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## *International Association for Obsidian Studies*

2002 – 2003

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## NEWS AND INFORMATION

### Be Sure to Attend the Annual IAOS Meeting

The meeting will once again be held in conjunction with the SAA meetings and is scheduled for 4:00 pm Friday April 11. Please check the program for room details.

### Melos International Workshop

**Date:** 2<sup>nd</sup> to the 6<sup>th</sup> of July, 2003

**Location:** Melos Island, Greece

**Organized by:**

Prof. I. Liritzis

Laboratory of Archaeometry  
Dept. of Mediterranean Studies  
University of the Aegean, Greece

&

Dr. C. Dillian

President, IAOS, USA

## New Obsidian Volume Now Available

**Effects of Fire Volume**, assembled and edited by Janine Loyd, Thomas Origer, and David Fredrickson, this timely volume of papers documenting the effects of fire on obsidian artifacts is now available in paper *and* Acrobat formats. If you have an interest in the effects of fire on obsidian artifacts, this is a must-have publication. Printable copies may be downloaded from the IAOS website, <http://www.peak.org/obsidian>. While supplies last, copies of the 219 page volume may be obtained on request and at no cost from:

**Northwest Research Obsidian Studies  
Laboratory**  
1414 NW Polk  
Corvallis, Oregon 97330  
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Bishop, California 93514  
Email: [Kirk\\_Halford@ca.blm.gov](mailto:Kirk_Halford@ca.blm.gov)

### Greetings from the Secretary/Treasurer:

It is time for you the members to put your heads together. We need nominations for our next President.

From my experience on the Board, much of the IAOS business is conducted via e-mail, so international representation on the Board should be encouraged.

To recap that section of the by-laws:

The President shall serve as the IAOS's chief executive officer and its representative in official affairs and transactions. The President shall make certain that all resolutions of the Executive Board are implemented.

The Vice-President (President-Elect) shall be elected for one-year, at the conclusion of which he/she shall succeed to the office to President to serve a two-year term. He/she will

then serve one year as Past-President.

The Secretary-Treasurer shall be elected for a two-year term.

The Executive Board of the IAOS shall consist of the President, Vice-President (President-elect or Past President), Secretary-Treasurer, the Newsletter Editor, and Institutional Members of the IAOS.

Mike Elam is currently serving as VP.Carolynn Dillian, our President, has one more year to go before graduating to VP. So we need a President-elect.

Thanks in advance for your in-put.

Janine Loyd  
Secretary/Treasurer IAOS

## Melos International Workshop

### Participants and Preliminary Program

**Michael Gottesman** (Sherman Oaks, California) - *Obsidian hydration dating: How good is it?*

**Dr. Maria Rosa Iovino** (Siracusa) - *Tribology and micro wear trace analysis on obsidian (Sicily and Turkey)*

**Dr. Wal Ambrose** (Australian National University) - *Powdered obsidian for determining hydration rates and site thermometry*

**Prof. Masao Suzuki** (Atlanta, USA) - *On an approach to the palaeoclimate reconstruction using obsidian hydration as a temperature indicator*

**Dr. Carlo Pantano** (Pennsylvania State University) - *Effects of composition and network connectivity on the leaching and dissolution of aluminosilicate glasses*

**Dr. Robin Torrence** (Australian Museum), **Glenn Summerhayes** (Australian National University), **Ivo Orlic** (ANSTO), **Philippa Rath** and **J.Peter White** (University of Sydney) - *Networks and Disasters: Changing patterns of obsidian procurement in West New Britain, Papua New Guinea*

**Dr. Harald Behrens** (University of Hannover, Germany) - *Diffusion of water in rhyolitic glasses and melts*

**Prof. Catherine Perles** (Universite de Paris X) - *Why the obsidian trade?*

**Prof. Youxue Zhang** (University of Michigan) - *H<sub>2</sub>O diffusion in obsidian glass and issues on obsidian dating*

**Dr. Bernard Gratuze** (IRAMAT CNRS, Centre Babelon, France) - *New investigations of the Gollu-Dag obsidian lava flows system: comparison between chemical, mineralogical and fission track data*

**Dr. Carolyn Dillian** (president IAOS) - *Sourcing belief: using obsidian sourcing to understand prehistoric ideology in northeastern California*

**Dr. Robert Tykot** (University of South Florida, USA) - *High-precision sourcing of obsidian assemblages from the central Mediterranean: Feasibility and utility for archaeological interpretation of the exploitation of the Italian island sources*

