IAOS

International Association for Obsidian Studies

Bulletin

ISSN: 2310-5097

Number 54 **Winter 2016**

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International Association for Obsidian Studies

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Web Site: http://members.peak.org/~obsidian/

NEWS AND INFORMATION

IAOS Annual Meeting

The International Association for Obsidian Studies will hold its annual meeting during the Society for American Archaeology conference in Orlando, Florida. Join us Saturday, April 9, 2016 from 12-1pm. Please see your SAA program for location information.

CONSIDER PUBLISHING IN THE IAOS *BULLETIN*

The *Bulletin* is a twice-yearly publication that reaches a wide audience in the obsidian community. Please review your research notes and consider submitting an article, research update, news, or lab report for publication in the *IAOS Bulletin*. Articles and inquiries can be sent to IAOS.Editor@gmail.com Thank you for your help and support!

STUDENT AWARD FOR INTERNATIONAL OBSIDIAN CONFERENCE

The IAOS Executive Committee is pleased to announce two student paper/poster awards for the upcoming International Obsidian Conference to be held June 1-3, 2016 in Lipari, Italy. The award will consist of $250 and a free one year student membership in the IAOS. Student presentations will be judged by the quality of the research and presentation, and overall match with the goals of the IAOS.

For consideration, please email your conference paper title and abstract to fergusonje@missouri.edu before April 1, 2016. Winners will be announced at the conference in Lipari. For more information about the conference, please see page 6 of this issue of the *IAOS Bulletin.*

NOTES FROM THE PRESIDENT

Due to my failed efforts to repeal presidential term-limits, this will be my final note as president of IAOS. I think the organization is in great hands for the next couple years with Dr. Robert Tykot as the incoming president. I will pass the authority over at the beginning of our annual meeting this April in Orlando. **Please note that the meeting this year will take place on Saturday (4/9/16) from 12:00 – 1:00 instead of the usual Friday slot.** Hopefully we can get a better turnout than the last few years. What else could you possibly have to do in Orlando – at least with an archaeologist's salary?

I would like to keep this letter brief, so there are only a couple additional notes. Please consider attending the upcoming International Obsidian Conference to be held in Lipari, Italy on June 1-3, 2016. Abstracts are due by January 31, 2016. For more information, visit the conference web site at http://rtykot.myweb.usf.edu/Obsidian%202016/. Student prizes are available. Please see the announcement on the front page of this issue of the *Bulletin*.

I managed to make one small obsidian collecting trip in late summer. Masami Izuho joined my as we visited a few sources I have visited before and a few in Arizona that I had not been too. The photo includes Dr. Izuho as well as (previous IAOS president) Ana Steffan at Obsidian Ridge in the Jemez Mountains of New Mexico. It was very interesting seeing the Valles Caldera National Preserve the day before administration turned over to the National Park Service. There was even a crane parked at the entrance ready to modify the road sign – presumably at the stroke of midnight.

I will take one final opportunity to thank those folks who are responsible for keeping the IAOS running during my term: Carolyn Dillian, Kyle Freund, Ellery Frahm, Matt Boulanger, Ana Steffen, Rob Tykot, and Craig Skinner. I will now take over the role of Past President for the next year and enjoy all the perks of that position.

Thanks,

Jeff Ferguson
fergusonje@missouri.edu
President IAOS
Research Assistant Professor
Archaeometry Group
University of Missouri Research Reactor Center

NEWS AND NOTES: Have announcements or research updates to share? Send news or notes to the *Bulletin* Editor at IAOS.Editor@gmail.com with the subject line "IAOS news."

RESEARCH UPDATE: CHIRIQUÍ, PANAMÁ

Karen Holmberg, Ph.D.
New York University, New York, NY, USA

As part of an ongoing research project I am examining obsidian from the highland western Panamá province of Chiriquí, or rather, the lack of it. While obsidian traveled extremely long distances in pre-Columbian Latin America, it never formed a significant portion of the artifact assemblages of this region.

