IAOS

International Association for Obsidian Studies

Bulletin

Number 48 **Winter 2013**

CONTENTS

NEWS AND INFORMATION

IAOS Annual Meeting 2013

The 2013 Annual Meeting of the IAOS will be held in Honolulu, Hawaii, on Friday, April 5 from 12-1:30pm during the Society for American Archaeology meetings. Please see your SAA program for location.

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!

NOMINATIONS SOUGHT FOR IAOS PRESIDENT-ELECT

Nominations are now being accepted for the position of IAOS President-Elect. Please consider running for this important leadership role in the organization. Nominations are due by March 1, 2013 and elections will be conducted via email shortly thereafter. The new President-Elect will be announced at the 2013 Annual Meeting in Honolulu, Hawaii, in April, and will assume duties as President at the 2014 Annual Meeting in Austin, Texas. Nominations can be sent to current President, Ellery Frahm at e.frahm@sheffield.ac.uk.

NOTES FROM THE PRESIDENT

Wintertime (or summertime for those in the Southern Hemisphere) greetings, and happy new year! IOAS had a very productive 2012, and I am looking forward to 2013. As you begin new projects this year and continue ongoing ones, please consider submitting an update on your research for the next IAOS Bulletin in summer. Keep sending us news, announcements, reports, or whatever else you think would be of interest to IAOS members.

Very soon we will need to choose a new President Elect/Vice President. I took over from Tristan Carter at the 2012 Society for American Archaeology annual meeting in Memphis, so his year-long term as Past President will be coming to an end soon. Please send us your nominations for the next President Elect/Vice President, who would become the new IAOS President for two years after SAA in Austin, Texas in 2014. We will hold the election via email and announce the winner in Honolulu. Now is also the time to make sure that you have paid your dues so that your vote counts in the election. Better yet, become a Lifetime Member and forget about paying those pesky annual dues!

I warn you, however, that being IAOS President really puts one in the public eye, and the press won't leave you alone. First, right before SAA in Memphis, Tristan's face was all over the news (http://www.livescience.com/19085-world-oldest-temple-tools-pilgrimage.html). Then, recently, I wound up in the British tabloids (Figure 1)! Should you wish to run for IAOS President, be prepared for fame, notoriety, and scandal!

In April, the 2013 Society for American Archaeology annual meeting in Hawaii will have an IAOS-sponsored oral session, titled *Obsidian Characterization in the Pacific Ring of Fire,* on Sunday (the 7th) morning. Rather than in the afternoon, the IAOS business meeting will be held at lunchtime (12:00-1:30)


FEATURES
The Star
OPINION
Retailers need more support
Emma's helping hand for women
Glass acts from an ancient world
Overdose led to depressed woman's death
Master plan for the Moors
Roads closed for repair work
Motorists urged to plan ahead
Getting scout and about
Benefit protester 'desperate for food'

Figure 1. I attained my 2012 resolution to appear in a British tabloid! The Star, 10 Sept 2012.

on Friday the 5th. This way there is no time conflict with the Society for Archaeological Sciences business meeting (Friday the 5th, 6:45-7:45 pm) or the Prehistoric Mines and Early Quarries (PMEQ) meeting (Thursday the 4th, 6:00-7:00 pm). I am also relieved about our new meeting time because there is a 10-hour time difference between Hawaii and England: any meetings at 6 pm will feel like 4 am. My talk in the session *Improving XRF Methods for the Geochemical Characterization of Archaeological Materials* is scheduled at 3:30 pm on the second day (the 4th). I have never given at talk at 1:30 am before, so I apologise in advance for perhaps being somewhat loopy. I have also been told that my accent gets thicker when I am tired, so I might sound like a character from the film *Fargo*. For those interested in Hawaiian obsidian, Honolulu is located on the island of Oahu, and obsidian only occurs at Pu'u Wa'awa'a volcano on the Big Island, so you'll have to hop islands.

IAOS is a sponsor of the Fifth Archaeoinvest Symposium, to be held in Romania, entitled *Stories Written in Stone: International Symposium on Chert and Other Knappable Materials*. An announcement and call for papers is included this issue. IAOS members will benefit from a 10% reduction on the attendance fee, which is €150 for professionals or €75 for students. Much more importantly, this is an excellent opportunity for the IAOS to raise its profile with the international community and lithic analysts. It would also be quite tempting, if one travels as far as Romania, to explore the Carpathian Basin obsidian sources. Iași, though, lies in the northeastern corner of Romania, near the border with Moldova, so it would take some travel to reach obsidian sources to the west in Slovakia, Hungary, and Ukraine.

I recently read through the first IAOS Bulletin, published in Fall 1989, to see what was envisioned for our society. Formed after an organisational meeting at the Society for California Archaeology conference, the IAOS initially had a strong focus on obsidian hydration dating in California. As explained by Robert Jackson, the first president, the goals were (1) to expand the society's coverage "throughout the world" and (2) to integrate hydration dating with "other kinds of glass studies, such as geochemical analysis and lithic technology." Thus, by IAOS sponsoring international symposia such as *Written in Stone*, we are furthering such goals. Another area with which obsidian studies can engage is craft production, a perspective that I have pursued recently by studying the spatial organisation of metal and ceramic production (Figure 2).

Figure 2. Analysing a Mycenaean kiln for chemical signals of copper metallurgy.

I also found it interesting that, in the first issue of the IAOS Bulletin, the main article was an interlaboratory comparison of obsidian hydration rim measurements. The focus was not error in dating, only measurement error in the thickness of the hydrated rims. This was in response to prior studies that showed observers obtained different measurements on identical thin sections of artefacts. The article authors -- Stevenson, Dinsmore, and Scheetz -- concluded their comparison dealt more with observers' choices than with different microscopes. Individual observers, rather than instruments or facilities, need assessment. In recognition of the role of observer choices, the test had no experimental controls, giving observers free rein to make choices within their *chaîne mesures*.

Therefore, observer, not instrument, was the dependent variable in the statistical analysis. The authors found a very high correlation among the observers' results based on linear regression analysis (i.e., the correction coefficient was over 0.99), even though the individual measurements differed by about 15% among the observers. Thus there was consistency in the measurements of each observer, even if there was some variance from the group means (i.e., the constructed "true" values of the rim depth). Simply put, they were inaccurate but still correlated. The error did not reflect the technical performance of the microscopes. That is, it "was contrary to that anticipated from an analysis of the limiting factor of optical resolution."

One interest was "to determine how each operator contributed to the total variance." For example, a few observers consistently reported values above the means, whereas others reported measurements below them. What caused the variance in observers' measurements? The authors propose the "criteria used by each operator to determine if a hydration rind what 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." Identifying an in-focus image was "in part a subjective decision," as was defining the edge of the hydrated rim.

How do they propose to adjust for the effects and facilitate interlaboratory compatibility? One possibility is training the observers "to make subtle variations in [their] methods" in order to produce values closer to the means as they take their measurements. The authors concluded that such an approach "could probably not be achieved." The second possibility, which they endorse, is enabling observers to calibrate their measurements *ex post facto*. Using their own approaches, observers could measure their unknowns with a series of reference thin sections. By comparing their measurements on the references to their accepted values, observers may derive a calibration factor to apply to the measurements: "With a calibration factor the rind measurements... could be adjusted on a statistical basis to more closely approximate the group mean." Rather than trying to adjust their measurements *a priori*, the authors argued it was acceptable and more practical to adjust internally consistent data using *ex post facto* statistical corrections. It is quite interesting that, in the first IAOS Bulletin, we can find an example of issues similar to those we face today in light of new techniques and instruments.

Let me again say that it is a pleasure to serve as the IAOS President. Please feel free to contact me with any comments or ideas you have. In particular, your suggestions for promoting IAOS and giving our organisation great visibility would be most welcome.