**Prof. Minoru Tomozawa** (Rensselaer Polytechnic Institute, USA) - *Water diffusion in silica glass at low temperatures*

**Prof. Michael Glascock** (Missouri University, USA) - *Obsidian characterization basics: analytical techniques, elements and sources*

**Dr. Tristan Carter** (Stanford University, USA) - *Problematizing the analysis of obsidian in the Aegean and surrounding worlds*

**Prof. Maciej Pawlikowski** (Mining and Metallurgy University, Poland), **Mariana Tsamasfyrou** and **Ioannis Liritzis** (University of the Aegean, Greece) - *Surface microscopic investigation of obsidians*

**Dr. Yiannis Bassiakos** (NRC Demokritos, Greece), **Dr. V.Kilikoglou** and **A.Sampson** - *Yali Island: geological and analytical evidence for a new source of workable obsidian*

**Dr. Martin Jones** (University of Auckland, NZ) - *Archaeological soil temperature and obsidian hydration: a case study in quantifying uncertainty in OHD age estimates*

**Prof. R.Brodkey** (Ohio State University), **Prof. Ioannis Liritzis**, **Maria Diakostamatiou** - *Transport phenomena related to OHD*

**Dr. Vincenzo Francaviglia** (CNR, Italy) - *Discriminating between Mediterranean obsidians*

**Dr. Chris Stevenson** (Virginia Dept of Historical Resources, USA), **Liritzis.I**, **Diakostamatiou.M** and **Novak.S.M** - *Further dating applications employing the ODDSIMS-SS and conventional OHD approach*

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Note:

Any attendee, except of the participants, should register. Registration Fee is 250 EURO including attendance of the Workshop, conference material, two excursions in the island. All other arrangements are made by their own.

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## Obsidian Sourcing in the Philippines

By: Lee M. Neri

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### INTRODUCTION

In prehistoric times, obsidian was considered a precious commodity. It has been ranked as the most widely exchanged material in prehistoric times (Dixon *et al* 1968; Rapp & Hill 1998). Obsidian was greatly prized for its function as a stone implement, decorative object, and surgical instrument. The name obsidian dates back as far as Pliny the Elder (23-79 AD) who described obsidian from Ethiopia as attributed to Obsius (Watson 1986; Rapp and Hill 1998).

Obsidian is a natural glass produced by extrusive action of the volcano. It belongs to the felsic type of glass that is rich in silica (SiO<sub>2</sub>) content (Bowes 1989). It is formed due to extreme rapid cooling of the molten rock that prevented the formation of distinct crystals. Its hardness ranges from 5 to 7 in Moh's scale. The specific gravity of the obsidian ranges from 2.3 to 2.7 depending on the chemical composition. Obsidian has a perfect conchoidal fracture due to its homogeneity and lack of structures. It is ideal for making stone tools- shaping them into desired form. Obsidian usually is black in color due to the presence of the microlith (magnetite). It may also be reddish to brown due to oxidation of Iron (Fe) also known as hematite while others are from greenish to gray. Combination of colors such as striped (red/brown/black) and patchy obsidian can also be found.

The magma from the volcanic eruption that forms the obsidian dome, lava flow or pyroclastic deposit produces authentic chemical "signature" in the different parts of the world. This unique chemical composition can be used to characterize a source and match artifacts to a particular origin. It is in this light that the obsidian sourcing plays a significant role in understanding the ancient exchange and mobility pattern of obsidian artifacts.

### OBSIDIAN IN THE PHILIPPINE ARCHAEOLOGICAL CONTEXT

The obsidian materials recovered from the archaeological sites were scanty compared to the tradeware materials. H. Otley Beyer (1947)

conducted an archaeological survey in the different areas in the Philippines and found obsidian materials in the Luzon area only. During his archaeological explorations in 1926-1941, he found obsidian in Rizal, Cavite, Batangas, Bulacan Provinces and others were just presented to him by his colleagues with provenance from Ilocos Norte and Laguna provinces.

In Rizal Province, Beyer (1947) recovered obsidian in the different areas and he divided these into different districts. The first district was in Novaliches-Marilao District, where he recovered obsidian and flint microliths and assigned this into Mesolithic Era. In the Lake District, he recovered the same lithic materials. The Central District and Special Sites were divided by Beyer into subdistricts such as: San Juan River Valley, Pasig-Tagig, Marikina-Puray, Special Santa Ana Site and Special Manila Site. San Juan River Valley and Pasig-Tagig Subdistricts yielded obsidian materials associated with flint flakes, stone adzes, chisels and tektite. Beyer (1947) believed that these materials belong to the Late Neolithic Period.

