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NEWS AND INFORMATION

NEWS AND NOTES

Have news or announcements to share? Send them to IAOS.Editor@gmail.com for the next issue of the *IAOS Bulletin.*

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!

ELECTIONS

The time has come to vote for our next IAOS President-Elect. Please take a look at the candidate's statement is presented on page four of this issue of the *IAOS Bulletin.* Voting will be conducted via email and the winner announced at the IAOS annual meeting during the Society for American Archaeology meetings in Vancouver this spring. To cast your vote, please send an email to IAOS President, Rob Tykot at rtykot@usf.edu before March 1, 2017.

NOTES FROM THE PRESIDENT

I hope you all have had a good and productive 2016. I have continued using a portable XRF to non-destructively analyze obsidian artifacts in museums and storage units, adding to what is now a very large database that may be used to address several research questions about distribution, transportation methods and frequency, and changes over time in the prehistoric Mediterranean. Over the past decade, I first used the Bruker III-V and since 2012 the III-SD; both were just perfect for distinguishing all of the Mediterranean island sources, and all of the subsources on the most important islands of Sardinia, Lipari, and Melos. The stronger beam on the III-SD model allowed even shorter analysis times for quantitative results; working with a colleague, we could do as many as 200 artifacts in one day, including basic descriptive information and photographs.

I have just tested and purchased the latest pXRF model, the Bruker 5i, which really seems to be the next generation. While they are still removing kinks and improving the operating software, it allows higher kV (50) and microamps (35) than before, along with a much more sensitive detector, potentially to provide results for rare earth elements such as Cs, Ba, and La (see Figure 1). Sodium is also now measurable, so all major/minor elements may be tested. I think that for obsidian studies this may resolve any limitations of the pXRF when compared with desktop or full-size XRF instruments. A wireless remote control and a 20-sample autochamber are very nice, while choice of beam size (8, 5, 1 mm) is really great when dealing with heterogeneous materials (e.g. ceramics).

Of course doing sourcing analysis is only one part of obsidian studies. Without techno-typology information, it is difficult to interpret production location and methods, while without use-wear studies deciphering the initial purpose and actual usage of the artifacts is limited. Some of the older obsidian collections that I have analyzed have limited contextual information, which is ideal for comparing usage in residential vs. burial and ritual locations.

Following the international obsidian conference held on Lipari this past June, Katalin Biró and András Markó have organized the 2nd International Obsidian Conference, to be held in Hungary in late May 2019. Further information will be posted on the IAOS and other websites, but the three-day conference will be held one day in Budapest (Hungarian National Museum) and the other two at the Rákóczi Museum in Sárospatak, along with excursions to the Carpathian 1 (Slovakian) and Carpathian 2 (Hungarian) obsidian sources.

Rob Tykot in Florence, Italy.

