provenance studies in addressing prehistoric Hawaiian exchange and interaction. He reviews volcanic glass studies in Hawaiian archaeology, identifies problems with previously collected archaeological volcanic glass, describes geologic sources of the material, describes the first two reported volcanic glass sources on West Moloka'i, and proposes a model--based on geologic data--to guide the discovery of additional volcanic glass sources on West Moloka'i. Weisler used an electron microprobe to characterize the geochemical similarity of source material and volcanic glass artifacts from distant habitation sites. He concludes that volcanic glass can be systematically discovered, and that microprobe analysis is well suited to geochemical characterization, accommodating small specimens. .

Hughes, Richard E.

1988 The Coso Volcanic Field Reexamined: Implications for Obsidian Sourcing and Hydration Dating Research. Geoarchaeology: An International Journal, Volume 3, No. 4, pp. 253-265.3

Dr. Richard Hughes has been studying the variability in trace element composition of obsidian within the Coso volcanic field in south-eastern California for the last couple, and he is currently investigasting intra-source geochemical varibility within t the Casa Diablo obsidian source area

Hughes' paper describes Coso locality obsidian in Inyo County, California, an important source of stone tool material for prehistoric southern California. Archaeologists have long regarded the Coso area obsidian as a single obsidian source. Based on evidence gathered by the U.S. Geological Survey indicating that geochemical variability exists among flows within the volcanic field, Hughes set out to determine whether archaeologists could benefit from these geochemical distinctions. Hughes performed nondestructive x-ray fluorescence analyses on samples from 15 obsidian exposures. He found that the Coso volcanic field contains geochemically distinct varieties of artifact-quality obsidian. Hughes then conducted nondestructive x-ray fluorescence analyses of prehistoric artifacts from two nearby archaeological sites, determining that different geochemical varieties of obsidian were used to manufacture tools. A number of implications for the study of prehistoric exchange as well as obsidian hydration are discussed.

Article

An Inter-Laboratory Comparison of Hydration Rind Measurements

by

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Editor's Preface

This paper reports the results of a comparison of obsidian hydration measurements between several obsidian hydration technicians (operators) from several laboratories across the United States. The results are extremely promising, suggesting that measurements between operators and laboratories are generally comparable. Participating operators produced measurements for most specimens that fell with the optical limits of resolution of the measurement process. This preliminary assessment of the variables involved in measuring hydration rinds sets the stage for more formal, better-controlled experiments that should establish standards by which operators, laboratories, and researchers can evaluate the results of individual operators.

In the spring of 1988, a number of obsidian hydration technicians and interested archaeologists from across the United States met in Reno, Nevada during a Materials Research Conference. The seeds of the International Association of Obsidian Studies were planted at that meeting with the identification of a number of issues of mutual concern. Foremost among these was the problem of comparability of measurement results between laboratory operators. Meeting operators agreed to participate in a comparison of measurements between laboratories and operators. No experimental controls were established, as the purpose of the comparison was to establish interaction between the various laboratories and conduct a preliminary assessment of the variables that might be important to include in a more formal comparison. While broad disclosure of the results was unintended, given the inception of the IAOS and its goal of information dissemination, the participants felt that the results of the informal comparison were worth sharing. Another of the goals of the IAOS is to establish more formal procedures for interlab comparison to ensure that operators are producing measurement results of reasonable accuracy and comparability. While broad disclosure of the results were unintended, given the inception of the IAOS and the close agreement between operators, the results of the informal comparison are worth sharing.

The editor made several changes based on concerns raised by participants in the comparison. Unfortunately, the primary author could not be consulted regarding these minor changes, as he was on Easter Island between submission of the paper and its inclusion in the newsletter. I hope the changes are acceptable Chris.

Introduction

In recent years, concerns over the degree of precision and accuracy inherent in the obsidian hydration dating method have been addressed by several researchers and have focused on the ability of different operators to replicate measurements on identical thin sections (Green 1986, Jackson 1984, Schiffman 1988), measurement methods (Stevenson et al. 1987) and the theoretical limits of resolution associated with the optical microscope (Scheetz and Stevenson 1988). These concerns over the ability of different labs to produce consistent results are well founded, since small differences in the measurement of hydration rinds can in some cases produce substantial age differences. This may be especially critical in situations where the hydration rate of an obsidian is slow.