In the Province of Cavite, Beyer (1947) recovered obsidian and flint microliths in plowed areas particularly in the main road to Tagaytay and near Indang area. In the province of Bulacan, particularly in Pugad-Baboy and Maysan areas, Beyer found a concentration of natural tektites associated with Mesolithic obsidian and flint microliths.

The province of Batangas is considered "to be the most important archaeological area yet discovered in the Philippines, and, as regards its uniquely rich Late Neolithic remains, one of the most remarkable Late Stone-Age sites found anywhere in the world" (Beyer 1947:243). In 1934, Beyer made an exploration in Lipa particularly in Balite Barrio, where he recovered 25 pieces of flaked obsidian implements.

Ronquillo and Ogawa (1996) also made explorations and conducted systematic excavations in the municipalities of Calatagan and Lian in Batangas Province. The exploration lasted for four months in 1994 and identified six

important sites. From the six sites only two yielded obsidian materials particularly in De los Reyes Property I and II Sites located in Sitio Dayap, Barangay Tanagan, southeast from the town proper of Calatagan. In De los Reyes Property I, they recovered earthenware sherds, four types of beads, net weights, animal remains and lithic materials such as quartz, vesicular basalt, andesite, and obsidian flakes. Archaeological evidence of artifacts, ecofacts and features provided information that the area was utilized for habitation. "This is deemed significant since all sites worked and reported on at Calatagan were burial areas and no actual habitation sites have been documented to date" (Ronquillo and Ogawa 1996:142). The De los Reyes Property II is located 800 meters southeast of De los Reyes Property I. The area was heavily cultivated with corn and the materials recovered were obsidian flakes, earthenware sherds, celadon sherds, blue/white porcelain sherds, seeds, bone fragments, and animal teeth remains.

De la Torre (1997) also conducted an archaeological exploration and systematic excavation in Ulilang Bundoc in Sitio Dayap, Barangay Tanagan, Calatagan, Batangas last April 1995 and May 1996. The results of the excavation yielded obsidian flaked materials associated with the secondary burial jars. Other materials recovered were earthenware sherds, polished stone adzes, shell beads, Indo-Pacific glass beads, and shells-both bivalves and univalves. Obsidian flakes were also confirmed by Angel Bautista (1995) in May 1995 when he excavated the same site. Other materials recovered were skeletal remains (adult and young), stone adzes, stone flakes, and beads. No tradeware ceramics were found (Bautista 1995).

Other provinces in Luzon which also yielded obsidian materials but was not personally explored by Beyer are Ilocos Norte and Laguna. Obsidian microliths were sent to Beyer by a local geologist and claimed that it was found near Pasugin, Ilocos Norte. Beyer said that "the area should be further explored, as no other obsidian implement has yet been reliably reported north of Bulacan Province" (Beyer 1947:215). Late 1945, a Dutch archaeologist, H.R. Van Heekeren, found 25 to 30 pieces of obsidian flakes and flint

semimicroliths in the foothill of Mt. Makiling, Laguna Province. This site was noted also by Beyer. Scott (1968) also reported obsidian microliths from Bulacan to Bicol Regions. Scott said that the possible source is located in Mount Banahaw. He also claimed that "if indeed, only this one source, this wide distribution bespeaks a considerable commercial mobility among Mesolithic Filipinos" (Scott 1968:23).

In Mindanao, there are three archaeological sites where obsidian materials were recovered. These areas are Municipality of Kibawe, Bukidnon Province, Bungiao Rock Shelter, Zamboanga and Huluga Open Site, Barangay Indahag, Cagayan de Oro City.

The archaeological survey and excavation was conducted by the South East Asian Institute of Culture and Environment (SEAICE) last April to June 1995 (SEAICE 1995). This is in compliance with the agreement to conduct both archaeological and ethnographic studies for the proposed Pulangi V Hydroelectric Project (HEP) located in the Province of Bukidnon. There were 11 sites that were properly explored and systematically excavated but there were only two sites that obsidian materials were recovered. These two sites were identified as Barangay Sanipon and Barangay Bukang Liwayway.