Warmest regards,

Ellery Frahm
e.frahm@sheffield.ac.uk
Marie Curie Experienced Research Fellow
Department of Archaeology
The University of Sheffield

FIFTH ARHEOINVEST SYMPOSIUM

'Stories Written in Stone'

International Symposium on Chert and Other Knappable Materials

20 -24 August 2013

"Alexandru Ioan Cuza" University of Iaşi, Romania

http://arheoinvestsymposium.uaic.ro/stone

As far as raw materials go, chert and other knappable stone stand out as some of the most common materials in the archaeological record, and at some sites the only preserved material. They were used in almost every corner of the world, from the Palaeolithic up until today. Use of these materials even predates the appearance of our own species. Being so widespread, both geographically as well as chronologically, this topic merits a global meeting of researchers to discuss and compare our findings.

This symposium will cover all aspects of knapped stone raw materials from geological origin, to mining, usage, and laboratory analyses on these materials. Although we expect that there will be more focus on chert and other microcrystalline quartz varieties, we also encourage presentations related to other knappable materials such as obsidian, quartzite, rhyolite. Papers will be accepted on any culture or time period. Whether you are a field archaeologist, laboratory researcher, ethnographer or a modern day knapper yourself, come tell your stories.

Main Sessions

The symposium will focus on two major themes: (1) the *chaîne opératoire* of knapped stone artefacts, and (2) *auxiliary sciences* related to lithics (in particular microcrystaline quartz).

Theme 1 — Chaîne opératoire

- Raw material exploitation strategies — mining and surface collecting
- Ancient lithic trade and economics
- Stone tool production and processing techniques
- Use-wear analyses — signs of usage on stone tools (a.k.a. traceology)

Theme 2 — Auxilliary sciences

- Microcrystaline quartz as a geological material
- Characterising lithic sources
- Lithotheques — collections of comparative raw materials
- Gemology — Microcrystaline quartz as a gemstone today and in the past

Submitting abstracts

The organisers of the symposium are now accepting abstracts for presentations. Abstracts should be around 200-300 words. They may also contain one image. Please include also the following information: (1) title; (2) presenter(s) and affiliated institutions of each; (3) preferred session (see the 'Sessions' page); and (4) presentation type — oral or poster. Abstracts should be sent to Otis Crandell at otis.crandell@ubbcluj.ro. All papers will be evaluated by the Scientific Committee. The deadline for submitting abstracts is 1 February 2013.

More information

For more information, please visit the symposium website, or contact Otis Crandell (otis.crandell@ubbcluj.ro) or Vasile Cotiugă (vasicot@uaic.ro).

This symposium is organised by *ARHEOINVEST* – the Interdisciplinary Research Platform in the Field of Archaeology, Faculty of History, "Alexandru Ioan Cuza" University of Iaşi, Romania.

FIFTH ARHEOINVEST SYMPOSIUM

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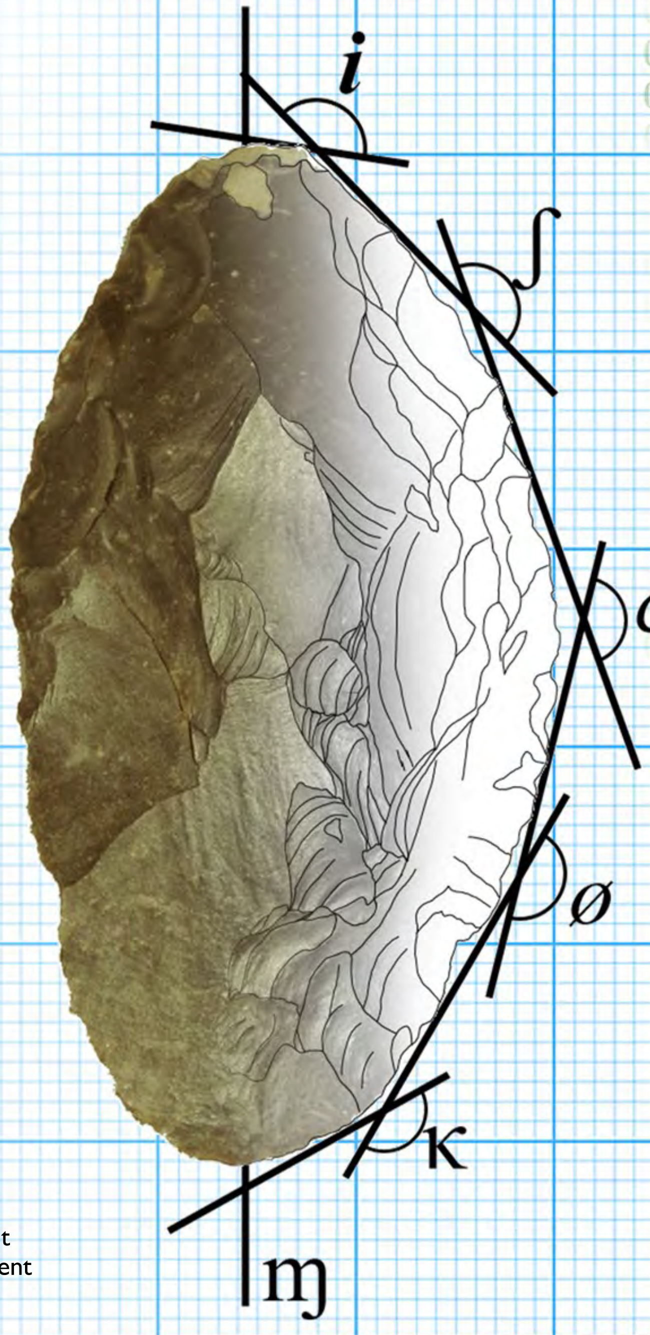

Organised in partnership with:

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“Babes-Bolyai” University of Cluj-Napoca, Geology Department
Society for Archaeological Sciences
International Association for Obsidian Studies
Meiji University Center for Obsidian and Lithic Studies

http://arheoinvestsymposium.uaic.ro/stone

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."

IAOS Sponsored Session at the 2013 Society for American Archaeology Annual Meeting, Honolulu, Hawaii, Sunday, April 7, 2013.

Obsidian Provenance in the Pacific Rim: Current Trends and Future Applications
Session Organizers: Jeffrey R. Ferguson and Kyle P. Freund

Participants: Kyle Freund; Jeffrey Ferguson and Masami Izuho; Richard Hughes; Michael Glascock, Michael Ohnersorgen, J. Andrew Darling, and Daniel E. Pierce; Charles Stern

Discussant: Robert Tykot

This session concerns obsidian characterization in the Pacific Ring of Fire - a band of volcanic activity encircling the Pacific Ocean that includes modern-day western South and North America, East Asia, and the Pacific Islands. Due to the prevalence of volcanic activity throughout the region, obsidian is fairly common and was widely exploited by people of the past. Papers in this session will discuss the current state of source characterization in each of these principal regions, including a brief background of the relevant geology, an overview of major regional archaeological research projects and the questions that drive them. Moreover, potential avenues for future research will also be highlighted.

The field of obsidian sourcing is flourishing, with a clear upward trend in the number of published studies in the past decade. As such, there is a broad diversity of applications to which provenance data are applied, in contexts ranging from mere description to those that use obsidian as a proxy for the examination of large-scale archaeological and anthropological issues. By highlighting the diverse aims and goals of obsidian provenance studies throughout the Pacific Rim of Fire, common themes will emerge that transcend the increasingly specialized world of archaeological discourse.

DAVID ALLEN FREDRICKSON
(1927-2012)

On August 28, 2012, David Allen Fredrickson, professor emeritus in anthropology at Sonoma State University, California, died at the age of 85. As an archaeologist Dave's influence was strongly felt in California, across America, and on the continent of Africa. The Society for California Archaeology bestowed upon Dave numerous awards while the Society for American Archaeology honored Dave in 1998 with the Award for Excellence in Cultural Resources Management. Because of Dave's recognized leadership in the field of Cultural Resources Management, he received a grant from the South African Research Council to travel to South Africa to meet with professionals there to discuss management of cultural resources.