Robert H. Tykot, IAOS President
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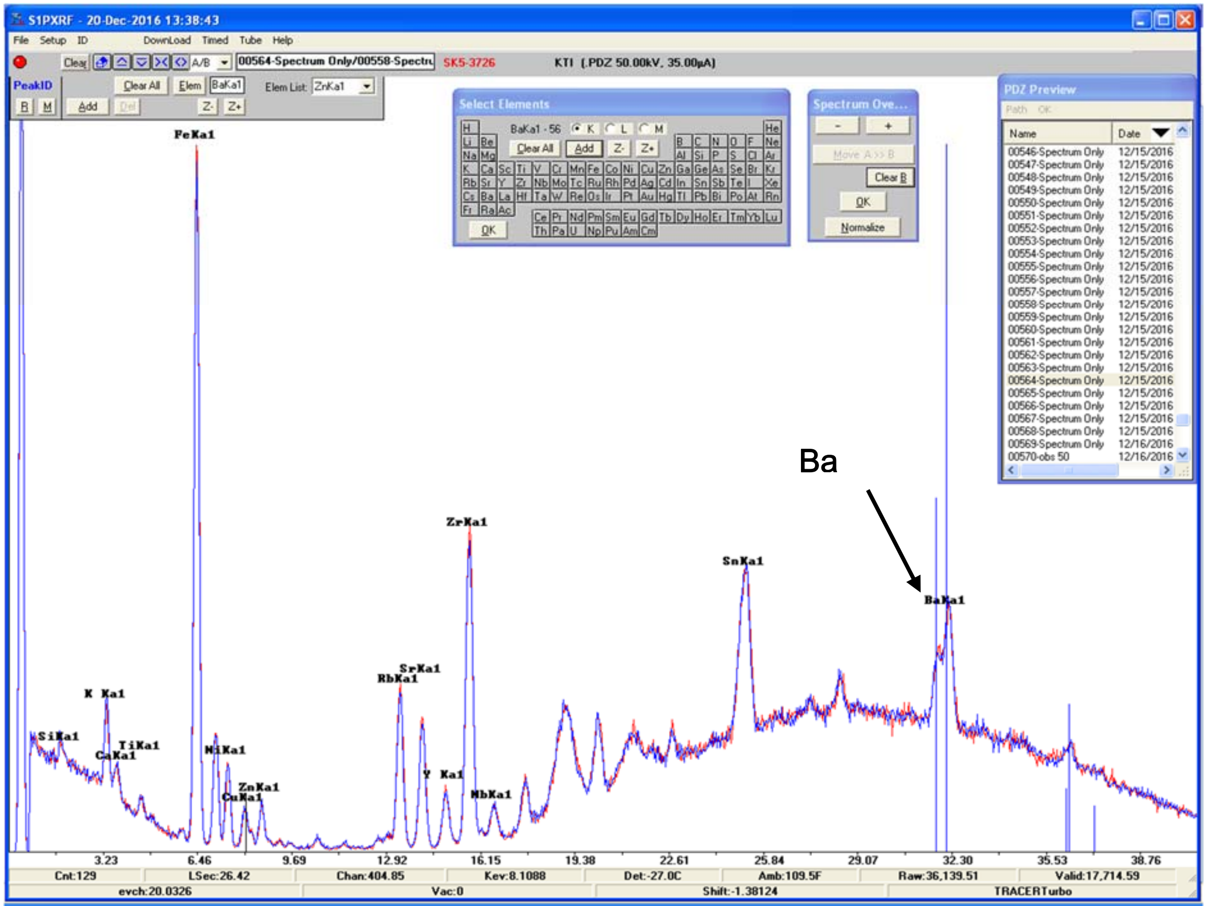
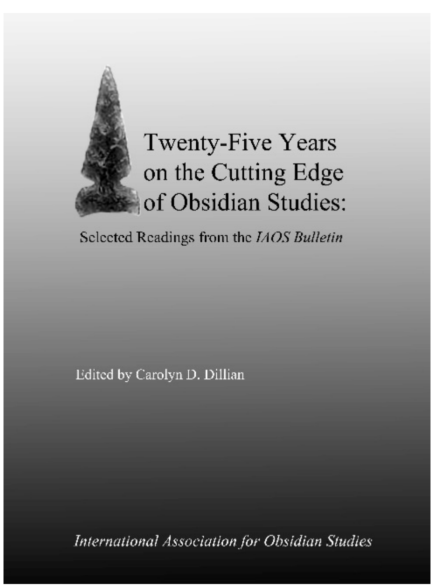


Figure 1. Spectra of two samples (depicted as red and blue above) from the same source (with high Ba values) analyzed with the Bruker 5i pXRF instrument.



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.

Candidate's Statement
IAOS President

Dr. Kyle Freund

I am currently an Assistant Professor of Anthropology at Indian River State College (Florida) whose primary research centers on prehistoric farming communities of the Central Mediterranean, with an emphasis on the reflexive relationship between material culture and long-term social processes. I have been working with and publishing on obsidian from the Mediterranean for the past eight years, having completed my Ph.D. at McMaster University in 2014 with former IAOS President Tristan Carter. Before that, I received my Masters degree from the University of South Florida working with current IAOS President Robert Tykot.

From 2011-2015, I served as your IAOS Secretary/Treasurer and had the opportunity to meet and correspond with a wide cross-section of the membership, an experience I found extremely rewarding and one that I look forward to building upon as President. Over the past several years IAOS has worked hard to provide valuable resources to its members, both within the U.S. and beyond, and I hope to expand these efforts in the future. Most recently this includes maintaining an up-to-date pdf library of global obsidian studies on our website as well as publishing an edited volume of articles from the *Bulletin*. Our continued sponsorship of workshops and events such as the International Obsidian Conference on the island of Lipari in 2016 and the "pXRF Shootout" in 2012 are also providing us with global perspectives on obsidian research as well as relevant results to those concerned about proper protocols for rapidly expanding technology. As IAOS President, I would also continue to collaborate with our membership to organize regular sessions at the SAAs, and perhaps elsewhere, in turn promoting the significance of our work to a wider academic audience.

Nevertheless, while expanding the scope of IAOS is important, it is just as important to remain true to the initial goals set forth in the IAOS by-laws, including the establishment of a "forum from which current issues and advances in the study of natural glasses may be presented and discussed," promoting awareness of "problems and potentials of the application of techniques from the physical and natural sciences in archaeology and geology."