The archaeological survey at Barangay Sanipon, Kibawe, was conducted at the floodplain area of Pulangi River which is currently planted with corn and upland rice (SEAICE 1995). During their archaeological survey, they found different cultural materials. These materials are composed of obsidian flakes, chert flakes, Chinese tradewares, earthenware sherds and other contemporary materials like rusted nails and other metal objects. Aside from the archaeological exploration they also excavated three test pits which measured 1X1 meter square. SEAICE (1995) also conducted an archaeological exploration in Barangay Bukang Liwayway in the municipality of Kibawe, Bukidnon. The exploration was conducted at the left bank of Pulangi River, which is still planted with corn and upland rice. Surface finds recovered were obsidian flakes, chert flakes, sherds of ceramic tradeware (Ming Dynasty) and other contemporary materials such as rusted metal

objects and others.

The second site was located in Bungiao Rock Shelter, Barrio of Bungiao, Manichan Municipality, Zamboanga. Seven obsidian flakes were recovered outside and inside the shelter varying from circular flakes (14mm to 18 mm in diameter and from 1mm to 4 mm thick) to irregular shaped flakes (19mm to 29mm long and 2 mm to 8 mm thick). Obsidian flakes collected were unretouched and have sharp edges for scrapping and cutting purposes (Spoehr 1973). He believed that the rock shelter "was first used at the time somewhere prior to the introduction of trade ceramics, though how much earlier cannot be determined" (Spoehr 1973:77).

Other obsidian materials recovered in an archaeological context in Mindanao is found at Huluga Open Site, Barangay Indahag, Cagayan de Oro City. Cabanilla (1970) conducted an archaeological exploration and excavation at Huluga area in October 26 to November 17, 1970. He was assisted by Messrs. Santiago and Gomez, both associated with Xavier University. There was no excavation at Huluga Cave Site due to its disturbed condition made by pot and treasure hunters. Its natural and geological formation of the cave also insinuates the exclusion of possibility from systematic excavation due to the increase percolation of water from the top. The cave has become small and possibly engulfing whatever artifacts left by the inhabitants (Cabanilla 1970). The concentration of the team diverted towards the Huluga Open Site. Three test pits were excavated. The recovered materials were local pottery sherds, 70 pieces of obsidian materials (3 were certainly utilized and others were waste flakes and chips), two flint flakes, broken piece of polished adze made from silicified sandstone with its blade measuring 3 and ½ centimeter and has a rectangular cross section. They also found ceramic sherds attributed to Sung and Ming Dynasties on the surface level. The recovered materials from their test pits and surface finds manifest "that the area has been continuously used by man from far back as the Late Neolithic or probably the early Metal Age about 500 BC" (Cabanilla 1970:2). They believed that this area was already occupied as early as 2,500 years ago (Cabanilla 1970; Demetrio 1995).

Burton (1975) made a thorough archaeological exploration and excavation at the Huluga site and its vicinities. Huluga area is two kilometers east of barrio Balulang. It is composed of open and cave Sites and both lie on the eastern side of Cagayan River and at the southern tip of Puntod Island bar. The exploration of the Open Site was first made and recovered varieties of materials such as obsidian, chert flakes, potsherds, and porcelain sherds were recovered. The excavation in Huluga Open Site was made in trenches in "T" form located at the middle of the site. They used the 20 centimeters arbitrary levels and reached up to 25 centimeters reaching the limestone bedrock (Burton 2002; personal communication). The materials recovered from their excavation were composed of obsidian flakes which some were utilized, chert flakes, potsherds, and a glass bead. Burton believed that the Huluga Open Site was used as a settlement in pre-Hispanic time (Burton 1975).

Another thorough archaeological exploration and excavation were conducted in Cagayan de Oro last September 9 to October 10, 1991 by Messrs. Angel Bautista and Melvyn Garcia, both from the National Museum (Bautista 1992). The explored areas were composed of Barangays Macasandig, Balulang and Lumbia in Cagayan de Oro and Barangay Walas, Municipality of Imbatog, Province of Bukidnon. There were 21 identified archaeological sites and Huluga Open Site is the only site that yielded obsidian materials.

The Huluga Open Site has a museum site code of X-91-Q2. Archaeological exploration was conducted in the said area and recovered a coral, obsidian flakes, 4 pieces of chert flakes, local pottery rims, 3 andesite cobbles, stoneware sherd, and 2 pieces of blue and white porcelain sherds. Bautista made a test pit excavation and found thin soil layers. According to the researcher, the Open Site's soil matrix is already disturbed due to erosion and agricultural activities of the locals.