Particularly germane to the IAOS, Dave was a founding member in 1989, and he served as president from 1997-1999. Dave's interest in obsidian spanned several decades. Back in the 1960s, Dave was the first anthropology instructor at Sonoma State College (now Sonoma State University) in California and he purchased equipment necessary to set up an obsidian hydration dating laboratory, which became functional a few years later. During the course of archaeological surveys, Dave asked that field crew members collect samples of obsidian specimens from each site discovered. Those specimens were later used to conduct research aimed at elucidating the movement of obsidian both geographically and temporally across the landscape in northern California. Among Dave's numerous obsidian documents include two samples cited here that early on set the tone for obsidian research in the far western United States. The first, presented at the 1987 Annual Meeting of the Society for California Archaeology was titled *The Use of Borax Lake Obsidian Through Time and Space*. Dave's analysis showed that Borax Lake obsidian was not distributed homogenously geographically or across ethnographic boundaries. Dave suggested that greater and lesser amounts of social distance existed between localities, and he concluded his presentation with the following words.

> *Obsidian studies can provide rich information not otherwise available as such a low relative cost. These studies allow us to have considerable confidence at what is essentially still the descriptive level. We have hopes, however, as our confidence increases that we*

> *will be able to pursue even higher levels of explanation, to seek reasons why these patterns of social distance occur.*

Shortly after, Dave published the results of a paper focused on a limited geographical area known as The Geysers, a geothermal area that spans the juncture of Lake, Mendocino, and Sonoma counties, approximately 100 miles north of San Francisco. In his 1989 publication, *Spatial and Temporal Patterning of Obsidian Materials in The Geysers Region*, Dave analyzed over 1,500 obsidian specimens from four geochemical sources collected at more than 150 archaeological sites distributed within several watersheds. Dave's analysis revealed differing patterns in the distribution of obsidian debris as opposed to the patterns exhibited by formal tools such as projectile points and bifaces. Also, while the physical distance from a geochemical source location to the watersheds under study varied, obsidian distribution patterns varied even more. Obsidian in its raw form (as flakes) moved from watershed to watershed in certain patterns/directions, while finished tools often moved across the landscape very differently.

Even after Dave's health began its decline, he exhibited unflagging enthusiasm for the study of obsidian. Several of us, stimulated by Dave's urging formed an *ad hoc* assemblage of interested researchers we named the Western Obsidian Focus Group that met more or less monthly, often at Dave's home in Berkeley. While no longer with us physically, Dave's unique and important understanding of obsidian will be remembered as we strive to live up to his teachings, which now form a part of his legacy as an archaeologist and gentle human being.

For much more extensive information about Dave, The Society for California Archaeology will be devoting the June 2013 (5:1) issue of its journal *California Archaeology* to Dave. Also, a festschrift, *There Grows a Green Tree: Papers in Honor of David A. Fredrickson* (White, et al. [eds.] 1993), was published by the Center for Archaeological Research at Davis. The festschrift includes a particularly relevant manuscript titled “The Accidental Scholar: Notes on an Archaeologist's Career.”

-Contributed by Tom Origer.

References Cited

Fredrickson, David A.

1987 The Use of Borax Lake Obsidian Through Time and Space. Paper presented in the symposium: "Trends in Obsidian Studies in Central and Northern California" at the 21st Annual Meeting of the Society for California Archaeology, Fresno, California.

1989 Spatial and Temporal Patterning of Obsidian Materials in the Geysers Region. In *Current Directions in California Obsidian Studies*, Richard E. Hughes (Ed.). Contributions of the Archaeological Research Facility, University of California, Berkeley. Number 48.

White, Greg, Pat Mikkelsen, William R. Hildebrandt, and Mark E. Basgall (Eds.)

1993 *There Grows a Green Tree: Papers in Honor of David A. Fredrickson,* Center for Archaeological Research at Davis, Publication Number 11.

PXRF SOURCING OF OBSIDIAN ARTIFACTS FROM SALAMANCA CAVE, NORTHWEST ARGENTINA

Elizabeth Pintar, Austin Community College
Julien Pessarossi-Langlois, Université Bordeaux

Here we report the results of x-ray fluorescence of 43 small obsidian retouch flakes and two tools from Cueva Salamanca. This site is located in a high elevation desert in NW Argentina known as the Salt Puna (Figure 1). The archaeological record at this site includes a stratigraphic sequence of at least nine successive occupations by groups of camelid hunter-gatherers between *ca*. 6200 BP and 8100 BP, eight of which date between *ca*. 7400 and 8100BP - a period of 700 radiocarbon years. This time period coincides with the Altithermal, a time of increased aridity and temperature. Assemblages contain remains of wild camelids, such as bone, sinew and cordage; plants, grasses, flowers, cactus thorns, spear shafts, and abundant stone tools and high densities of lithic debitage. Plant and animal remains are of local origin, as is most lithic raw material used. However, the presence of cane shafts (*Chusquea lorentziana*) and cactus thorns (*Trichocereus pasacana*) indicate an origin for these artifacts some 300km away, in the eastern lowlands. A small shell bead may be of maritime origin. Of non-local origin too is obsidian, which at this site was used for making projectile points.

Our objectives in carrying out this analysis were threefold:

1. To identify the source for 43 obsidian retouch flakes (sizes ~ 1cm x 0.5 cm) from one excavation unit ($0.25m^2$) in occupation level 2(7), dated to *ca*. 7600 BP.
2. To examine whether the source provenance of retouch flakes matched that of obsidian tools previously analyzed in that level.
3. To compare the macroscopic identification of a small nodule (level 2(3), dated to *ca*. 7400 BP) and a bifacial fragment (level 2(8), dated to *ca*. 7900 BP) recently recovered at the site excavation with XRF source determination. The nodule was believed to be from Laguna Cavi source; the tool was thought to be from Cueros del Purulla source.

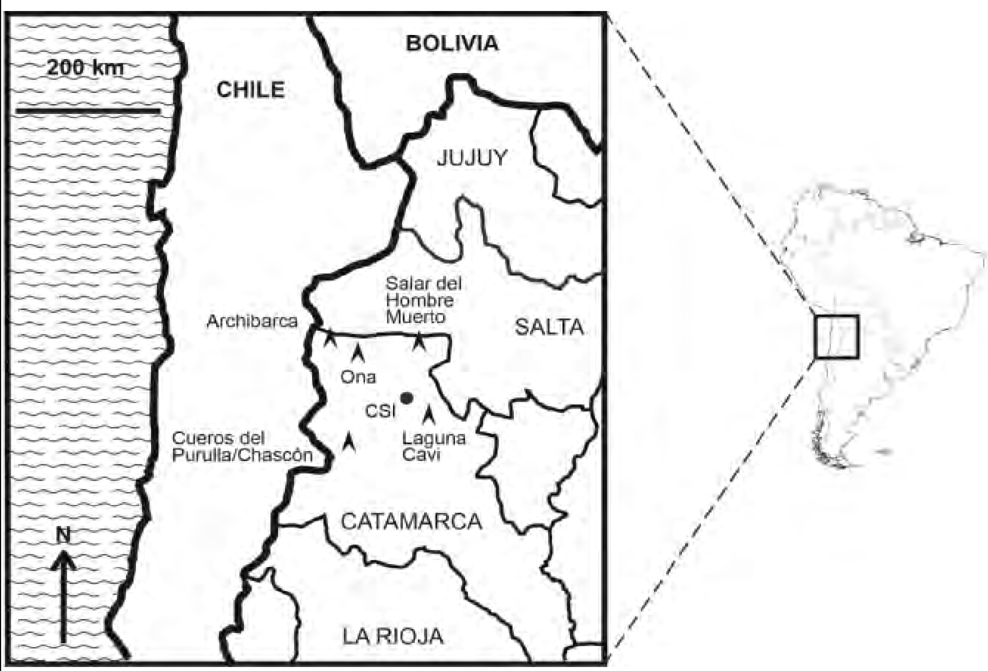

Figure 1. Area map of NW Argentina denoting Cueva Salamanca site (CS1) and obsidian sources (Archibarca, Salar del Hombre Muerto, Ona, Laguna Cavi, Cueros del Purulla/Chascón) in Catamarca province.