I encourage you to explore some of my publications and presentations through the link below.

https://irsc.academia.edu/KyleFreund

HYDRATION RATES FOR CASA DIABLO AND FISH SPRINGS OBSIDIANS, EASTERN CALIFORNIA

Alexander K. Rogers
Maturango Museum

Abstract
This paper reports a computation of hydration rates for Casa Diablo and Fish Springs obsidians from eastern California. The computation is based on projectile point data from Tulare Lake and a known rate for Coso West Sugarloaf obsidian. The points, all Tulare Lake Wide Stemmed, are sourced to Coso West Sugarloaf (N=3), Casa Diablo Lookout Mountain (N=6), Casa Diablo Sawmill Ridge (N=16), and Fish Springs (N=5). The hydration rate of each obsidian source can be computed by assuming that the projectile points were manufactured at approximately the same time, irrespective of obsidian source; they experienced similar temperature histories; the hydration rate for Coso West Sugarloaf is known (18.14 μ^2/1000 years at 20ºC); and the growth of the hydration rim is proportional to the square-root of time. Resulting rates are 13.04 μ^2/1000 years for Casa Diablo Lookout Mountain, 12.70 μ^2/1000 years for Casa Diablo Sawmill Ridge, and 11.87 μ^2/1000 years for Fish Springs, all at a reference temperature of 20°C.

Introduction

This paper reports the computation of hydration rates for Casa Diablo and Fish Springs obsidians based on projectile point data from Tulare Lake and a known rate for Coso West Sugarloaf obsidian. The obsidian sources are located in eastern California. Data from Tulare Lake provide hydration rim measurements and XRF source determinations for a set of Tulare Lake Wide Stemmed projectile points. The points are sourced to Coso West Sugarloaf (N=3), Casa Diablo Lookout Mountain (N=6), Casa Diablo Sawmill Ridge (N=16), and Fish Springs (N=5).

Hall and Jackson (1989) presented an exhaustive summary of studies of hydration rates of Casa Diablo obsidians known at the time of their publication. The approach they used was to estimate rates based on temporally-sensitive projectile points. Unfortunately, the work predates the development of mathematical methods for correcting for effective hydration temperature, including effects of burial depth (Hull 2001; Rogers 2007). Furthermore, the analysis employed functional forms for the hydration equation which are at variance with the physics and chemistry of hydration. The data of Hall and Jackson are not considered further here.

Bettinger (1989) developed a rate for Fish Springs obsidian by a similar technique. However, he assumed a linear form for the equation and did not account for temperature, so his results are again not based on physics and are not considered here.

Analytical Approach

The analysis in the current study uses an approach which explicitly accounts for temperature and subsource. The hydration rate for Coso West Sugarloaf obsidian is known to be 18.14 μ^2/1000 years at 20ºC (revised from Rogers 2011). The hydration rates for the other sources can be computed analytically by assuming that the sample projectile points were manufactured at approximately the same time, irrespective of obsidian source; that they experienced similar temperature histories; and that the growth of the hydration rim is proportional to the square-root of time (Doremus 2002).

Casa Diablo Lookout Mountain		Casa Diablo Sawmill Ridge		Fish Springs		Coso West Sugarloaf	
Cat. No.	Mean, µ	Cat. No.	Mean, µ	Cat. No.	Mean, µ	Cat. No.	Mean, µ
DRL2JH5	10.45	DRL2JH4	10.05	DRL2JH2	9.59	DRL4JH22-1	11.89
DRL4JH20	10.63	DRL2JH7-1	7.92**	DRL2JH-1	9.68	DRL4JH22-2	12.63
DRL4JH21-1	9.52	DRL2JH-2	10.17	DRL2JH3-2	10.00	DRL3JH33	11.93
DRL4JH21-1	10.50	DRL2JH8-1	9.29	DRL4JH23	10.00	DR11W6164	12.01
DRL3JH36	10.59	DRL2JH8-2	10.02	DRL3JH34-1	9.55		
DRL4JH38-1	12.44*	DRL2JH11	10.01	DRL3JH34-2	10.02		
DRL4JH38-2	14.04*	DRL4JH13	6.17*	DRL4JH37	9.59		
DRL3JH39-1	8.98	DRL4JH14-1	9.32				
DRL3JH39-2	9.54	DRL4JH14-2	9.99				
DRL3JH39-3	9.89	DRL4JH15	10.50				
		DRL4JH18	9.99				
		DRL4JH19	9.28				
		DRL4JH24-1	10.52				
		DRL4JH24-1	11.47				
		DRL2JH26-1	9.00				
		DRL2JH26-2	10.53				
		DRL2JH27	10.53				
		DRL2JH29	10.30				
		DRL4JH30	10.50				
		DRL4JH31	8.01**				
		DRL3JH35	9.95				

Table 1. Analysis data set, TLWS points from Tulare Lake.
* Removed by Chauvenet's criterion;
** removed judgmentally; hyphenated numbers indicate successive cuts on one specimen.