The deeply social relationships that people have with obsidian, past and present, require perspectives and considerations beyond quantitative data generation. There is not only room but *need* for humanities-based vantages that dialogue closely with geochemical data to provide a more complete understanding of the material. Obsidian, past and present, has a rich set of associations that go beyond the functional elements of the material. Even in modern western settings, filled with myriad choice of sharp and shiny objects, obsidian holds a particular allure that exceeds the utilitarian and enters the conceptual. In one sparkling example a superhero named Obsidian - son of Green Lantern and Thorn and twin to a sister, Jade - inherited mental instability from his villain mother that prompted him to steal the shadows from a city and spread darkness over the world. Following a return to mental health Obsidian came out as gay, retired, then returned to work as a superhero after the death of his sister. In this contemporary case, obsidian is resilient, complex, and just. These characteristics exceed the simple utilitarian definitions of sharpness or reflectiveness. Pre-Columbian associations with obsidian would have differed widely from those of the present. The presence of varied, tangled, heavily symbolic layering of meanings upon obsidian that extend or transcend the utilitarian elements of the material, however, may have been one similarity.

Obsidian forms most commonly from rapid deposition and subsequent densification of hot and viscously deformable melt pyroclasts and particles in the formation of high grade rhyolitic ignimbrites. By contrast, the Volcán Barú in Chiriquí, Panamá is primarily andesitic with a small amount of trachyandesite, basaltic andesite, and dacite. There are no known local sources of high quality obsidian and the closest known obsidian sources for pre-Columbian populations were Honduras or Guatemala to the north or southern Colombia and eastern Ecuador to the south. Obsidian, overall, is infrequently found in the 'Intermediate Area' of the isthmus. To be provocative, perhaps the absence of obsidian in the Chiriquí study area artifact assemblages is not a result of its lack of value to pre-Columbian populations or their lack of access to the material via trade networks. Perhaps, instead, the pre-Columbian residents' landscape *richness* prevented them from having need for obsidian if its primary function was as a distinctive, portable material very specifically linked to the volcano.

Ruth Dickau et al. (2012) discuss a cache of 12 unusual stones excavated recently in the Casita de Piedra preceramic rock shelter near the Volcán Barú in western Panamá that

is dated to 4800-4000 cal BP. The stones include quartz, pyrite, a chalcedony vein nodule, a bladed quartz and jarosite aggregate and a human-modified dacite cylinder. The researchers suggest that these stones were ritual or shamanistic paraphernalia, based upon ethnographic records of groups such as the Bribri and Cabécar of southeastern Costa Rica and western Panamá. Each of these stones has various lithologies from multiple geological contexts outside the immediate are of the rock shelter, though all potentially came from the young volcanic belt of the western Panamá Cordillera.

In recently published work I have examined the social role of tephra in the Barú area (Holmberg 2015). In my fieldwork I also examine the use and transport of basalt columns and dacite slabs, which like tephra can be reframed not just as geochemical materials but as socially valiant ones with multiple roles and with past meaning that was associative to the volcano. While the absence of pyramids or megaliths in the region can be interpreted as an impoverishment of monumental architecture, the luxuriantly extant monumentality of the volcano and the multiple volcanic materials that already traveled widely in its midst proposedly made pyramids or long-distance obsidian redundant. There may have been no need to remember or materially link to the chthonic, volcanic power that was already a daily constant in the lived landscape and already encompassed in other stones that have escaped traditional archaeological scrutiny in the region.