XRF Analyses

XRF analysis at Cueva Salamanca began as a way to explore source provenance for obsidian projectile points, which comprise 100% of the obsidian tools. Obsidian flakes constitute about 10% to 25% of the very abundant lithic debitage at the site. Initial XRF analysis of 16 obsidian tools (14 projectile points and 2 bifacial fragments) and 7 flakes representing all occupation levels showed that four sources of obsidian were used: Salar del Hombre Muerto, Ona, Archibarca, and Cueros del Purulla/Chascón (Figure 1), although all sources were not used synchronically. These sources are located between 60km and 120km from Cueva Salamanca. A fifth source, located at Laguna Cavi, which constitutes the nearest source (35km away), was not determined through XRF analysis. On average 2 or 3 sources were used per level, and according to our initial calculations, the average distance from the cave to all sources utilized during any given occupation ranged between 56km and 76km (Pintar et al. 2012).

Figure 2. Portable EDXRF Bruker Tracer III - Sitting vertically to optimize the analysis (photo by Julien Pessarossi-Langlois). Missouri University Research Reactor Laboratory.

Analytical Methods

For the determination of obsidian sources, we used a Bruker III portable EDXRF analyzer, with a Rhodium target film to generate the x-rays. It is operated at 40 kV and 17 µA, for 180 seconds. Moreover, a filter composed of Cu, Ti, and Al, is used together with an accurate calibration of the pXRF, using different well-known obsidians (obsidian source samples by INAA, MD-ICP-MS and LA-ICP-MS, Michael D. Glascock and Jeffrey R. Ferguson 2012). This allows an accurate determination of the samples' chemistry by reducing the spectrum's background and selecting the spectrum's best x-ray range for each element. This way, there is no need to run the obsidian standard with each analysis. This technique was preferred for its non-destructive property and its speed over INAA, which is very accurate, but both slow and destructive.

In order to have stable and non-variant parameters for the analysis, the pXRF was vertically fixed, with the samples sitting directly on the top of it. Also, to get the most of the x-rays and limit the variations from one sample to another, we tried to select the flattest and cleanest part of each sample (Figure 2).

Results

The artifacts' spectrums were compared to the MURR obsidian database. This database is built from the pXRF analysis of geological samples from the different known obsidian sources of the area. Through the use of bivariate plots of the elements, chemical groupings were established, using the "GAUSS" software developed at MURR. The following bivariate plots were realized (Figures 3 and 4), based on the chemical composition of both the artifacts and the database. The different elements Mn, Zn, Zr, Sr, Nb and Y were compared to Rb. The most accurate separation was obtained using Rb vs. Zr and Rb vs. Sr (Figure 3 and Figure 4).

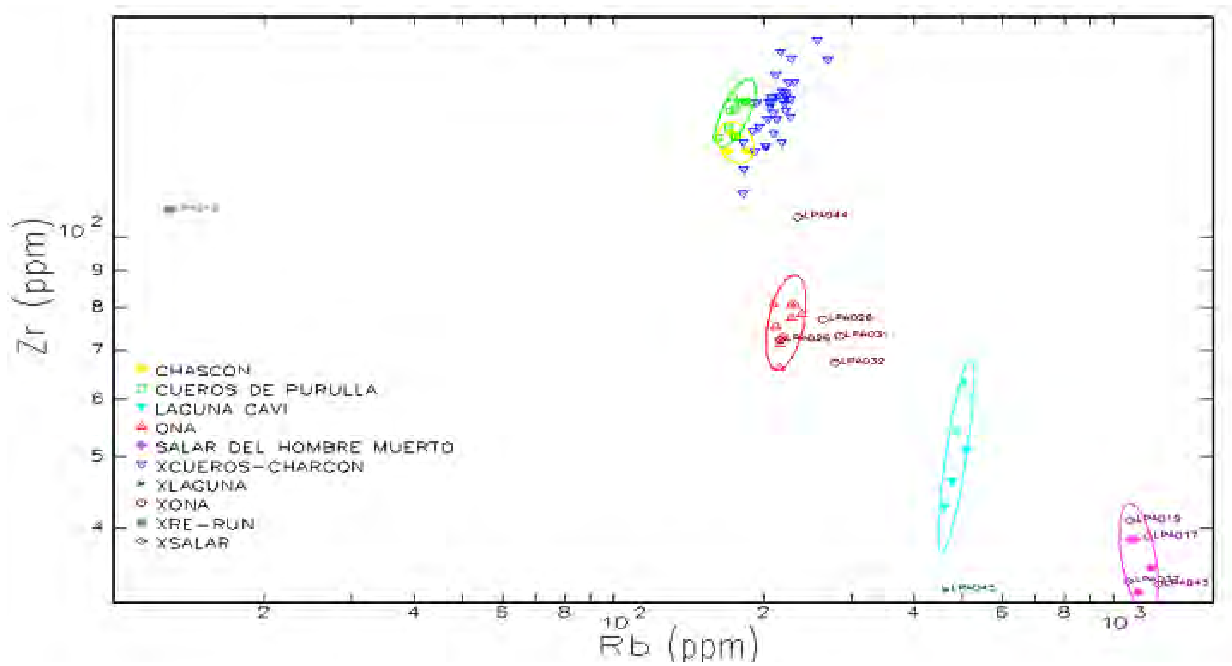

Figure 3. Bivariate linear plot of Rb vs. Zr concentrations for obsidian sources samples and artifacts by pXRF analysis. The ellipse and their plots represent the geological sample groups. The plot “Xname” are the artifacts.

The sample LPA012 found no match, and showed abnormal Rb, Fe, and Nb values. It was re-run in order to check for errors in the analysis itself, but the same result was found. Most of samples (n=34) are probably from the Cueros de Purulla / Chascón sources, 5 are probably from the Ona source, 1 from Laguna Cavi and the 5 remaining from Salar del Hombre Muerto (Table 1).

Interpretation

Identifying sources: Prior to submitting the sample of flakes from occupation level 2(7) for XRF analysis, these flakes (LPA001 - LPA043 in Table 1) had been macroscopically classified into three categories by color and translucence, presumably representing different sources. We assumed that one of these sources was Laguna Cavi. However, XRF results showed that none of the flakes were from Laguna Cavi source, but rather 4 flakes were from Ona source, 4 flakes were from Salar del Hombre Muerto source, and 34 flakes were from Cueros del Purulla source. Prior to these studies, it was thought that Cueros del Purulla source had not been utilized by hunter-gatherers who produced the assemblage of flakes in level 2(7).

Comparing tools and flakes (invisible tools): The utilization of two sources, Ona and Salar del Hombre Muerto, had already been established in level 2(7), *ca.* 7600 BP, as there is one projectile point from each source. The presence of retouch flakes but no tools from Cueros del Purulla was a pleasant surprise, and shows the presence of "invisible" tools that were maintained on-site and discarded elsewhere.

Macroscopic identification gone wrong: XRF analysis showed the small nodule in level 2(3), *ca.* 7400 BP (LPA045 in Table 1), is in fact from Laguna Cavi source, as suspected. However, the small bifacial fragment from level 2(8), *ca.* 7900 BP (LPA044 in Table 1), is not from Cueros del Purulla, but rather from the Ona source, which had already been identified in this level as the source for two artifacts.