The data set employed for the analysis is from the Tulare Lake Archaeological Research Group (Alan Garfinkel, personal communication). The obsidian subsources were determined by XRF, and each obsidian subsource was treated separately for purposes of analysis. Two data points were removed from consideration by Chauvenet's criterion, one each from Casa Diablo Lookout Mountain and Casa Diablo Sawmill Ridge. In addition, two more were removed judgmentally from the Sawmill Ridge data set because they seem so small that they probably represent later rework of the point. They are archaeologically valid, but are not germane to this analysis, which addresses the initial manufacturing episode. Table 1 presents the resulting data set.

Mean and standard deviation for each source were then computed, resulting in the data presented in Table 2.

Performing a Student's t-test on the rim data for the Casa Diablo Lookout Mountain and Casa Diablo Sawmill Ridge samples shows them to be statistically indistinguishable at the 5% confidence level, and combining the data sets would be justified. However, they are from physically and chemically distinct sources, and the Lookout Mountain sample size is small, so separate rates were computed for each subsource. Coso West Sugarloaf is a geochemically distinct subsource of Coso

Statistic	Casa Diablo Lookout Mountain	Casa Diablo Sawmill Ridge	Fish Springs	Coso West Sugarloaf
Mean, μ	10.23	10.10	9.76	12.07
S. D., μ	0.44	0.43	0.16	0.14
N	5	14	5	3

Table 2. TLWS statistics by obsidian source.

obsidian. There are no subsources recognized for Fish Springs obsidians.

The analysis process is based on the hydration equation

$$r^2 = kt \quad (2)$$

where r is the hydration rim measurement, t is age, and k is the hydration rate. If we assume that the sample points are of the same age, regardless of obsidian source, that they have experienced the same temperature history, and that we know the hydration rate of one source such as Coso West Sugarloaf, then the hydration rate of any other source is

$$k = k_{WSL} \times (r/r_{WSL})^2 \quad (3)$$

The value of r_{WSL} is 18.14 u^2/1000 years at 20°C.

Since the rate for Coso West Sugarloaf is for an effective hydration temperature (EHT) of 20ºC, the rim data must also be converted to the same EHT. The EHT for the Tulare Lake area can be computed based on meteorological data from nearby Hanford, California. Since there is virtually no elevation relief in this part of the San Joaquin Valley, and no break in weather patterns, the Hanford data should be applicable. Thirty-year temperature data were downloaded from the website of the Western Regional Climate Center as a basis for computation (Table 3).

The parameters needed for computing EHT are average annual temperature (T_a), annual variation (V_a, hottest-month mean minus coldest-month mean), and mean diurnal variation (V_d) (Rogers 2007). Table 4 presents the values of these parameters for Hanford, computed from Table 3.

Effective hydration temperature was computed by numerical integration of the temperature variation of hydration rate (Rogers 2007), which yields a specimen EHT of 19.98ºC. The difference between this and 20°C is only 0.02º C and could probably be ignored, but was taken into account here.

The rim values can be converted to an EHT of 20ºC by the equation

$$r = r_{20} \times \exp(-10000/(EHT_r + 10000/EHT_s) \quad (4)$$

where EHT_r is the reference EHT of 20°C and EHT_s is the specimen EHT of 19.98 °C. The

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Max, deg F	54.0	61.0	67.6	74.4	83.1	90.7	96.1	95.1	89.4	79.4	63.1	54.3
Avg. Min, deg F	36.4	40.0	44.1	48.1	54.7	60.4	64.4	62.8	57.8	49.8	39.9	35.9

Table 3. Temperature data for Hanford 1S, station 043747; 1981 - 2010.

Parameter	Value
Average annual	17.00
Annual variation	15.56
Mean diurnal variation	14.53

Table 4. Temperature Parameters for Hanford, California, in °C

procedure now is to correct the hydration rim data of Table 2 to an EHT of 20°C by equation (4), and then to compute hydration rate by equation (3). Table 5 summarizes the computational process.

Discussion

It is important to highlight some unknowns and caveats about these artifacts. All were recovered from the Tulare Lake area in the central San Joaquin Valley of California, from the region of terminal Pleistocene-early Holocene Lake Tulare. Numerous Paleoindian period artifacts have been recovered from the area, including Great Basin Concave Based points and crescents (Hopkins 2008), so artifacts of this age are not unusual. The land is currently agricultural, and no formal excavations have ever been conducted; the artifacts were recovered by interested professional and avocational archaeologists, and were brought to the surface as a result of plowing. The artifacts thus were in the "plow zone" at shallow depth. The analysis here assumes the depth was shallow enough to make the burial depth effect on EHT negligible. Further, since provenience is unknown, or was homogenized by plowing, it is assumed that the specimens all experienced virtually the same temperature history.