#### OBSIDIAN SOURCES IN THE PHILIPPINES

Obsidian, considered a gemstone material, is classified as a semi-precious stone based on the market value. "Obsidian is associated with quaternary volcanics in Mabitac, Laguna and in

Pagudpod, Ilocos Norte" (Bureau of Mines 2000:2). According to the Bureau of Mines (2000) there are only three obsidian sources in the Philippines for now. These sources are in Brgy. Caunayan, Pagudpod, Ilocos Norte, Brgy. Manaol, Nagcarlan, and Brgy. Tawid Apoy, Mabitac, Laguna Provinces. The writer made a verification of these identified sources and it was indeed a possible source of obsidian except in Brgy. Tawid Apoy, Mabitac, Laguna, where obsidian cannot be found and unknown to the locals. Hence, the writer made an ocular inspection at the site (with the geographic coordinates of 14° 24'36" North latitude and 121° 23'43" East longitude) and its surrounding vicinities. Still, obsidian is no where to be located. Instead, jasper was commonly found in the area. According to Mr. Avelino Cortes, Brgy. Chairman in Matalata, Mabitac, they used to have a machine for manufacturing obsidian pendants and rings as their livelihood projects, which they import obsidian from the Nagcarlan, Laguna.

In Brgy. Caunayan, Pagudpod, Ilocos Norte, obsidian appeared in angular fragments from three to ten centimeter in diameter. The local term of this glass is "Berdadero" which means high class type of green stone. The source was found in the Caunayan forest with a geographic coordinates of 18° 37' 35" North latitude and 120° 49' 51" East longitude. The source occurred as a conglomeratic deposit probably of colluvial or alluvial in origin (De los Angeles 2002: personal communication). This glassy material was being quarried, according to Mr. Artemio Lurenzo, Chief Tanod in Brgy. Caunayan, by the locals and sold them at P20/kilo to some people from Cagayan Valley. The purpose of buying the obsidian from the locals was unknown.

The second source of obsidian is found in Brgy. Manaol, Nagcarlan, Laguna. The source was pointed out by Mr. Larry Bisbe, Brgy. Chairman in Mt. Nagcarlan. It has a geographic coordinates of 14° 10' 41" North latitude and 121° 21' 52" East longitude. Obsidian appeared as floats from cobble to boulder sizes exposed along the lower ridges of volcanic plugs. The local term of obsidian is called "Batong Dalig" refers to the place with an unknown meaning. It has a high opacity or dark colored glass containing elongated

or rounded bubbles. Obsidian was scattered along the surfaces of the slopes and on top of the mountain with a scenic view of the Laguna de Bay. According to the Bureau of Mines (2000:6) this "gemstone material is approximately 1% of 1,000 sq. m. area." The obsidian materials found in this area has the following characteristics (Bureau of Mines 1986:309):

Fracture is conchoidal; luster is vitreous. It is opaque to transparent and isotropic with refractive index of 1.48 to 1.52. The hardness ranges from 5 to 5.5 in Moh's scale and specific gravity varies from 2.33 to 2.50 depending on the abundance of vesicles. It consists mainly of glass with some minute inclusions of crystallites and amygdules of quartz and zeolites.

#### ANALYSIS AND RECOMMENDATION

The sourcing of obsidian is a "straightforward" process and can be traced directly. Unlike chert, sedimentary rocks have a lot of discrepancy and inconsistency in their trace chemical elements where the process of proveniencing will not totally be achieved (Whittaker 1994; Rapp and Hill 1998). The importance of obsidian sourcing is to understand the mobility pattern of exchange/trade of the early people since obsidian was considered as a high regard raw material for making stone tools in ancient time. The different sources are geochemically different and can be characterized by its authentic chemical composition (e.g. Rb, Sr, Zr...). Like humans, they have their own "signature" and "thumb-marks."

According to the Mineral Resources of the Philippines (Bureau of Mines 2000), the three identified source of obsidian are all located in Luzon. No obsidian source, yet, in Visayas and Mindanao areas have been found.