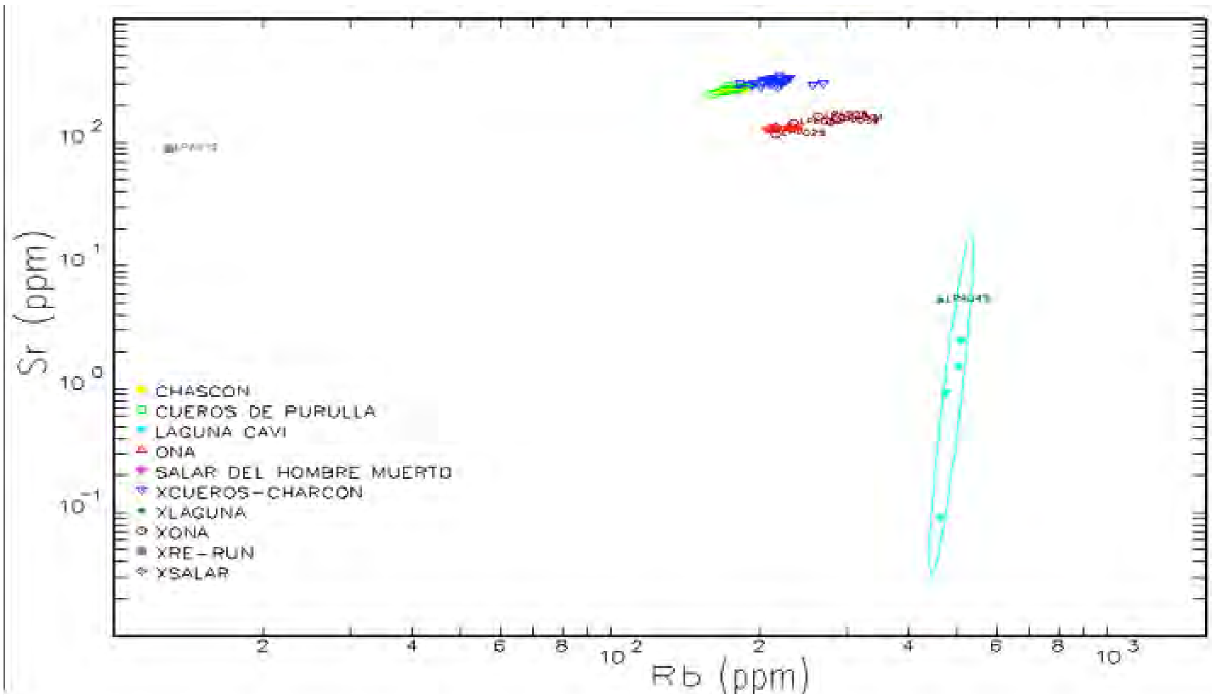

Figure 4. Bivariate linear plot of Rb vs. Sr concentrations for obsidian sources samples and artifacts by pXRF analysis. The ellipse and their plots represent the geological sample groups. The plot "Xname" are the artifacts.

These results suggest that it might be easier to macroscopically identify larger tools or tool fragments than small tools and flakes. This was also the conclusion from the 43 flakes in level 2(7). XRF analyses on 43 flakes showed that macroscopic identification of small obsidian flakes can be very misleading. Small fragments of tools and retouch flakes are often too similar to the naked eye.

Discussion

In a previous paper we calculated the average distance to sources utilized in several occupation levels at Cueva Salamanca dating to *ca.* 7400 - 7600 BP (Pintar et al. 2012). This distance ranged between 56km and 76 km, and was used as a means to discuss mobility strategies changed in the Salt Puna prior to and during the Altithermal. These calculations did not include the result of XRF analysis of this sample of flakes presented here, and included the Laguna Cavi source as determined from visual inspection during debitage analyses. Clearly, these numbers need to be reworked now.

In the case at hand, for occupation level 2(7), dated to *ca.* 7600 BP, average distance to the sources is now modified, as it should take a new source into consideration, i.e., Cueros del Purulla, and ignore our macroscopic identification of Laguna Cavi (which should be limited to larger tools and flakes). The new average distance to these three sources is now 71km, rather than 56 km. Recalculated average distances to obsidian sources for levels 2(3) and 2(8) remain the same: 56km and 68 km respectively.

Calculating the average distances from sites to source areas is thus limited by the technological analyses we have at hand, our budget constraints, tool sizes and excavation sample size. Perhaps a better indicator of mobility is the distance from Cueva Salamanca to the furthest obsidian source (~120km), and the maximum distance between these sources (~130km). These

Table 1. Most probable source for each artifact.

MURR ID	Most probable Source	MURR ID	Most probable Source
LPA001	Cueros de Purulla / Chascón	LPA023	Cueros de Purulla / Chascón
LPA002	Cueros de Purulla / Chascón	LPA024	Cueros de Purulla / Chascón
LPA003	Cueros de Purulla / Chascón	LPA025	Ona
LPA004	Cueros de Purulla / Chascón	LPA026	Ona
LPA005	Cueros de Purulla / Chascón	LPA027	Cueros de Purulla / Chascón
LPA006	Cueros de Purulla / Chascón	LPA028	Cueros de Purulla / Chascón
LPA007	Cueros de Purulla / Chascón	LPA029	Cueros de Purulla / Chascón
LPA008	Cueros de Purulla / Chascón	LPA030	Cueros de Purulla / Chascón
LPA009	Cueros de Purulla / Chascón	LPA031	Ona
LPA010	Cueros de Purulla / Chascón	LPA032	Ona
LPA011	Cueros de Purulla / Chascón	LPA033	Cueros de Purulla / Chascón
LPA012	NON OBSIDIAN	LPA034	Cueros de Purulla / Chascón
LPA013	Cueros de Purulla / Chascón	LPA035	Cueros de Purulla / Chascón
LPA014	Cueros de Purulla / Chascón	LPA036	Cueros de Purulla / Chascón
LPA015	Cueros de Purulla / Chascón	LPA037	Salar del Hombre Muerto
LPA016	Cueros de Purulla / Chascón	LPA038	Cueros de Purulla / Chascón
LPA017	Salar del Hombre Muerto	LPA039	Cueros de Purulla / Chascón
LPA018	Cueros de Purulla / Chascón	LPA040	Cueros de Purulla / Chascón
LPA019	Salar del Hombre Muerto	LPA041	Cueros de Purulla / Chascón
LPA020	Cueros de Purulla / Chascón	LPA042	Cueros de Purulla / Chascón
LPA021	Cueros de Purulla / Chascón	LPA043	Salar del Hombre Muerto
LPA022	Cueros de Purulla / Chascón	LPA044	Ona
		LPA045	Laguna Cavi

numbers have interesting implications for hunter-gatherers inhabiting a high elevation desert during the Altithermal. These distances could suggest that logistical mobility averaged 80 km (minimum distance to source being about 30 km, maximum distance to source being 130km), and that it was at its limit at around 130km.

Conclusion

The application of the results obtained from XRF analyses show us which obsidian sources were utilized by hunter-gatherer groups that inhabited Cueva Salamanca over 7000 years ago. In this study we used a mixed strategy: sampling tools and a random sample of flakes in order to better understand source use and distances traveled to sources. With these results we expect to model hunter-gatherer mobility in the Salt Puna during a time of extreme aridity. As our fieldwork continues, we predict we will be adding artifacts to our XRF studies.

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XRF ANALYSIS OF OBSIDIAN FROM CENTRAL AND SOUTHERN ARIZONA

Helen L. O'Brien and Jon Boyd
Centre for Archaeological Field Training, Pima Community College

The Burro Creek/Pine Creek Archaeological Survey has been underway since 2003 as a joint venture between Pima Community College (PCC) and the Kingman Field Office of the Bureau of Land Management (BLM) in a remote area of Arizona about 40 miles northwest of Prescott (Figure 1). The project has now completed its 10th field season, and to date 7,700 acres have been surveyed, 121 sites have been recorded and 274 projectile points have been collected, typed and analyzed (Booth 2011).

Figure 1. Locations of the Burro Creek/Pine Creek Survey Area and Tucson, Arizona.

In June 2011 Bruker Elemental made a Tracer III-V+ portable x-ray fluorescence analyzer available to project participants for a month. The promise of a battery-powered portable analyzer with a PDA interface seemed suitable for a remote and logistically difficult field setting.

The project area is characterized by mesa tops covered with homogeneous basalt fields overlying strata with a large and diverse set of lithic raw materials (Boyd and Haller 2011). PCC has recorded many sites in the survey area and one of these, AZ M:4:60(ASM), is a local source of obsidian, composed of obsidian nodules (marekanites) embedded in perlitic flows identified by BLM archaeologist John Rose and PCC in 2003. M. Steven Shackley visited the site in the fall of 2003 to collect samples for XRF analysis and subsequently identified the site as one of his previously unknown sources (Shackley 2006). Shackley named this obsidian Bull Creek after the name of a small creek that runs just south of the quarry area.

An x-ray fluorescence (XRF) instrument bombards samples with high energy x-rays and uses a detector to collect and analyze the return signatures to determine elemental composition. XRF technology has been used for many years, but the recent development of relatively inexpensive hand-held analyzers has made the technology much more widely available (Liritzis and Zacharias 2011). Pima Community College faculty, staff and students were trained in May 2011 to use the Tracer and subsequently brought it into the Burro Creek/Pine Creek survey area to collect elemental analyses from *in situ* source materials and immobile artifacts as well as portable artifacts and samples.