The temperature history was inferred from weather records from Hanford, California, and is based on a 30-year data set. The assumption is made that use of current data gives a reasonable representation of climate over the archaeological past. It is well known that temperature regimes have varied in the past (West et al. 2007), but it has been shown that no correction is necessary for artifact ages less than approximately 13,000 cal years (Rogers 2015). Thus, no paleotemperature correction was applied here.

Tulare Lake Wide Stemmed points are morphologically similar to the Borax Lake type (Justice 2002: 101). A cultural assumption was made that the specimens were manufactured over a short period of time relative to their age, and that all were manufactured at essentially the same time. It is known that obsidian from sources in eastern California such as Coso were exploited by at least 11,000 years ago and traded or exchanged toward the Central Valley and the coast (Erlandson 2011), and it is likely that sources at Fish Springs and Casa Diablo were similarly exploited and traded. It has been further argued that the trade or exchange of

Source	Rim @ 19.98ºC, μ	Rim @ 20.0ºC, μ	Rate @ 20.0ºC, μ^2/1000 yrs
Coso West Sugarloaf	12.07	12.09	18.14
Casa Diablo Lookout Mountain	10.23	10.25	13.04
Casa Diablo Sawmill Ridge	10.10	10.12	12.70
Fish Springs	9.76	9.78	11.87

Table 5. Hydration rate in μ^2/1000 years from Tulare Lake data.

obsidian was a major endeavor (Gilreath and Hildebrandt 2011), so it is not surprising to find large numbers of obsidian artifacts at Tulare Lake. The Borax Lake point type is stated to have had a long duration of use (6000 – 3000 BC or 8000 – 5000 BP; see Justice 2002: 101). Unfortunately, little is known about the temporal duration of the Tulare Lake Wide Stemmed point series itself.

No measurements have been made of intrinsic water content for the Casa Diablo or Fish Springs obsidian sources, so the intra-source variability of the rates cannot be assessed. For Coso it ranges between 15% and 20% (Stevenson et al. 1993), and it is likely that the variability in the other sources is similar.

These rates should be treated with caution, as they are based on a relatively small sample size. In applying the rates it is vitally important to correct both hydration rate and rim data to the same EHT; furthermore, the correction must be by the method described above for Hanford, and not by the Lee equation (which gives incorrect results) or by rules of thumb. Application of the rates of Table 5 to age estimation must be done by equation (2), which can be rearranged as

$$t = r^2/k \quad (5)$$

No other form of the age equation is valid.

Finally, this analysis explicitly links the hydration rates of the Coso West Sugarloaf, Casa Diablo Lookout Mountain, Casa Diablo Sawmill Ridge, and Fish Springs subsources. The subsequent mathematical analysis is valid given the assumptions and follows the current understandings of the physics and chemistry of hydration, but if any of the analytical assumptions are incorrect, the rates will need to be reassessed.

Conclusions

This analysis has derived values for the hydration rates of Casa Diablo and Fish Springs obsidian from archaeological data. The best estimates are: rate for Casa Diablo Lookout Mountain = 13.04 μ^2/1000 years; rate for Casa Diablo Sawmill Ridge = 12.70 μ^2/1000 years; and rate for Fish Springs = 11.87 μ^2/1000 years (all at an EHT of 20°C.) These rates are significantly slower than typical rates from the Coso volcanic field, which range from 18 – 27 μ^2/1000 years at 20°C. Intra-source variability in hydration rate due to intrinsic water content is probably on the order of 15 - 20%, although no data are available.

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IS THERE MAHOGANY OBSIDIAN IN NORTHEASTERN SONORA, MEXICO?

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Abstract
A piece of mahogany obsidian came to the attention of the senior author during an excavation project near the town of Mata Ortiz, Chihuahua, Mexico in 2015. Because mahogany obsidian in northwestern Mexico is particularly rare, the question was raised, from what obsidian source did this sample derive? Using energy-dispersive X-ray fluorescence (EDXRF) spectrometry, we demonstrate it comes from the Agua Fria obsidian source in northeastern Sonora, Mexico. Unfortunately, we do not know where this sample was collected. We discuss these results and the significance of this find in this paper, but more investigation is certainly warranted.