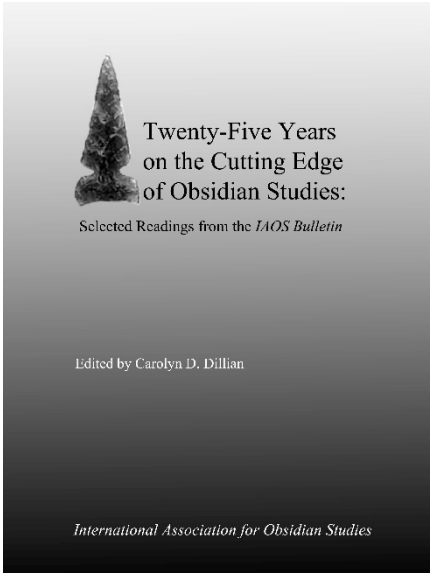
One component of future fieldwork that I would like to complete in the Barú area includes the identification of the obsidian source or sources for the small amounts of local obsidian excavated in the Casita de Piedra rock shelter in the 1970's and published by Linares and Ranere (1980). The consideration of how this low silica content, local obsidian was perceived in relation to higher quality non-local obsidians and the stones represented by the unusual cache of stones described by Dickau et al (2012) from the rock shelter is something I intend to further via an interdisciplinary writing fellowship with the Rachel Carson Center for Environment and Society at Ludwig Maximillian University of Munich during the 2016-17 fellowship year in collaboration with researchers in the Department of Earth and Environmental Sciences Section for Mineralogy, Petrology, and Geochemistry. I actively welcome all further thoughts, collaborations, or brainstorming on sourcing and analyses of Barú obsidian or any other input that may add to this project.

References

Dickau, R., S. Redwood, and R. Cooke (2012) A 4,000-year-old Shaman's Stone Cache at Casita de Piedra, Western Panama. *Archaeological and Anthropological Sciences* 5(4): 331-49.

Holmberg, K. (2015) The Cultural Nature of Tephra: 'Problematic' Ecofacts and Artifacts and the Barú Volcano, Panama, *Quaternary International* x-xx.

Linares, O. and A. Ranere (eds.) (1980) *Adaptive Radiations in Prehistoric Panama*. Peabody Museum Monographs No. 5, Cambridge, Massachusetts.



Twenty-Five Years on the Cutting Edge of Obsidian Studies: Selected Readings from the IAOS Bulletin

Edited volume available for purchase online!

As part of our celebration of the 25th anniversary of the IAOS, we published an edited volume highlighting important contributions from the *IAOS Bulletin.* Articles were selected that trace the history of the IAOS, present new or innovative methods of analysis, and cover a range of geographic areas and topics. The volume is now available for sale on the IAOS website for $10 (plus $4 shipping to U.S. addresses).

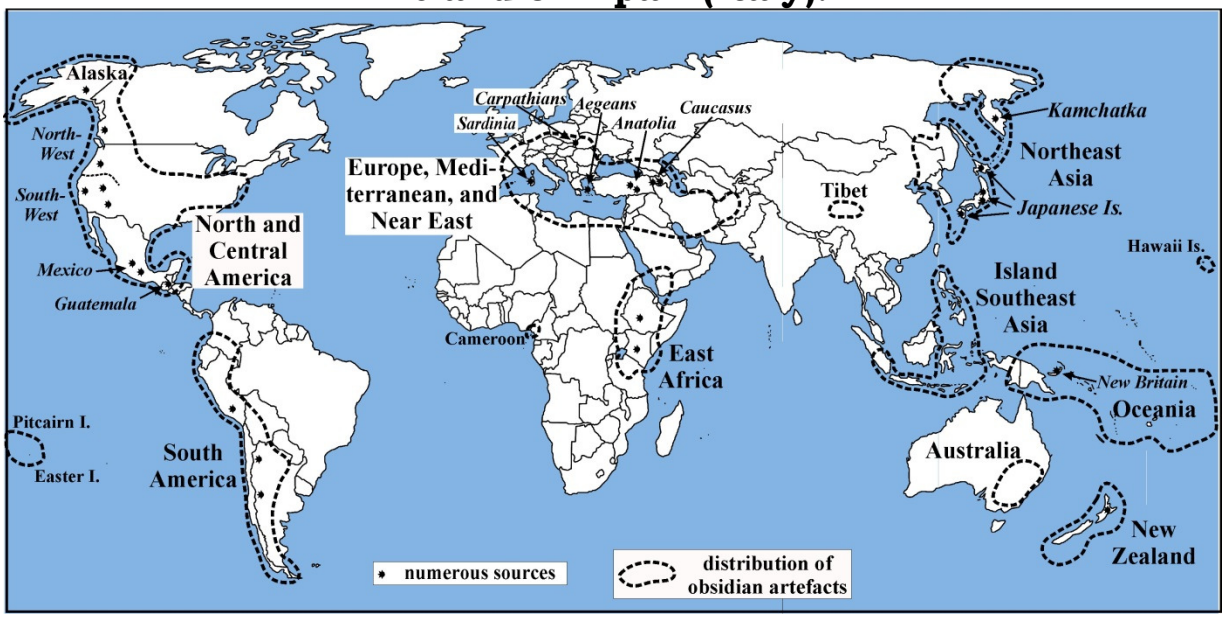
http://members.peak.org/~obsidian/iaos_publications.html

International addresses, please contact us directly at IAOS.Editor@gmail.com for shipping information.