During the month that the Tracer was available the Pima College archaeology team assayed 372 items including:

- Obsidian source samples from M:4:60
- Non-obsidian source materials from a nearby quarry, BCPC-98
- 274 projectile points collected since 2003
- 15 obsidian flakes from AZ AA:12:15(ASM) in Tucson, AZ
- A sample of other flaked stone artifacts from the survey area
- Obsidian from other sources beyond the project area

Obsidian is the archaeological material type most commonly submitted for XRF analysis in Arizona because obsidian sources in the greater southwestern United States have been analyzed and identified for over 40 years (Shackley 1988). During the brief time period the Tracer was available to us, we attempted to sample as many different materials and sources as possible. The following discussion focuses on results of the elemental analyses of obsidian projectile points from the Burro Creek/Pine Creek area as well as obsidian debitage from a southern Arizona site: AZ AA:12:15(ASM).

Since none of the students, staff, or faculty had performed XRF analysis in the past, the data collection was done in close collaboration with the experts at Bruker Elemental. They guided the use of the Tracer and the filters, timing, and settings used. All samples were run using the same settings, whether in the field, the field lab, or the Tucson lab. Spectra were collected using S1PXRF software with Backscatter off, Voltage: 40kV, Current: 24.60 micro amps, for 300 seconds. The Tracer "green" filter (0.006" Cu, .001" Ti, .012" Al) was used with all samples. The spectra were analyzed and illustrated using ARTAX software and then normalized to parts per million (ppm) with Bruker's S1PXRF software for selected trace elements. This normalization made the results comparable to those of other researchers and allowed us to match these obsidians with sources outside the study area.

A total of 202 complete and partial obsidian projectile points collected from the Burro Creek/ Pine Creek survey area were assayed and separated into groups which showed different elemental compositions. By far the most common (*n*=169) were points whose composition visually matched those of marekanites from M:4:60. We were not surprised to find that most of the projectile points seemed to be made from locally available obsidian. In an attempt to broaden our obsidian sample geographically we also assayed fifteen pieces of obsidian debitage from a site in the Tucson Basin. The debitage analyzed from AZ AA:12:15(ASM) fell into three distinct groups.

Once we determined that we had points from Burro Creek/Pine Creek apparently manufactured of obsidian from nine different sources, and flakes from AZ AA:12:15(ASM) from three different sources, the next step was to compare the elemental concentrations in ppm to those published by M. Steven Shackley for obsidian sources in the greater southwestern United States and northern Mexico (1988, 1991, 1994, 1995, 2005).

Because the device, the filter, the calibration and the software we used to produce elemental ppms were different than those used by Shackley to produce the published data, we were not certain if our elemental concentrations could be compared directly to his. To address this issue, we assayed nine marekanites from M:4:60, the same source visited and published by Shackley as Bull Creek (2006). This enabled us to compare the elemental ppm values of samples he analyzed (Table 1) with those that we analyzed (Table 2). This approach is not as rigorous as that advocated recently by Shackley (2010) but does provide a standard of comparison.

Element	N	Min.	Max.	Mean	Std. Dev
Ti	23	698	856	698	39
Mn	23	397	573	482	41
Fe	23	6306	7571	7003	354
Rb	23	186	212	199	8
Sr	23	17	31	23	3
Y	23	25	43	32	4
Zr	23	67	88	77	4
Nb	23	17	37	29	4
from www.swxrflab.net/bull_creek.htm					

Table 1. Elemental concentrations for Bull Creek, Arizona source standards from samples collected by Shackley at AZ M:4:60(ASM).

Element	N	Min.	Max.	Mean	Std. Dev
Ti	n/a	n/a	n/a	n/a	n/a
Mn	9	390	533	449	59
Fe	9	5070	6201	5721	319
Rb	9	174	198	189	7
Sr	9	16	21	19	2
Y	9	25	34	31	3
Zr	9	76	89	81	4
Nb	9	26	29	28	1
from assays by Pima Community College					

Table 2. Elemental concentrations for samples collected by Pima Community College from AZ M:4:60 (ASM).

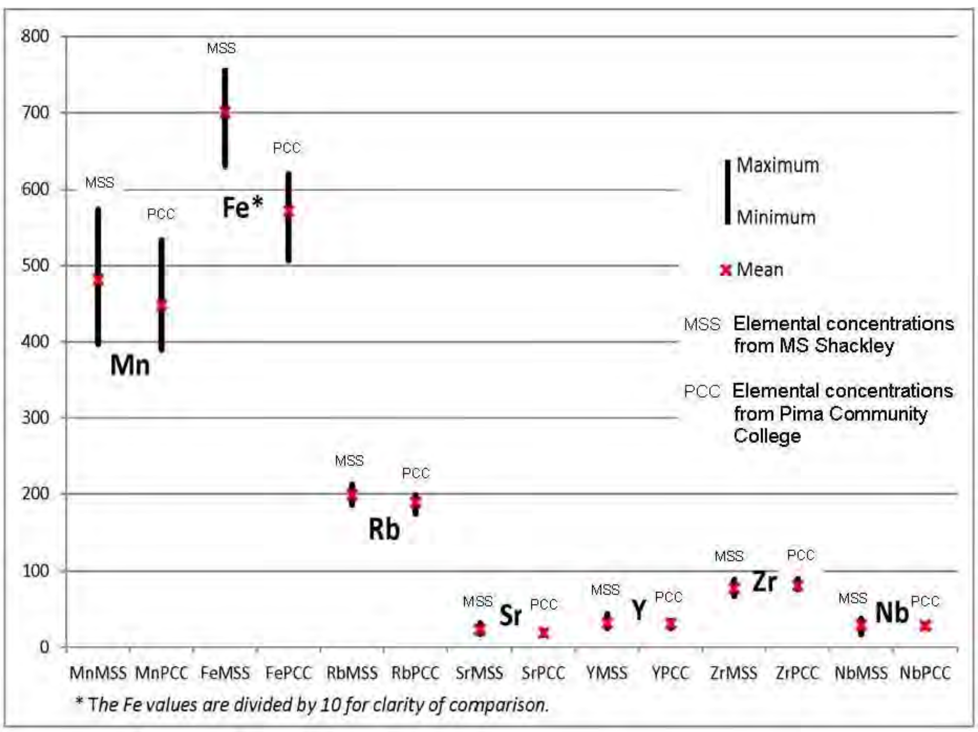

Figure 2. Comparison of measured elemental concentrations of obsidian samples from AZ M:4:60(ASM) by M.S. Shackley and Pima Community College

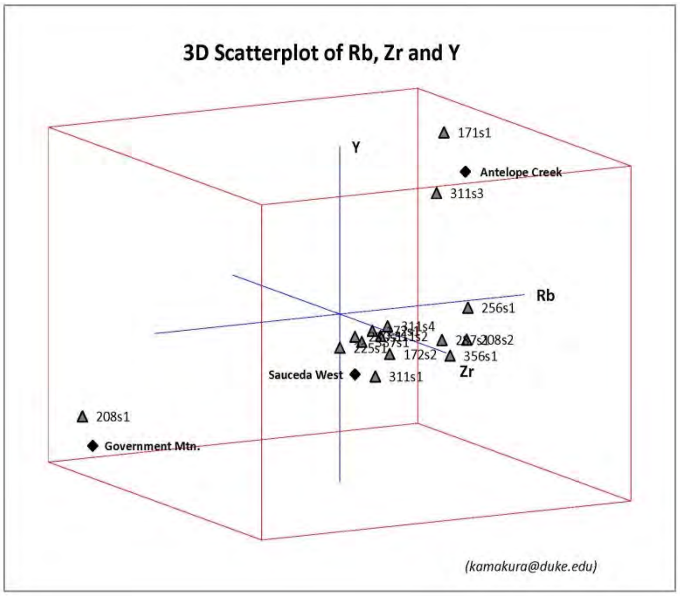

Figure 3. 3D Scatterplot of Rubidium, Zirconium and Yttrium concentrations from artifacts from AZ AA:12:15(ASM) and those of published obsidian sources.