Introduction

Many obsidian sources exist throughout the diverse Mexican Northwest and the U.S. Southwest landscape (Shackley 2005). Obsidian is either opaque or translucent, and the color is primarily black but can be a blackish-gray, brown, and most rare is mahogany (LeTourneau and Steffen 2002; Shackley 2005). The color of obsidian depends on varying levels of oxidation, temperature, and elemental composition when it forms. For example, high concentrations of Fe give obsidian flakes a greenish or brownish color. Mahogany obsidian is a combination of a reddish/brown and black color. Fragments of mahogany color occur in various obsidian sources, but these are numerically rare (Shackley 2005). Although mahogany obsidian is extremely scarce in northern Mexico or the U.S. Southwest, LeTourneau and Steffen (2002) documented a mahogany variety of Cerro del Medio (Valles Rhyolite) obsidian in the Valles Caldera located in the Jemez Mountains of north-central New Mexico. Folsom artifacts made of this mahogany Cerro del Medio obsidian were found near Albuquerque, New Mexico. This mahogany variety has the same geochemical fingerprint as the black or translucent gray variety of Cerro del Medio obsidian (LeTourneau and Steffen 2002; see also Letourneau et al. 1996; Steffen 2005).

A piece of mahogany obsidian came to the attention of the senior author during an excavation project near the town of Mata Ortiz, Chihuahua in 2015. Since mahogany obsidian in this part of the world is particularly rare, we raised the question, from which obsidian source did this mahogany sample derive? Using energy-dispersive X-ray fluorescence (EDXRF) spectrometry, the sample sourced to the Agua Fria primary outcrop in northeastern Sonora. In this paper, we briefly discuss the significance of this find.

Obsidian in Northern Mexico

Less is understood about obsidian in northwestern Mexico in the states of Chihuahua and Sonora compared to north of the border where most of the obsidian sources are geochemically and geographically known (Shackley 2005:76-85). Fortunately, however, research has increased in the past decade or so concerning obsidian geochemistry and the prehispanic use of this extremely sharp volcanic glass (Darling 1993, 1998; Dolan