Avoid paying the shipping fee! Purchase your copy in person at the IAOS meeting in Orlando, FL, at the SAAs in April. Contact IAOS.Editor@gmail.com to reserve a copy.

International Obsidian Conference (1–3 June, 2016)

Dear colleagues, we invite you to participate in the International Obsidian Conference, 1–3 June, 2016 on the island of Lipari (Italy).



The meeting's program will include issues related to different fields of obsidian studies — archaeology, geology, anthropology, and archaeometry. The meeting's venue is the **Regional Aeolian Archaeological Museum "Luigi Bernabò Brea", on Lipari** which is reachable by hydrofoil or ferry from Milazzo, Messina, and Palermo in Sicily, as well as Reggio Calabria and Naples in Italy. Non-stop flights from Rome to Reggio are available for about $140 roundtrip. On Lipari, a range of hotels and residences within walking distance are available, many for $100 or less per night.

The suggested registration fee, depending on financial support, is about **100 € (125 US $) for professionals, and 50 € (65 US $) for students**.

The website for the conference is now available. Please go to:
http://rtykot.myweb.usf.edu/Obsidian%202016/

We are now ready to accept your suggestions about the sessions and topics; please contact the Organizing Committee.

SUBMISSION DEADLINE: January 31, 2016

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HYDRATION RATE ACCURACY IN INDUCED HYDRATION OF OBSIDIAN: A SIMULATION STUDY OF ERROR CORRELATIONS

Alexander K. Rogers, MA, MS, RPA
Maturango Museum

Abstract
Induced hydration is a laboratory method for developing a hydration rate for obsidian which does not require association with outside chronometric data. The principle is to hydrate a set of obsidian samples at elevated temperatures, compute the obsidian parameters, and compute a hydration rate for archaeological temperatures. Unavoidable measurement errors in the experimental protocol lead to uncertainty in obsidian parameters, and thus in hydration rate. This analysis addresses the question of whether the errors are correlated, which determines the required method for estimating the uncertainties in hydration rate. The question is addressed by a Monte Carlo simulation, which shows that there is a strong (negative) correlation between errors in the obsidian parameters. Thus the standard deviation of the hydration rate cannot be computed conveniently from the experimental data, but requires use of Monte Carlo simulation methods.

Introduction

Induced hydration is a laboratory method for developing a hydration rate for obsidian which does not require association with outside chronometric data. The hydration rate of obsidian is strongly temperature-dependent, so if hydration is allowed to proceed at elevated temperatures, measurable hydration rims develop in days rather than years. The temperature dependence of the hydration rate has a well-attested mathematical form, so the principle of induced hydration is to hydrate a set of obsidian samples at elevated temperature, compute the obsidian parameters - activation energy (E) and pre-exponential constant (k_0) – and scale the hydration rate to archaeological temperatures (Rogers 2006; Stevenson and Scheetz 1989; Stevenson et al. 1998).

However, the accuracy of the process is affected by measurement errors which unavoidably arise in the experimental protocol, notably rim measurement errors. Thus there are unavoidable uncertainties in both E and k_0 as experimentally determined, which lead to uncertainties in the computed hydration rate. The analysis here addresses the effects of these errors on the measured hydration rate, and also the question of whether the errors in E and k_0 are correlated or not. The answer to this question determines the required method for estimating the uncertainties in hydration rate.

In the discussion that follows, it is assumed that the experimental protocol involves sufficiently long hot-soak times to avoid the problem of non-equilibrium conditions (Rogers and Duke 2011; Stevenson and Rogers 2014).