Despite the differences in procedures and equipment, the values obtained for ppm of elements by PCC are similar to those published by Shackley. The exception is the concentration of Fe which is higher in Shackley's data than in ours (Figure 2). The concentration or relative concentration of Fe is not commonly used to distinguish between different obsidian sources in central Arizona (Shackley 1988, 1995, 2005) so we felt confident in comparing the data we obtained with that published by Shackley.

First we considered the data derived from the specimens from AZ AA:12:15(ASM) because of the relatively smaller number of cases, n=15 vs. n=202. The obsidian flakes as described by their spectra and elemental ppm fell into three groups. The ppm values of these flakes were compared with those of all the sources published by Shackley over the last several decades and made easily available on the Geoarchaeological XRF Lab website.

Figure 4. 2D Scatter plot of Strontium and Rubidium concentrations from central Arizona projectile points and published obsidian sources.

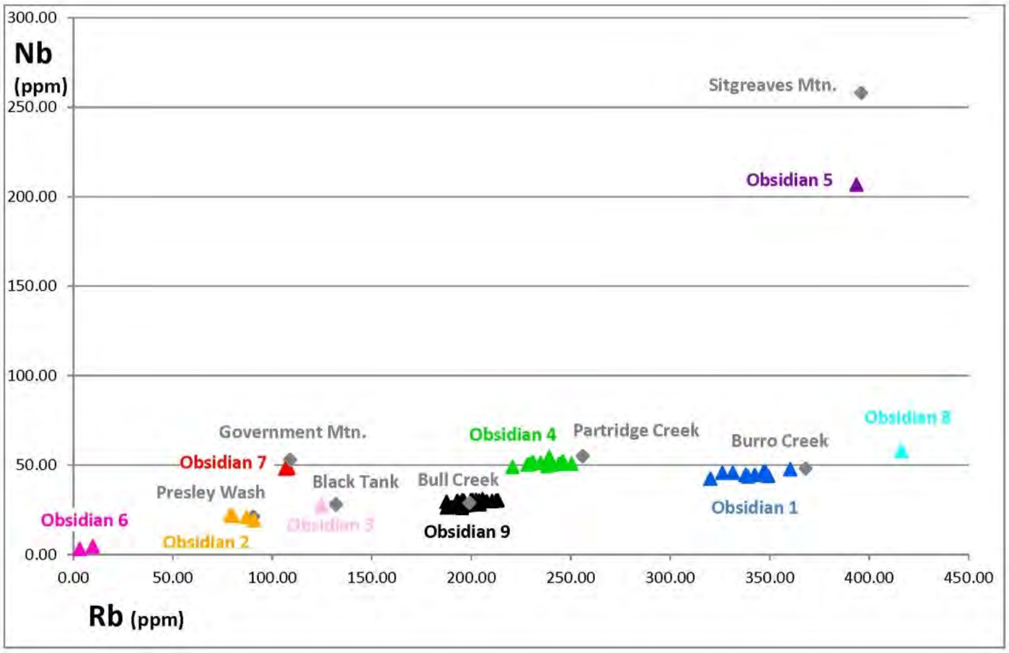

Figure 5. 2D Scatter plot of Niobium and Rubidium concentrations from central Arizona projectile points and published obsidian sources.

We found that Rb, Zr and Y most clearly showed the similarities between the obsidian artifacts assayed and the elemental concentrations of the sources. One sample, FN 208s1 groups with Shackley's Government Mountain source, two samples group with the Antelope Creek Group and the rest are most closely grouped with Sauceda West (Figure 3). Although the fit is not perfect for any of these, they fall within the known ranges of ppm values of samples from these sources, and further they do not match at all with the values from other published sources (O'Brien 2012). The discrepancy between ppm values for Fe remained consistent in this and the following analysis.

We then moved to a closer examination of the 202 samples from Burro Creek/Pine Creek and attempted to match the ppm values of those samples with the published data. Figures 4 and 5 present bivariate plots of concentrations of Sr versus Rb and Nb versus Rb for the PCC projectile points and from the data published by Shackley. The nine different obsidians are clearly grouped in the charts and seven of those nine plot with one of Shackley's published sources. We were able to confidently source seven of the nine obsidians described with two remaining that did not match published sources.

With a loan of equipment and training from Bruker Elemental, faculty, staff and students from Pima Community College were able to learn to use an XRF device to reliably and consistently collect data from obsidian and other materials. Using data made readily available by M. Steven Shackley, we were able to compare the elemental concentrations we determined from samples taken from a source he had previously described. This allowed us to identify the source of 15 obsidian flakes from AZ AA:12:15(ASM) and 199 of the 202 obsidian projectile points collected during the course of the BCPC archaeological survey. This analysis has allowed us to add a meaningful chapter to the understanding of obsidian procurement in west-central Arizona and cast additional light on obsidian procurement at a Classic Period Hohokam site in southern Arizona.

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OBSIDIAN SOURCING, DATING, AND TECHNOLOGY IN THE NEW WORD: READINGS FROM *AMERICAN ANTIQUITY* AND *LATIN AMERICAN ANTIQUITY* (1962-2012)

Ellery Frahm
Department of Archaeology, The University of Sheffield

Last spring, I submitted a proposal to edit a new volume in the SAA Reader series. These books compile foundational and influential articles from *American Antiquity* and *Latin American Antiquity* involving a central theme. For example, there are readers on lithic technology, religion and ideology, archaeological theory, ceramic analysis, dating techniques, and so on. I proposed a volume on New World obsidian studies with an integrated perspective. The book would include not only obsidian sourcing and dating but also technology, quarrying, use-wear, craft production, and more. Furthermore, it would focus on the archaeological applications and interpretations of obsidian studies, not analytical techniques themselves or reports on source characterisation. The title of this paper was that of the proposed reader.

There were three reasons, I argued to SAA Press, to publish such a volume now. First, it has been almost 15 years since the last edited book on obsidian studies that covered a significant portion of the world, and there has never been a book on obsidian research that offers a historical perspective, from the foundational studies of 1960s until the current day. Additionally, other than site reports, there have been no books that cover sourcing, dating, and lithic technology together. Thus I proposed a book that followed artefacts' use-histories from acquisition and distribution to tool manufacture and post-depositional processes.

Second, 2012 marks the 50th anniversary of the first successful obsidian sourcing study (Renfrew and Cann started their spectroscopic analyses of Aegean obsidians in 1962), and 2014 will be the 50th anniversary of its publication. Furthermore, 2014 will be the 25th anniversary of the International Association for Obsidian Studies, which grew out of an organisational meeting at the 1989 Society for California Archaeology conference.

Third, obsidian research is nearing a crossroads today. A push over the last decade or two for approaches with high anthropological significance has been largely overshadowed by debates regarding analytical issues and instrumentation advancements, in particular the debates regarding portable X-ray fluorescence analysers. *American Antiquity* and *Latin American Antiquity* have a history of anthropologically significant applications and a corpus of obsidian research focused on archaeological interpretations, not analytical details.

Since research published in those journals primarily involves the Americas, I proposed to focus on New World obsidian studies. Additionally, the Americas is the largest regional focus of SAA members, so a choice to focus on New World obsidian studies would engage the interests of this majority. Furthermore, a New World focus also reflects the largest regional interest of SAA members engaged in obsidian research. The 2012 SAA conference in Memphis had two sessions sponsored by the IAOS, including a poster session titled "Obsidian Studies Across the Americas: Alaska to Argentina and Beyond." In both sessions, the presentations all involved the Americas. In addition, the 2013 SAA meeting in Honolulu will have the IAOS-sponsored session "Obsidian Characterization in the Pacific Ring of Fire."

Such a reader, I argued, could have broad appeal, particularly with an integrated approach that included topics such as lithic technology, use-wear analysis, and quarrying. A primary focus on the archaeological interpretations and applications would broaden the appeal beyond obsidian specialists to New World archaeologists in general. Demonstrating a variety of applications, like reconstructing the organisation of production, mobility and resource territories of hunter-gatherer groups, and economic systems of complex societies, would reveal the breadth of obsidian studies and the types of anthropological issues with which it can engage. A historical perspective would show how obsidian studies articulates with archaeological thought and its history, such as its role in the development of central place theory.