Obsidian materials can be recovered through archaeological explorations and excavations. All of the recovered obsidian materials in the Philippines were all flakes and some were considered microliths by Beyer (1947). The recovered obsidian flakes were associated between Mesolithic to Neolithic Periods (Beyer 1947, Cabanilla 1970, Scott 1973, and Demetrio 1995). We only have two sites in Luzon (specifically in Batangas) that yielded obsidian



materials and these were systematically excavated. The rest of the recovered materials were from explorations conducted by H. Otley Beyer. Visayas area, for now, is totally devoid of obsidian in an archaeological context, which means, the acquisition of the material during ancient time was possibly hard and inaccessible. In Mindanao, we only have three sites (Province of Bukidnon, Bungiao Rock Shelter, and Huluga Open Site) and these were also systematically excavated.

There is no study yet of obsidian sourcing in the Philippines and it is a total pity considering that we are staying and surrounded by more than 200 volcanoes and 22 are considered active in the Philippines. In Mindanao, we have 15 different kinds of volcanoes and seven of these are considered active. A haven for possible extrusive volcanic obsidian source. Just like in Mesoamerica and the Pacific, where all obsidian sources were already identified, plotted and analyzed through X-Ray Fluorescence Analysis (XRF) or Proton Induced X-Ray Emission and Proton Induced Gamma Ray Emission (PIXE/PIGME). It is high time that we give importance to this material and analyze their chemical composition of the possible source/s in the Philippines. Through this identification, we can be able to infer or understand the process of acquisition of obsidian materials recovered in an archaeological context. Hence, gaining information about the mobility patterns of exchange/trade or quarrying activities in ancient times.

Obsidian calls a challenge to all archaeologists in the Philippines. This method will contribute a lot to our understanding of the internal and external exchange/trade of early Filipinos and to Philippine archaeology in general.

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- 1995 Summary Report, Visit, and Assessment of On-Going Archaeological Excavation at Ulilang Bundoc Site, Dayap, Tanagan, Calatagan, Batangas. *Field Report*. National Museum. Manila. Philippines.

The writer made an initial study and the subject of his masteral thesis is on obsidian sourcing particularly in Huluga Open Site, Barangay Indahag, Cagayan de Oro City.

Huluga Open Site is part of Sitio Taguanao, Barangay Indahag (previously part of Barangay Macasandig), Cagayan de Oro City (DENR 2001). Situated at the eastern bank of Cagayan River, it is 8.5 km south of the city center. Archaeologists believed that this area was already occupied before the introduction of tradeware ceramics. The presence of cultural materials from the Late Neolithic until the Age of Contact (12<sup>th</sup> – 15<sup>th</sup> centuries AD) provide evidence of continued human existence (Cabanilla 1970; Demetrio 1995).

Previous archaeological excavations and explorations conducted at the Huluga Open Site yielded obsidian materials identified as utilized and waste flakes (Cabanilla 1970, Burton 1975 and Bautista 1992).

The obsidian sourcing applied to the collected materials at Huluga Open Site is an important research. At present, there has been no study on the provenience of obsidian flakes from the Philippine islands. This study will serve as a pioneering approach in Philippine archaeology. All possible obsidian sources that will be identified in this study may serve as a future reference for obsidian studies in the Philippines.

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### Revival of Obsidian Studies

by Ioannis Liritzis

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The recent progress in obsidian hydration dating and characterization has gained an international interest and there exists an ongoing collaboration between colleagues from interdisciplinary fields. Since 1960s, the dating efforts culminated by recent advances employing modern technology. The analysis and characterization studies have improved with the advent of modern techniques. Such efforts, however, must be treated with due caution, and such matters will be presented in the planned international workshop on Melos, Greece, 2-6 July 2003. Along with the announcement of this international meeting I take the opportunity to summarize the steps that lead to the advent of recent OHD development and present the current activities of the Rhodes group.

The advanced techniques and mechanisms for the studies concerning the determination of age and the analysis of obsidian tools and cores have lately gained a considerable impulse. The background work on both aspects has shown the direction of research (Shackley, editor, 1998; Green, 1998; Friedman et al., 1997; Anovitz et al., 1999; Stevenson et al., 2000, 2001a,b; 2002; Liritzis and Diakostamatiou, 2002).

In obsidian hydration dating the emphasis has been directed onto non-optical methods of rim determination. Lee et al., (1974), Leach and Naylor (1981), and Leach (1977) assessed the potential of several measurement methods and

foresaw some promise for electron microscopy, ion spectroscopy and argon milling.