The results of the first large scale inter-laboratory comparison conducted by Green (1986) have not been published and are currently not available for analysis by other archaeologists. A second and different set of slides was circulated to many of the analysts involved in the first comparison. Six operators, from four laboratories, returned hydration rind measurements conducted on the reference set of 24 thin sections. One of the operators was unwilling to measure the hydration on several specimens due to reported problems with slide quality. The limited results of this operator were not included in the inter-laboratory comparison.

Interlaboratory Comparison

The thin sections were prepared according to laboratory specifications presented in Michels and Bebrich (1971). The slides were selected from the available laboratory collections and included obsidians from Easter Island, Chile, the New Mexico sources of Cerro del Medio, Mule Creek, Obsidian Ridge, and Polvadera Peak, and a variety of unknown obsidians from Ecuador and Alaska. As a result, the slide set contained glasses containing a variety of optical images. The range of hydration rind widths was typical of that normally encountered in many obsidian studies and varied between approximately 1 um and 11 um (Table 1).

Each laboratory also supplied a description of the measurement instrument that included the numeric aperture of the objective and the level of magnification used in the measurement process (Table 2). Using these data we have calculated the theoretical optical resolution associated with each measurement system.

During the measurement process each of the operators evaluated the quality of the thin section. Although the rating method was not standardized, descriptions of "unacceptable" or "disqualified" were used as a basis for eliminating certain thin sections from the set of hydration rinds. The remaining slides were classified as either "good" or "adequate"*. On the basis of these criteria, the authors excluded two of the 24 thin sections from the statistical analysis.

Statistical Analysis of the Hydration Rind Measurements

An analysis of variance was conducted to compare the results from each of the five operators over all of the samples. Each operator was used as the dependent variable and the hydration rind measurements as the independent variables. An inspection of the results indicated that there is a very high degree of correlation between individual operator results and the least squares regression line computed from the results of the entire group. The total variability accounted for by the independent variables taken together (i.e., the range of hydration rind thicknesses between specimens) was very high, with the coefficient of determination, R^2, exceeding 0.99 each time. This implied, that on an overall basis, the set of operators were measuring the same optical image.

The residuals were plotted in relation to the least squares regression line (Figure 1A). An inspection of this plot indicated that the approximately half of the measurements were within +/- one standard deviation of the group mean. Very few measurements were outside the resolution limit of the optical systems used by each of the operators (Table 1). Their occurrence however indicated that other causes of variation (mechanical, judgmental) were also involved.** Each operator had at least one measurement that was greater than the resolution limit from the group mean.

The distribution also revealed a tendency for the variation in hydration rind measurements to increase in magnitude as the hydration rinds increased in size. This trend was illustrated by a plot of the variance versus hydration rind size (Figure 1B). In this analysis the variance is low and approximates 15%.

In order to determine how each operator contributed to the total variance, the residuals for each technician were plotted and inspected. These plots (Figures 2, 3) graphically portray the differences between the observed rind measurements reported by each operator and the overall group mean calculated from all measurements contributed by the five operators included in the analysis.

An inspection of each residual plot revealed how each of the operators in the group measured obsidian hydration rinds. The analyses provided by Operator 1 (Figure 2A) revealed a range in residual error of approximately 1.0 um. There also appeared to be tendency for Operator 1 to produce hydration thickness measurements slightly lower than the group mean. This pattern of lower-than-mean measurements was slightly more pronounced for Operator 2 (Figure 2B). However, except for a single data point the dispersion of residuals is much narrower than that exhibited by Operator 1.

Precisely the opposite pattern was identified for Operator 3 (Figure 2C). Operator 3's range of measurements was approximately 0.9 um and all except two residuals were located above the group mean. The tendency for Operator 3 to produce higher-than-mean hydration rind thicknesses was not followed by Operator 4 (Figure 3A). In the measurement of hydration rinds in the 1 um to 3 um range the results are very close to or slightly above the group mean. For hydration rinds greater than three microns there is appears to be a tendency for Operator 4 to produce lower-than-mean hydration rind measurements.

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* Table 2 was modified by the editor to include all six operator's measurements and their comments. Comments made by the various operators were standardized and coded.