Theory

The temperature dependence for diffusion in glass is described by the Arrhenius equation,

$$k = k_0 \exp(-E/T) \quad (1)$$

where k is the diffusion rate in μ^2/unit time, E is the activation energy in °K, T is temperature in °K, and k_0 is the pre-exponential in μ^2/unit time. Both E and k_0 are independent of temperature. The laboratory procedure is to hydrate samples of obsidian at three or more elevated temperatures in the range of 100°C – 150°C, well below the glass transition temperature (Rogers and Duke

2011). The hydration rims (r) resulting from hot-soak at a temperature T are measured after a time t, and used to compute activation energy and pre-exponential.

Mathematically, the method is to compute the parameters k_0 and E by a linear least-squares best fit to the logarithmic form of equation (1), and then compute the hydration rate at any desired site temperature (Rogers 2006). The logarithmic form is

$$\ln(k) = \ln(k_0) - E/T \quad (2)$$

The hydration rate is, by definition, r^2/t, so equation (2) becomes

$$\ln(r^2/t) = \ln(k_0) - E/T \quad (3)$$

If we define

$$y = \ln(r^2/t) \quad (4)$$

and

$$x = 1/T \quad (5)$$

equation (2) becomes a linear equation of the form

$$y = Y + Sx \quad (6)$$

with $Y = \ln(k_0)$ is the y-intercept and $E = -S$ is the slope. Given data for r, t, and T for three or more points, equation (6) can be solved as a weighted least-squares linear best-fit (Rogers and Duke 2011). The weighting factor is included to compensate for the change of variable in equation (4) (Cvetanovic et al. 1979). The expected standard deviation of the slope and y-intercept can also be computed analytically (Rogers and Duke 2011). Once k_0 and E are determined, the hydration rate k at any desired site temperature T_s can then be computed as

$$k = k_0 \exp(-E/T_s) \quad (7)$$

This value can then be applied in archaeological analyses.

The Current Issue

In a typical experimental case, a single data set is used to compute best estimates of E, k_0, and k; standard deviation of E and k_0 are also computed analytically (Rogers and Duke 2011). However, with a single set of data there is no obvious way to estimate a standard deviation for rate. The question posed here is: can we infer the error standard deviation of rate if we know the error standard deviations of activation energy and pre-exponential? If the two error sets are uncorrelated, we can do so, but not otherwise.

In induced hydration, in which $\ln(r^2/t)$ (the y-variable) is plotted against 1/T (the x-variable), any errors in r, t, or T will affect both E and k_0. Therefore it is possible that the resulting errors in E and k_0 are in fact correlated. The question can be resolved by an experiment using a numerical simulation.

The problem can be approached by simulating the induced hydration process to create an artificial data set. The data set is created to be error-free, and then random errors are introduced into the rim value in equation (4), with a standard deviation determined from experimental data. Values of E, k_0, and k are then computed. Multiple iterations are made on the same data but with different random errors, unlike a laboratory experiment, and statistics can be collected to determine the standard deviation of hydration rate directly. The standard deviation of rate from the simulation can then be compared against the value that would be inferred from the standard deviations of activation energy and pre-exponential. A simulation was written in MatLab® to create the data for analysis.

An alternative expression for equation (1) is

$$k = \exp(Y - E/T) \quad (8)$$

with Y defined as above. If the errors in Y and E are uncorrelated, then by propagation of errors theory the errors in k are

$$\sigma_k = \sqrt{[(\partial k/\partial Y)^2\sigma_Y^2 + (\partial k/\partial E)^2\sigma_E^2]}$$

(Taylor 1982). Working out the algebra, this becomes

$$\sigma_k = k\sqrt{(\sigma_T^2 + \sigma_E^2/T^2)} \quad (9)$$

Simulation

The theoretical model on which the simulation was based is described in Rogers 2015. Briefly, the hydration rate is given by the equation

$$k = \exp(A + Bw + C/T + Dw/T) \quad (10)$$

where k is hydration rate in μ^2/1000 years, w is intrinsic water in wt%, T is temperature in °K, A = 37.76, B = -2.289/wt%, C = -10433°K, and D = 1023°K/wt%. The rationale for this equation and the values of the constants are described in Rogers 2015; as stated therein, the values of the constants are based on a very small data set and must be treated as provisional. The equation gives valid hydration rates for archaeological temperatures and for $0.5 < w < 1.2$; however there are indications it does not give valid rates for $w <\sim 0.1$ wt% (C. Stevenson, personal communication). Despite its provisional nature, it provides a reasonable basis for simulation.