After I submitted this proposal, I learned that sales of the existing volumes were not very good (which, I suppose, is unsurprising given that all but the very latest articles are available for download via JSTOR), and SAA Press did not expect to publish any new readers. In short, I was told that the proposal was essentially dead on arrival.

As a part of the proposal, I prepared a list of 30 articles published between 1962 and 2012 in *American Antiquity* and *Latin American Antiquity.* The list included the most influential, most archaeologically important, and most cited articles from the last fifty years. Crabtree's paper, for example, has been cited in over 110 articles, according to Google Scholar. Including a variety of applications was another criterion for the list. From this list, I ultimately would have chosen half to two-thirds of the papers to be included in final reader.

Below is my list (with stable URLs) so that, if interested, one can download these articles as a virtual reader (one unauthorised by SAA Press, of course). Hopefully this virtual reader can be of some use as an introduction to archaeological obsidian research, perhaps giving students a concise overview of its various aspects and applications.

1962
Blades and Cores in Oregon
D. E. Dumond
American Antiquity 27(3):419-424
http://www.jstor.org/stable/277807

1967
The Obsidian Industry of Teotihuacan
Michael W. Spence
American Antiquity 32(4):507-514
http://www.jstor.org/stable/2694078

1968
Mesoamerican Polyhedral Cores and Prismatic Blades
Don E. Crabtree
American Antiquity 33(4):446-478
http://www.jstor.org/stable/278596

1969
Identification of the Sources of Hopewellian Obsidian in the Middle West
James B. Griffin, A. A. Gordus, and G. A. Wright
American Antiquity 34(1):1-14
http://www.jstor.org/stable/278309

1976
Classic Maya Obsidian Trade
Raymond V. Sidrys *American Antiquity* 41(4):449-464
http://www.jstor.org/stable/279011

1981
Obsidian Production and the State in Teotihuacan
Michael W. Spence
American Antiquity 46(4):769-788
http://www.jstor.org/stable/280105

1982
Toward a More Comprehensive Model of Interregional Commodity Distribution: Political Variables and Prehistoric Obsidian Procurement in Mesoamerica Robert N. Zeitlin *American Antiquity* 47(2):260-275
http://www.jstor.org/stable/279900

1984
Tikal Obsidian: Sources and Typology Hattula Moholy-Nagy, Frank Asaro, and Fred H. Stross
American Antiquity 49(1):104-117
http://www.jstor.org/stable/280515

Trace Element Analysis of Obsidian Artifacts from a Classic Maya Residential Group at Nohmul, Belize Norman Hammond, Mary D. Neivens, and Garman Harbottle
American Antiquity 49(4):815-820
http://www.jstor.org/stable/279747

1987
The Chipped Stone Industry of Cihuatan and Santa Maria, El Salvador, and Sources of Obsidian from Cihuatan
William R. Fowler, Jr., Jane H. Kelley, Frank Asaro, Helen V. Michel, and Fred H. Stross
American Antiquity 52(1):151-160
http://www.jstor.org/stable/281066

1988
Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study M. Steven Shackley *American Antiquity* 53(4):752-772
http://www.jstor.org/stable/281117

1990
Hopewell Obsidian Studies: Behavioral Implications of Recent Sourcing and Dating Research
James W. Hatch, Joseph W. Michels, Christopher M. Stevenson, Barry E. Scheetz, and Richard A. Geidel
American Antiquity 55(3):461-479
http://www.jstor.org/stable/281278

1992
Another Look at Hopewell Obsidian Studies
Richard E. Hughes
American Antiquity 57(3):515-523
http://www.jstor.org/stable/280939

1993
The Obsidian Hydration Dating Project at Copan: A Regional Approach and Why It Works
David Webster, AnnCorinne Freter, and David Rue
Latin American Antiquity 4(4):303-324
http://www.jstor.org/stable/972070

1994
An Initial Consideration of Obsidian Procurement and Exchange in Prehispanic Ecuador
Richard L. Burger, Frank Asaro, Helen V. Michel, Fred H. Stross, Ernesto Salazar
Latin American Antiquity 5(3):228-255
http://www.jstor.org/stable/971882

1995
Microwear Analysis in the Southeast Maya Lowlands: Two Case Studies at Copan, Honduras
Kazuo Aoyama
Latin American Antiquity 6(2):129-144
http://www.jstor.org/stable/972148

1996
Commodity or Gift: Teotihuacan Obsidian in the Maya Region
Michael W. Spence
Latin American Antiquity 7(1):21-39
http://www.jstor.org/stable/3537012

Central-Place Analyses in the la Entrada Region, Honduras: Implications for Understanding the Classic Maya Political and Economic Systems
Takeshi Inomata and Kazuo Aoyama
Latin American Antiquity 7(4):291-312
http://www.jstor.org/stable/972261

1998
Lines in the Sand: Competition and Stone Selection on the Pajarito Plateau, New Mexico
Michael R. Walsh
American Antiquity 63(4):573-593
http://www.jstor.org/stable/2694109

1999
Mexican Obsidian at Tikal, Guatemala
Hattula Moholy-Nagy
*Latin American Antiquit*y 10(3):300-313
http://www.jstor.org/stable/972032

2000
Determining the Geological Provenance of Obsidian Artifacts from the Maya Region: A Test of the Efficacy of Visual Sourcing
Geoffrey E. Braswell, John E. Clark, Kazuo Aoyama, Heather I. McKillop, and Michael D. Glascock
Latin American Antiquity 11(3):269-282
http://www.jstor.org/stable/972178

2003
Lithic Source Use and Paleoarchaic Foraging Territories in the Great Basin
George T. Jones, Charlotte Beck, Eric E. Jones, Richard E. Hughes
American Antiquity 68(1):5-38
http://www.jstor.org/stable/3557031

Source Attribution and the Utilization of Obsidian in the Maya Area
Hattula Moholy-Nagy
Latin American Antiquity 14(3):301-310
http://www.jstor.org/stable/3557561

2004
Preclassic Obsidian Procurement and Utilization at the Maya Site of Colha, Belize
David O. Brown, Meredith L. Dreiss, and Richard E. Hughes
Latin American Antiquity 15(2):222-240
http://www.jstor.org/stable/4141555

2007
Reduction Strategies and Geochemical Characterization of Lithic Assemblages: A Comparison of Three Case Studies from Western North America
Jelmer W. Eerkens, Jeffrey R. Ferguson, Michael D. Glascock, Craig E. Skinner, and Sharon A. Waechter
American Antiquity 72(3):585-597
http://www.jstor.org/stable/40035862

Formative and Classic Period Obsidian Procurement in Central Mexico: A Compositional Study Using Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry
David M. Carballo, Jennifer Carballo, and Hector Neff
Latin American Antiquity 18(1):27-43
http://www.jstor.org/stable/25063084

2008
The Economy of Supply: Modeling Obsidian Procurement and Craft Provisioning at a Central Mexican Urban Center Kenneth G. Hirth
Latin American Antiquity 19(4):435-457
http://www.jstor.org/stable/25478243

2011
Quarrying Evidence at the Quispisisa Obsidian Source, Ayacucho, Peru
Nicholas Tripcevich and Daniel A. Contreras
Latin American Antiquity 22(1):121–136
http://www.metapress.com/content/h013158r2u6122q2/

Obsidian Source Use in the Greater Yellowstone Area, Wyoming Basin, and Central Rocky Mountains
Laura L. Scheiber and Judson Byrd Finley
American Antiquity 76(2):372–394
http://www.metapress.com/content/v871224423455hj6/

2012
Reconsidering Paleoarchaic Mobility in the Central Great Basin
George T. Jones, Lisa M. Fontes, Rachel A. Horowitz, Charlotte Beck, and David G. Bailey
American Antiquity 77(2):351-367 http://www.metapress.com/content/uh2q350163516424/

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

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Kyle Freund
IAOS
c/o McMaster University
Department of Anthropology
Chester New Hall Rm. 524
1280 Main Street West
Hamilton, Ontario, Canada
L8S 4L9
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Membership inquiries, address changes, or payment questions can also be emailed to freundkp@mcmaster.ca

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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
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IAOS
c/o McMaster University
Department of Anthropology
Chester New Hall Rm. 524
1280 Main Street West
Hamilton, Ontario, Canada
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