** Editor's note: a group mean is a measure of central tendency that reflects the entire distribution. The group mean does not equate with the "correct" hydration thickness. Any of the operators, for any individual measurement, could be closer than the rest in approximating the hydration of that specimen, even if that operator's measurement is furthest from the group mean.

The hydration rinds provided by Operator 5 show a relatively even distribution around the group mean (Figure 3B). The range of residual error is 2.1 um, twice the range of other operators. If a single outlier was eliminated Operator 5's range would be comparable..

The pattern for the residual errors (Figure 1A) was contrary to that anticipated from an analysis of the limiting factor of optical resolution (Scheetz and Stevenson 1988). In theory, the magnitude of the error should be inversely proportional to the width of the hydration rind. That is to say, thinner rinds are more difficult to identify and measure, with the error being greater relative to the rind size. Under these circumstances operators would not be expected to return hydration rind measurements with error factors that increase with larger hydration rind widths.

Discussion

The analyses conducted above show a good agreement between persons in the field who measure obsidian hydration rinds. The high R^2 values for the correlations conducted between individual operator measurements and the low variance (15%) for all observers are gratifying. However, the outcome of the analysis raises two questions:

1) Why did the trend of increasing residual error contradict the pattern predicted from a consideration of the effects of optical resolution on the measurement process?

2) Why was there a tendency for operators to either produce lower-than mean or higher-than mean measurements of the width of the hydration rind?

At this point in time a compelling explanation to the first question is not to be found. It is possible that the trend toward increasing residual error with greater rind width is a combination of several factors that include operator calibration, sample preparation, and the quality of the optical image. We consider the latter factor to be of greatest importance. It is our experience, for larger hydration rinds, that in some cases the intensity of the rind image may be less and that the diffusion front less clearly defined. Under such conditions it may be difficult to locate the transition with the certainty experienced in the measurement of thinner rinds.

The criteria used by each operator to determine if a hydration rind was in focus and to define the limits of the diffusion front would appear to offer a reasonable explanation for the bias toward higher- or lower-than-mean measurement results. It has been repeatedly observed by the senior author that a hydration rind may be in focus over a narrow focal length yet at the same time vary appreciably in width. Defining an "in focus" image is therefore in part a subjective decision. A second subjective decision is made in defining the interior limits of the hydration rind. In white light, the edge of the diffusion front is often represented by a grey band of finite thickness that may be up to 0.1 um in thickness. Deciding where to terminate the measurement process on this line may add some additional amount of variance to the process.

As noted above the amount of variance between individual operators is approximately 15%. Reducing the variance to a lower value would involve the operator trying to make subtle variations in his measurement methods. We suggest that such a strategy could probably not be achieved because of the fine modifications in judgement required on optical images that themselves exhibit a significant amount of variation. One possible option would be to develop a "operator calibration factor" using a standard set of calibration slides. With a calibration factor the rind measurements of the "higher-than-mean" and the "lower-than-mean" operators could be adjusted on a statistical basis to more closely approximate the group mean. Such an approach could bring the results of different labs into closer agreement if properly conducted. We see such a procedure as enhancing the credibility of obsidian hydration dating within the archaeological discipline.

References

Green, J.

1986 Obsidian hydration measurement: are we getting what we expect? Paper presented at the Great Basin Archaeological Conference, Las Vegas, Nevada.

Jackson, R. J.

1984 Current Problems in Obsidian Hydration Analysis. In Obsidian Studies in the Great Basin, edited by R. E. Hughes, pp. 103-115. *Contributions of the University of California Archaeological Research Facility.* Department of Anthropology, University of California, Berkeley.

Michels, J. W., and C. Bebrich

1971 Obsidian hydration dating. In Dating Techniques for the Archaeologist, edited by H. N. Michael and E. K. Ralph, pp. 164-221. MIT Press, Cambridge.

Scheetz, B. E. and C. M. Stevenson

1988 The role of resolution and sample preparation in hydration rim measurement: implications for experimentally determined hydration rates. American Antiquity 53:110-117.

Schiffman, Robert

1988 An Experiment in the Use of Obsidian Hydration: Effect of Laboratory Variability on the Research and Interpretation of Sites. In Obsidian Dates for a Compendium of the Obsidian Hydration Determinations Made at the UCLA Obsidian Hydration Laboratory, edited by C. W. Meighan and J. L. Scalise. Pages 13-18. Monograph XXIX, Institute of Archaeology, University of California, Los Angeles.