The simulation procedure was to construct a hypothetical data set, error free, from equation (10). The simulations modeled five different values of intrinsic water (w) and an effective hydration temperature of 20°C (293.15°K). Five hydration temperatures were modeled (110°C, 120°C, 130°C, 140°C, 150°C), with hot soak times of 60, 50, 40, 30, 20, and 20 days, respectively. These hot soak times are considerably longer than are typical of induced hydration protocols (e.g. Rogers and Duke, 2011) in order to ensure that equilibrium conditions prevail (Stevenson and Rogers 2014). After the error-free data set was constructed, measurement errors in hydration rim reading were introduced with an error standard deviation of $\sigma_r = 0.1\mu$, which is typical of laboratory data, and values of E, Y, and k were computed. The errors were then changed to another random set and the process repeated. At the end of 100,000 iterations, statistics were computed for output. The output included a mean value for E, Y, and k, as well as standard deviations. The standard deviations in E and Y were then used to compute σ_k from equation (9). Table 1 summarizes results. Here σ_{ks} is the standard deviation of hydration rate from the direct simulation, and σ_k is the value inferred from equation (9).

Discussion and Conclusion

Examination of the data in Table 1 shows clearly that there is a strong cross-correlation between errors in E and errors in Y which renders equation (9) invalid. For example, with an intrinsic water content of 1.0 %wt, an effective hydration temperature of 293.15°K, and a hydration rim standard deviation of 0.10μ, the standard deviation of hydration rate from the direct simulation is 3.28μ^2/1000 yrs; if one had inferred it from errors in activation energy and pre-exponential for the same conditions, using equation (9), the result would have been 14.01 μ^2/1000 yrs. Thus the

w, wt%	Mean E, sim	Mean Y, sim	Mean k, sim	σ_E, sim	σ_Y, sim	σ_{ks}, sim	σ_k, eq (9)
0.2	10228	24.49	11.59	288	0.70448	3.28	14.01
0.6	9819	23.58	18.65	273	0.66791	4.98	21.37
1.0	9410	22.66	30.02	257	0.63082	7.55	32.46
1.2	9205	22.20	38.12	250	0.61336	9.29	40.06
1.5	8898	21.52	54.48	239	0.5866	12.68	54.73

Table 1. Simulated mean and standard deviations for induced hydration of obsidian.

correlation term is negative, and errors in rate are actually smaller by a factor of approximately 4.3 than would be expected if the errors in activation energy and pre-exponential were uncorrelated (which is good news). Further variation of hot-soak times and or intrinsic water content showed that the factor of 4.3 in the difference still holds.

This shows that it is not valid to estimate the standard deviation of rate by equation (9). Further, as pointed out above, an expected standard deviation of rate from an induced hydration experiment cannot be computed conveniently from the experimental data. The only feasible method for estimating the standard deviation of the hydration rate is by a Monte Carlo simulation. The method is straight-forward, but requires access to a computing package such as MatLab® or Python. The author can make available such a simulation upon request.

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ABOUT OUR WEB SITE

The IAOS maintains a website at http://members.peak.org/~obsidian/
The site has some great resources available to the public, and our webmaster, Craig Skinner, continues to update the list of publications and must-have volumes.

You can now become a member online or renew your current IAOS membership using PayPal. Please take advantage of this opportunity to continue your support of the IAOS.

Other items on our website include:

- World obsidian source catalog
- Back issues of the *Bulletin.*
- An obsidian bibliography
- An obsidian laboratory directory
- Photos and maps of some source locations
- Links

Thanks to Craig Skinner for maintaining the website. Please check it out!