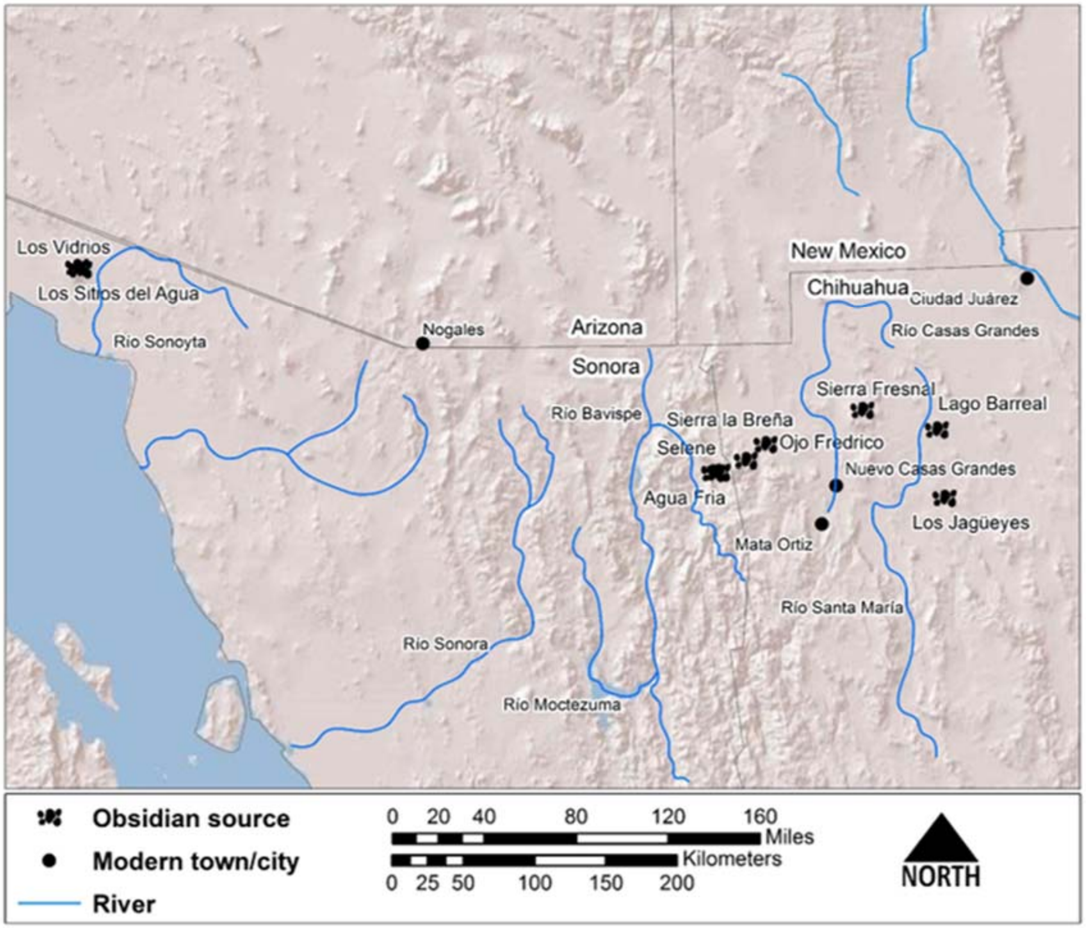

Figure 1. Known obsidian sources in Chihuahua and Sonora.

2016; Fralick et al. 1998; Kibler et al. 2014; Martynec et al. 2011; Pailes 2016; Shackley 2005; Vierra 2005). As of now, there are five known obsidian sources in Chihuahua: Sierra Fresnal, Lago Barreal, Los Jagüeyes, Sierra la Breña, and Ojo Fredrico, and four in Sonora: Los Vidrios, Los Sitios del Agua, Selene, and Agua Fria (Figure 1) (Kibler et al. 2014; Martynec et al. 2011; Shackley 2005). There are also two unknown obsidian sources likely somewhere in Chihuahua, as they are tentatively called Chihuahua Unknown A and B, but they could be located elsewhere. There is also another unknown source that is simply labeled as unknown. People in northwestern Chihuahua used the three unknown sources to manufacture expedient stone tools (Dolan 2016; Vierra 2005). More archaeological and geoarchaeological pedestrian survey is required to determine the primary and secondary source location of all unknowns. Also, although the primary outcrop of Antelope Wells obsidian is not in northwestern Mexico but in extreme southwestern New Mexico in the boot heel, this obsidian extends at least 15 to 20 km south into Chihuahua where it is known as El Berrendo obsidian (Findlow and Bolognese 1980; Shackley 2005:57).

The Mahogany Obsidian Piece

The mahogany obsidian piece came to the attention of the senior author while he was in Chihuahua in 2015. Mr. Juan Quezada, the world-renowned potter from Mata Ortiz, collected it south of Mata Ortiz during one of his hikes. There was no evidence of knapping

Figure 2. The mahogany obsidian piece after sourcing analysis.

or cultural modification on the sample before EDXRF analysis. While Figure 2 illustrates the sample as being approximately seven cm in length, the original piece shown in Figure 3 was larger. We flaked pieces off for sourcing and to keep part of it in Chihuahua. We also noticed the material quality was not as high as other obsidian sources in the NW/SW, but due to its distinctive mahogany color and the fact that this sample was larger than most from northwestern Mexico, an EDXRF analysis was deemed necessary to determine the source.

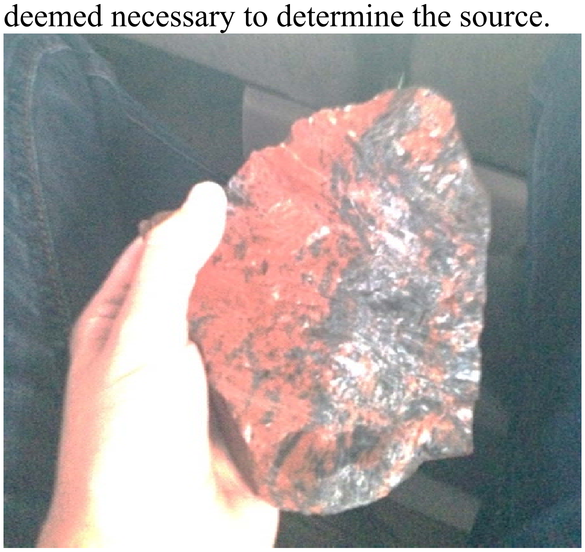

Figure 3. The original un-flaked piece.

EDXRF Spectrometry

EDXRF spectrometry is an established technique to characterize the trace elements of obsidian to determine the primary source outcrop. It is non-destructive to the artifact with little sample preparation, many universities and labs have EDXRF machines, and it is cost-efficient (Glascock 2011; Shackley 2011). The mahogany sample was analyzed using a ThermoScientific *Quant'X* EDXRF spectrometer at the Geoarchaeological XRF Laboratory in Albuquerque, New Mexico (Shackley 2015).

The results presented below are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate X-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). In other terms, these data through the analysis of international rock standards, allow for instrument comparison with a predictable degree of certainty (Hampel 1984; Shackley 2011).