Stevenson, C. M., Freeborn, W., and B. E. Scheetz

1987 Obsidian hydration dating: an improved optical technique for measuring the width of the hydration rim. Archaeometry 29:120-123

Table 1
Operator Measurement Conditions

Operator	Instrument	Magnification	Numeric Aperture	Resolution	Residual Error
1	IM-SP	800X	0.65	0.42	1.0
2	Filar	500X	0.65	0.42	1.0
		750X	0.85	0.32	
3	Filar	563X	0.65	0.42	0.8
4	Filar	450X	0.66	0.41	0.9
5	Filar	325X	0.85	0.32	2.1
6	Filar	325X	0.85	0.32	2.1

IM-SP= Watson image-splitting measurement instrument

Table 2
Operator Hydration Rind Measurements

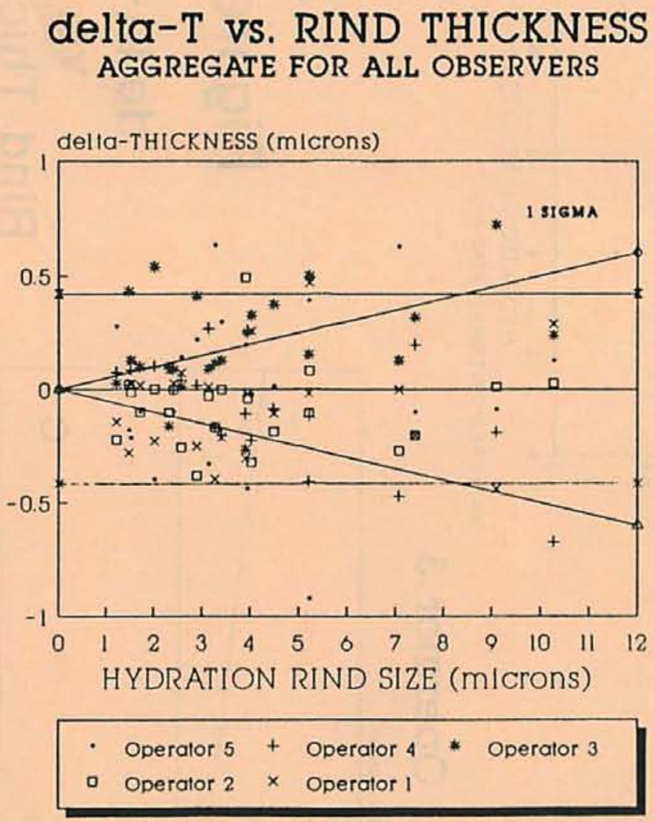
*OH=Obsidian Hydration measurement, C=Comments

Lab No.	Operator 1	Operator 2		Operator 3		Operator 4		Oper. 5	Oper.6	
	OH	OH	C	OH	C	OH	C	OH	OH	C
87-012	4.38	4.3	V	4.86		4.4		4.5	NR	
87-019	2.43	2.4	S/D	2.49		2.4	V/F	2.3	NR	
87-188	2.63	2.5/6.9	V/D	3.29/7.29		2.9/7.4	F	3.1/7.2	NR	
87-243**	5.91	6.7	S/D	6.50	V/D	6.1	P	6.0	NR	
87-248**	9.89	9.8	V	10.66	V/D	9.9	P/V	NR	NR	
87-261	3.92	3.9		4.19	V	4.2		3.5	NR	
87-317	2.87	3.1		3.38	V	3.1-4.3	V/F	3.9	NR	
87-361	4.28	3.7/6.2		4.35/6.52	S/V	3.8/6.3		4.0	NR	
87-346	5.69	5.3		5.72		5.1		4.3	NR	
87-343	7.07	6.8	V	7.20	P/V	6.6	D	7.7	NR	
87-337	3.19	3.4		3.53		3.2		3.7	2.6	
87-385	1.72	1.6		1.80		1.8		1.6	1.8	
87-391	1.20	1.5	S	1.91	S	1.5		1.3	NR	
87-390	1.08	1.0	S	1.25	S	1.3		1.5	NH	
88-220	7.20	7.2	S/V	7.72/9.61	P	7.6	D	7.3	9.0	D/I
88-242	3.14	3.1/2.2		3.22/2.48		3.4/2.4		2.8	NR	
88-257	3.60	4.4	S/D	3.60/4.6	S/V	3.8	F	4.1	4.5	P
88-287	2.39	2.2	S	2.14	D	2.4		2.4	I	
88-304	2.63	2.3/2.9	V	2.57	S	2.6	D	2.7	2.0	
88-309	1.77	2.0	V	2.54		2.1	D	1.6	1.8	
88-173	10.56	10.3	V	10.51		9.6	V/F	10.4	11.4	
88-150	1.54	1.5		1.64		1.6		1.3	NR	
88-188	8.65	9.1	V/F	9.81	V/F	8.9	F	9.0	8.1-8.7	
88-170	5.19	5.1		5.36	P	4.8		5.6	NR	
88-333*	NR	2.7	V	2.55		2.5		2.9	NR	