CALL FOR ARTICLES

Submissions of articles, short reports, abstracts, or announcements for inclusion in the *Bulletin* are always welcome. We accept electronic media on CD in MS Word. Tables should be submitted as Excel files and images as .jpg files. Please use the *American Antiquity* style guide for formatting references and bibliographies.
http://www.saa.org/Portals/0/SAA/Publications/StyleGuide/StyleGuide_Final_813.pdf

Submissions can also be emailed to the *Bulletin* at IAOS.Editor@gmail.com Please include the phrase "IAOS Bulletin" in the subject line. An acknowledgement email will be sent in reply, so if you do not hear from us, please email again and inquire.

Deadline for Issue #55 is May 1, 2016.

Email or mail submissions to:

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Inquiries, suggestions, and comments about the *Bulletin* can be sent to IAOS.Editor@gmail.com Please send updated address information to Matt Boulanger at Boulanger.Matthew@gmail.com

MEMBERSHIP

The IAOS needs membership to ensure 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/year*
Student Member: $10/year or FREE with submission of a paper to the *Bulletin* for publication. Please provide copy of current student identification.
Lifetime Member: $200

Regular Members are individuals or institutions who are interested in obsidian studies, and who wish to support the goals of the IAOS. Regular members will receive any general mailings; announcements of meetings, conferences, and symposia; the *Bulletin*; and papers distributed by the IAOS during the year. Regular members are entitled to vote for officers.

*Membership fees may be reduced and/or waived in cases of financial hardship or difficulty in paying in foreign currency. Please complete the form and return it to the Secretary-Treasurer with a short explanation regarding lack of payment.

NOTE: Because membership fees are very low, the IAOS asks that all payments be made in U.S. Dollars, in international money orders, or checks payable on a bank with a U.S. branch. Otherwise, please use PayPal on our website to pay with a credit card.
http://members.peak.org/~obsidian/

For more information about membership in the IAOS, contact our Secretary-Treasurer:

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Membership inquiries, address changes, or payment questions can also be emailed to Boulanger.Matthew@gmail.com

ABOUT THE IAOS

The International Association for Obsidian Studies (IAOS) was formed in 1989 to provide a forum for obsidian researchers throughout the world. Major interest areas include: obsidian hydration dating, obsidian and materials characterization ("sourcing"), geoarchaeological obsidian studies, obsidian and lithic technology, and the prehistoric procurement and utilization of obsidian. In addition to disseminating information about advances in obsidian research to archaeologists and other interested parties, the IAOS was also 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 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 the advances in obsidian studies and the analytic capabilities of various laboratories and institutions.

MEMBERSHIP RENEWAL FORM

We hope you will continue your membership. Please complete the renewal form below.

NOTE: You can now renew your IAOS membership online! Please go to the IAOS website at http://members.peak.org/~obsidian/ and check it out! Please note that due to changes in the membership calendar, your renewal will be for the next calendar year. Unless you specify, the *Bulletin* will be sent to you as a link to a .pdf available on the IAOS website.

___ Yes, I'd like to renew my membership. A check or money order for the annual membership fee is enclosed (see below).

___ Yes, I'd like to become a new member of the IAOS. A check or money order for the annual membership fee is enclosed (see below). Please send my first issue of the IAOS *Bulletin*.

___ Yes, I'd like to become a student member of the IAOS. I have enclosed either an obsidian-related article for publication in the IAOS *Bulletin* or an abstract of such an article published elsewhere. I have also enclosed a copy of my current student ID. Please send my first issue of the IAOS *Bulletin.*

NAME: _____

TITLE: _____ AFFILIATION:_____

STREET ADDRESS: _____

CITY, STATE, ZIP: _____

COUNTRY: _____

WORK PHONE: _____ FAX: _____

HOME PHONE (OPTIONAL): _____

EMAIL ADDRESS: _____

My check or money order is enclosed for the following amount (please check one):
___ $20 Regular
___ $10 Student (include copy of student ID)
___ FREE Student (include copy of article for the *IAOS Bulletin* and student ID)
___ $200 Lifetime

Please return this form with payment: (or pay online with PayPal http://members.peak.org/~obsidian/**)**

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