The analysis for mid Zb condition elements Ti-Nb, Pb, Th, the x-ray tube is operated at 30 kV, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity Ka-line data for elements titanium (Ti), manganese (Mn), iron (as $Fe_2O_3^T$), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). Not all these elements are reported since their values in many volcanic rocks are very low. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian

Sample	Ti	Mn	Re	Rb	Sr	Y	Zr	Nb	Ba	Source
Chihuahua 1	1609	345	10421	200	90	31	271	14	116	Agua Fria
RGM1-S4	1613	288	13328	145	109	22	211	6	821	Standard

Table 1. Elemental concentrations for the archaeological sample and USGS RGM-1 Rhyolite Standard. All measurements in parts per million (ppm).

Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements. When barium (Ba) is acquired in the High Zb condition, the Rh tube is operated at 50 kV and up to 1.0 mA, ratioed to the bremsstrahlung region (see Davis et al. 2011; Shackley 2011).

The data from the WinTrace software were translated directly into Excel for Windows software for manipulation and on into SPSS for Windows for statistical analyses. To evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 a USGS obsidian standard is analyzed during each sample run for obsidian artifacts to check machine calibration (Table 1). Source assignment of the mahogany sample was made with reference to Shackley (1995, 2005).

Results and Discussion

The elemental concentrations of the mahogany piece match the Agua Fria obsidian source (Tables 1 and 2). According to Shackley (2005), the Agua Fria source appears to be chemically diverse, but it is obviously derived from the same magma source (Table 2). Although not likely, we caution, however, it is possible that this mahogany sample represents a source that is nearly elementally identical to Agua Fria.

The Agua Fria obsidian source is located approximately 50 km south of the Arizona border (Figure 1). This is a considerable distance from south of Mata Ortiz where it reportedly was found. Agua Fria is a Tertiary period source, and the material quality appears to be excellent for tool production. Nodule size is around five cm in diameter. The color is black to brown-black, aphyric and vitreous, and some flakes exhibit banding, but this study also shows there may be a mahogany variety.

We were intrigued with the result of Agua Fria for the source of this mahogany piece. Mahogany samples were not part of the 19 Agua Fria samples Shackley (2005:79-80) analyzed for John Douglas during an earlier archaeological investigation along the Río Bavispe and Río Huachineras in Sonora. Artifacts made from Agua Fria obsidian do show up in some obsidian assemblages in northern Chihuahua and Sonora, but no mahogany flakes have been reported (Dolan 2016; Douglas and Quijada 2005).

Element	Minimum	Maximum	Mean	Std. Error	Standard Deviation
Rb	208	252	237.2	2.4	10.443
Sr	72	118	88.84	2.78	12.13
Y	32	34	32.89	0.15	0.658
Zr	158	261	190.4	5.7	24.825
Nb	20	22	21.05	0.09	0.405
Ba	454	1004	619.2	31.56	137.547

Table 2. EDXRF concentrations for Agua Fria, Sonora (from Shackley 2005:Table A.13)

The question remains, however, if the primary outcrop of Agua Fria obsidian is in Sonora, how did this piece end up reportedly in Chihuahua? We offer four possibilities. (1) It is possible that someone in the past moved it from Sonora to Chihuahua, but there is no evidence that knapping occurred. (2) This piece eroded from Sonora and traveled into Chihuahua via waterways and ended up in river gravels. (3) Although the elemental concentration best characterizes to Agua Fria, there may be another unknown obsidian source in Chihuahua with a similar chemical fingerprint. Moreover, finally (4), it may be possible that this mahogany sample was not picked up south of Mata Ortiz, but somewhere else. Unfortunately, at this time, we cannot offer solutions to the four possibilities listed above without more archaeological and geoarchaeological work in northern Chihuahua and Sonora.

Conclusions

Is there a mahogany variety of Agua Fria obsidian? The answer seems to be yes based on this one study. However, more archaeological and geoarchaeological work needs to be conducted in northwestern Mexico to corroborate the presence of an Agua Fria mahogany variety. Future sourcing research may pinpoint the primary and secondary source locations for the unknown and understudied obsidian sources, and maybe illuminate more information concerning the Agua Fria obsidian source.

It is exciting to see new archaeological research coming out of Chihuahua and Sonora in recent years (e.g., Minnis and Whalen 2015; Newell and Gallaga 2004; Pailes 2016). We are hopeful more archaeologists will be interested in sourcing obsidian artifacts from northwestern Mexico. The use of obsidian in this region has a long history as it goes back to the late Pleistocene (Sanchez and Carpenter 2016; Sanchez et al. 2014), and as a result, sourcing obsidian artifacts will provide a better understanding of mobility and procurement patterns through time and across space in an understudied region.

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