**The smaller of two reported rinds were used for the analysis **Eliminated from the statistical analysis

Codes used in 'Comments' Columns D=discontinuous V=vague P=poor edge
S=single surface I=inclined F=faint, vague

A



resolution limit +/- 0.5 UM
based on 550 nm 'green'

B

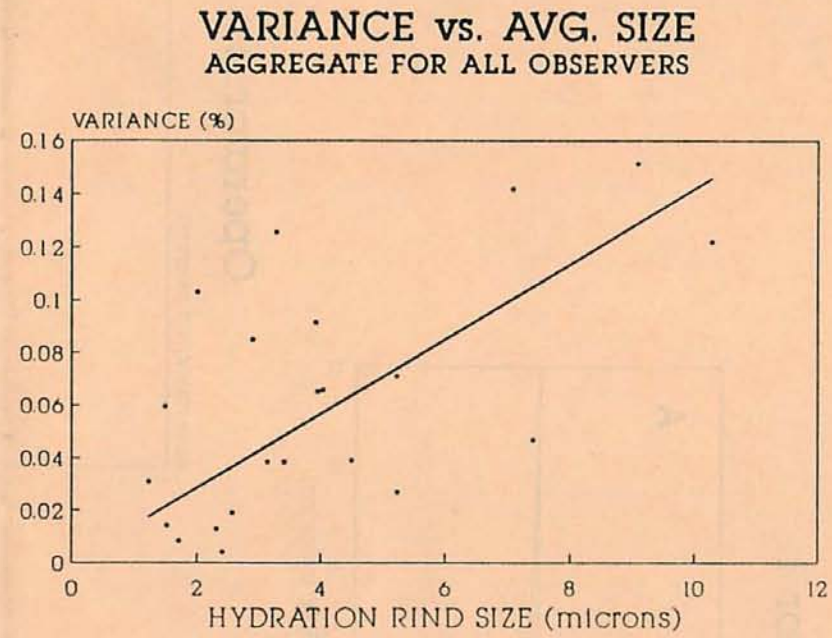
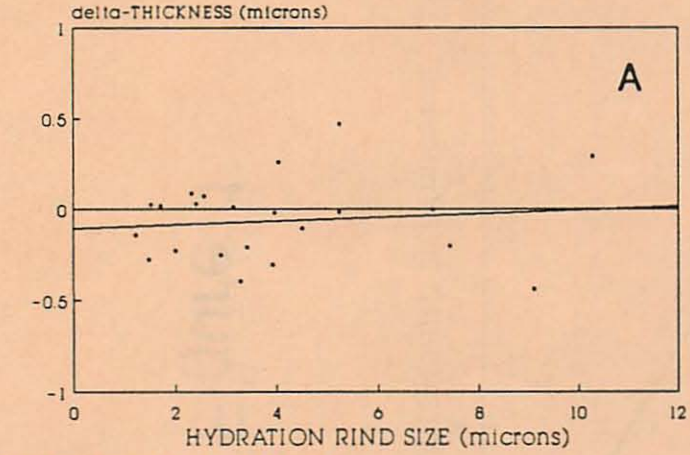


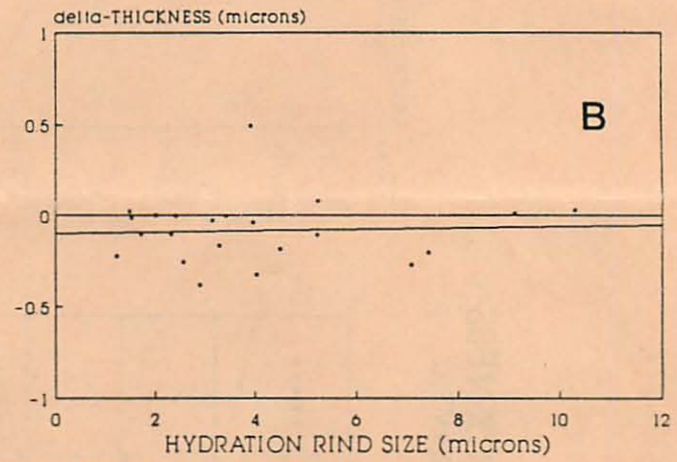
Figure 1

Operator 1



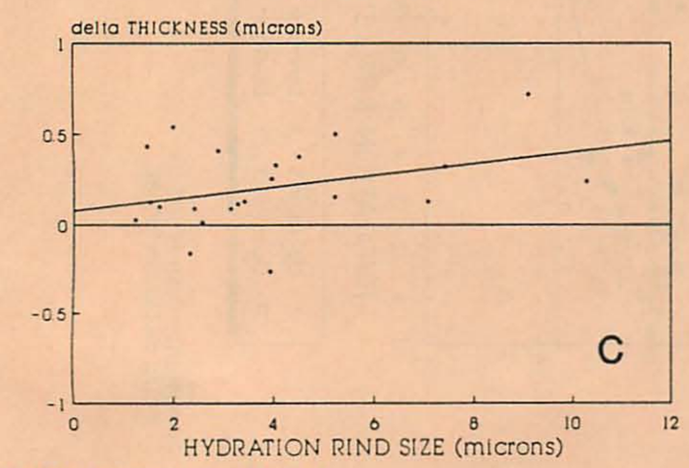
SOLID LINE SHOWS TREND IN READINGS

Operator 2



SOLID LINE SHOWS TREND IN READINGS

Operator 3



SOLID LINE SHOWS TREND IN READINGS

Figure 2

delta-T vs. Rind Thickness

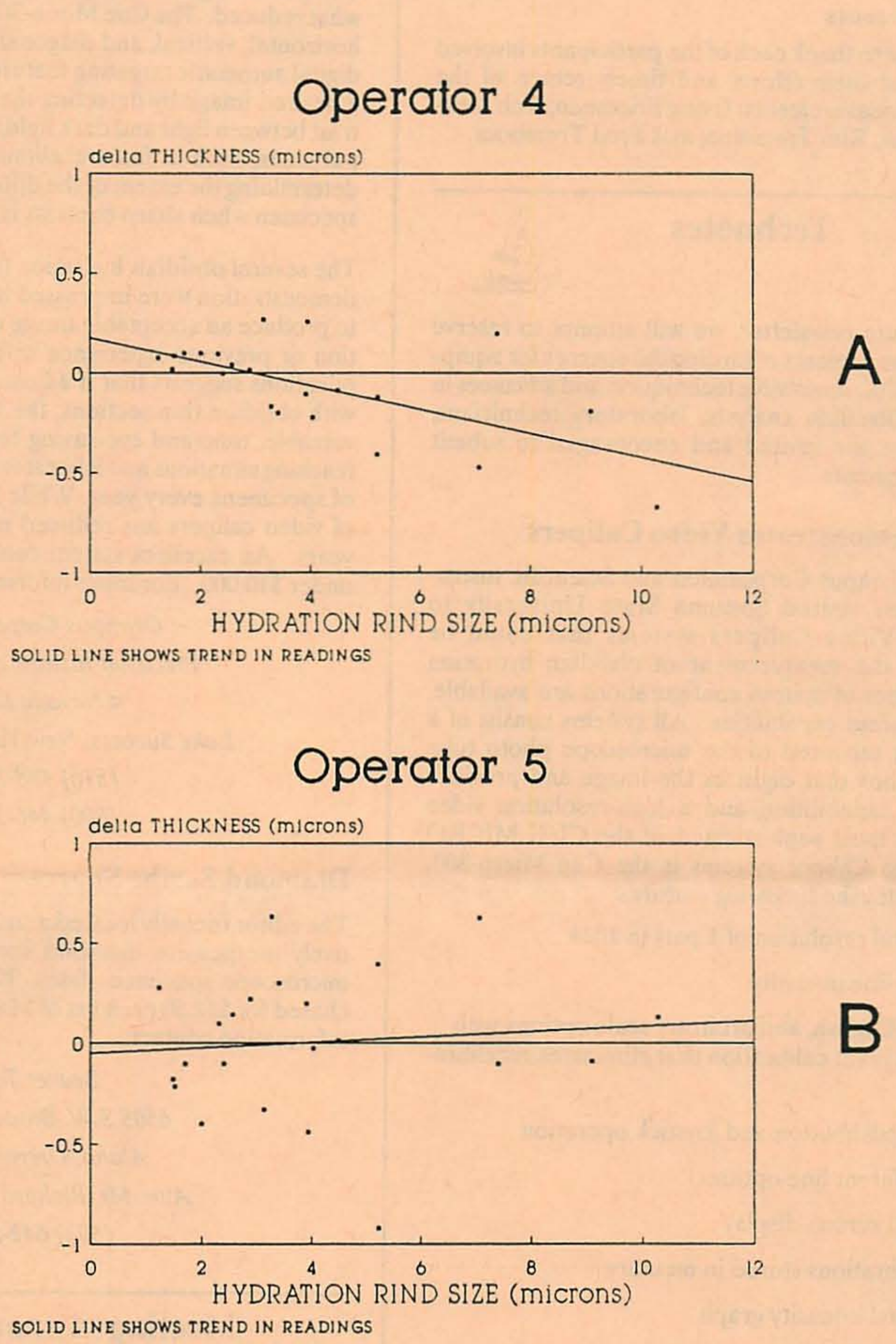


Figure 3

delta-T vs. Rind Thickness

Acknowledgements

We would like to thank each of the participants involved in the study for their efforts and timely return of the hydration rind measurements: Irving Friedman, Rob Jackson, Tom Origer, Kim Tremaine, and Fred Trembour.

Technotes

In this and future newsletter, we will attempt to reserve space for announcements regarding the sources for equipment and supplies, innovative techniques, and advances in technology. Obsidian analysts, laboratory technicians, and researchers are invited and encouraged to submit short announcements.

Olympus Demonstrates Video Calipers

Last spring, Olympus Corporation and Scientific Instrument Company visited Sonoma State University to demonstrate Video Calipers systems that could be employed for the measurement of obsidian hydration rinds. A number of system configurations are available, each with different capabilities. All systems consist of a camera that is mounted to the microscope photo tube head, control box that digitizes the image and provides measurement capabilities, and a high-resolution video monitor. The most sophisticated of the CUE MICRO SERIES Video Caliper systems is the Cue Micro-300, which is provides the following features:

- horizontal resolution of 1 part in 1024
- variable line intensity
- Metric, English, and arbitrary scale options with decimal point calibration that eliminates recalibration
- remote pushbutton and joystick operation
- four different line options
- five-digit screen display
- five calibrations stored in memory
- horizontal intensity graph
- data histogram printer output
- dual horizontal caliper lines
- digital automatic targeting (automatic edge detection)

By digitizing the image, video calipers eliminate the mechanical and optical error associated with filar measurement by producing a flat image without physical distance separation between measuring device and image. The Cue Micro system demonstration produced both black and white and color images that duplicated the image observable under the microscope eyepiece, although the brightness and contrast of the image was somewhat reduced. The Cue Micro-300, in particular, provides horizontal, vertical, and diagonal tracking, and includes a digital automatic targeting feature that locates the edge of a desired image by detecting the point of maximum contrast between light and dark fields. For obsidian hydration purposes, such a feature eliminates the subjectivity of determining the extent of the diffusion front or edge of the specimen when sharp contrast is absent.

The several obsidian hydration technicians present at the demonstration were impressed by the system. The ability to produce an acceptable image without special modification or previous experience with obsidian hydration applications suggests that if adjusted to maximize its ability with obsidian thin sections, the video calipers could be a valuable, time-and eye-saving tool. It would be ideal for teaching situations and laboratories that process hundreds of specimens every year. While not inexpensive, the cost of video calipers has reduced nearly four-fold in recent years. An excellent system could be assembled for well under $10,000. For more information, contact:

Olympus Corporation
Precision Instrument Division
4 Nevada Drive
Lake Success, New York 11042-1179
(516) 488-3880
(800) 446-5967

Diamond Scribe Source

The editor recently located a source for high-quality, relatively inexpensive diamond scribes suitable for etching microscope specimen slides. These scribes can be purchased for $12.50 each (as of March 1989). For additional information contact:

Beaver Tool
6505 S.W. Broad Oak Dr.
Aloha, Oregon 97007
Attn. Mr. Richard Hammann
(503) 642-5530

Meeting Announcements

Society for California Archaeology Annual Meeting Symposium on Obsidian Studies

A symposium on obsidian studies in California is planned for the Society for California Archeology Annual Meeting in Redwood City, April 4-8, 1990. At the time of this writing, the following papers are scheduled:

David Bieling and Sunshine Psota, Sonoma State University - *Visual sourcing of Eastern Sierra obsidians*

Michael Jablonowski, Sonoma State University - *Exploring the potential for use of specific gravity to discriminate eastern California obsidians.*

Kim Tremaine, Sonoma State University - *The Results of Induced Hydration Experiments on Casa Diablo and Bodie Hills obsidian*

Tom Origer and Joanna Freunde, Sonoma State University; Kathleen Hull, Yosemite National Park *Inter- and Intra-operator Variability in Obsidian Hydration Measurement Results*:

Robert Jackson, Lithichron Laboratory - *Exploring Archaeological and Site Formation Process Complexity in Assessing Obsidian Hydration.*

Space is limited, but if you are interested in presenting a paper at the symposium, contact:

Kim Tremaine
Cultural Resources Facility
Sonoma State University
1801 E. Cotati Ave.
Rohnert Park, California 94928
(707) 664-2381

Society for American Archaeology Symposium

Dr. J. E. Ericson plans to chair a symposium titled "Advances in Hydration Measurement, Hydration Experiments and Chemical Characterization of Lithic Sources" at the 55th Annual Meeting of the Society for American Archaeology Symposium at the Riviera Hotel in Las Vegas, Nevada. The SAA Annual Meeting will be held Wednesday, April 18 - Sunday, April 22, 1990.

The following participants and papers are proposed:

J. Regester and J. Hendersen - *Hydrogen Profiles of Obsidian Using Proton Beam.*

B. Scheetz, C.M. Stevenson, and K. Vadem - *Spectroscopic Ellipsometry: An Alternative Analytic Method to Achieve Angstrom Resolution of Obsidian Hydration Rims.*

I. Friedman, F. Trembour, and F. Smith - *Obsidian Hydration Rates as a Function of Relative Humidity.*

C. Stevenson, J.J. Mazer, and J.K. Bates - *The Effect of Relative Humidity on the Rate of Hydration: Implications for Obsidian Hydration Dating.*

K. Tremaine - *The Complexities of Glass Surface Reactions and Implications for Obsidian Dating.*

E. Skinner and R.J. Jackson - *A Critical Review of Obsidian Hydration Sampling Strategies in California and the Great Basin.*

G. Pope - *Quartz ydration of Glacial Tills, Eastern California as a Dating Tool.*

P. Bouey - *Recognizing the Limits of Obsidian X-ray Fluorescence Analyses.*

J. Ericson and J. Kimberlin - *Chemical Differentiation of Flows and Source Areas in California by Instrumental Neutron Activation and Statistical Analyses.*

M.S. Shackley - *Early Hunter-Gatherer Procurement Ranges and Mobility in the American Southwest: Evidence from Obsidian Geochemistry and Lithic Technology.*

J.R. Newman - *Notes on the X-ray Fluorescence Characterization of the Rhyadocite Sources of the Taos Plateau, New Mexico.*

Call For Articles and Information

If you are interested in submitting a short article or announcement for inclusion in the next newsletter, the submission should be received by February 15, 1990. We accept electronic media on IBM compatible 3.5" or 5.25" disk, in Wordperfect (4.2 or 5.0), Wordstar, or ASCII text formats, as well as hard copy submissions if electronic media cannot be provided. Send your information to::

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