Later research promoted these earlier ideas using ion spectroscopy, in particular the secondary ion mass spectrometry (coined SIMS) has been used to determine the hydrogen and other cation profiles of obsidians, for the development of an intrinsic method following a special calibration procedure by the team at Oak Ridge National Laboratory and Tennessee University (ORNL/UT) in a thoroughly presented article (Anovitz et al., 1999).

In fact this team applied a closest fit to the measured hydrogen profile, obtained using a fully-implicit, finite difference solution with variable distance and time-steps. This has proven to be the most stable solution, and used an equation which describes the variation of the diffusion coefficient with water concentration. In fact, by using "characteristic points" on the hydrogen profile (half-fall depth, inflection point depth) simple hydration rate equations were evaluated against time constraints provided by associated C-14 dates. This model has been calibrated to experimental data from Mount 65, Chalco, Mexico (personal communication with ORNL/UT team and Riciputi et al., 2002).

Almost the same time SIMS was used in comparison with infrared photoacoustic spectroscopy for a more accurate determination of the hydration rim by the Virginia Department of

Historic Resources and Evans East team, extended to Aegean obsidians in collaboration with the Rhodes group (Stevenson et al., 2001b; 2002b).

The use of SIMS technique was taken up by another team at the University of the Aegean, Rhodes, Greece who proposed a different solution of 2nd Fick's law of diffusion based on the non-steady state concentration-dependent diffusion for semi-infinite medium, where diffusion coefficient varies exponentially during diffusion, and for certain initial and boundary conditions. The age equation of the obsidian diffusion dating employing SIMS derives from a differential equation that describes diffusion. An essential factor addressing this alternative model is the surface saturation (SS) plateau level at certain depth, which is the result of the diffusion mechanism in the first about 1-2  $\mu\text{m}$ . (Liritzis and Diakostamatiou, 2002a, 2002b). This proposed approach was coined ODDSIMS, an acronym created by the ORNL/UT team (Riciputi et al., 2002) and modified by the Rhodes team as ODDSIMS-SS to include the new surface saturation (SS) approach and the different method of solution of the diffusion equation.

The ODDSIMS-SS approach, coupled with the diffusion mechanism and accomplished by appropriate mathematics (based on Crank, 1975), opens a new era in the obsidian chronological studies.

Evidently, many more obsidian samples must be tested covering wider provenance areas and time range. The hydrogen profiling by SIMS needs more attention regarding involved errors, both random and systematic. Nevertheless, all such initiatives are welcome but any drawn conclusions must be treated with due caution (Stevenson et al., 2002b). Along the latter notion more obsidian samples from the Aegean region, provided by the Rhodes team, are going to be processed by the ORNL/TU team, aiming at a forthcoming joint publication

Similarly, more samples from the Aegean and other areas, have been analyzed by SIMS, in an ongoing collaboration with Virginia and Evans East group, which will soon be jointly announced. Particular focus on the surface status of obsidian is another field of research, which is currently under study, to examine dissolution and weathering effects (1-2  $\mu\text{m}$  scale) pertinent to the dating aim, along with interpretation of the water mass transport phenomenon. Such international collaborative efforts, surely strengthens the new dating approaches.

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**Abstracts from the 28th annual Great Basin Anthropological Conference  
Elko, Nevada**

Submitted by Janine Loyd

*Raw Material Sources and Prehistoric Lithic Technology of the Birch Creek Site (35ML181), Malheur County, Southeastern Oregon.*  
Cole, Clint R. (University of California, Davis)

This paper summarizes the relationship between prehistoric lithic technology and raw material economy at the Birch Creek Site (35ML181), southeastern Oregon. This site includes a stratigraphic sequence of three occupation surfaces and fill episodes above Mazama ash and dates to within a period of approximately 4400-2400 B.P. Abundant local chert provides the staple lithic resource at 35ML181 and non-local obsidian was transported from thirteen distinct geologic sources. Four source groups (Coyote Wells,

Indian Creek Buttes, Sourdough Mountain, and Venator) dominate the obsidian artifact assemblage and most volcanic glass was potentially obtained from within 40 kilometers of the site.

*Lithic Technology at the Fallen Eagle Site: Mobility and Exploitation.*  
Edmisten, Scott

This paper will discuss the stone tool assemblage at the Fallen Eagle Site. The major points will focus on unique characteristics of the lithics observed on the site, specifically those recovered while excavating the main Fremont occupation. Obsidian hydration and sourcing results will be discussed in relation to foraging for local

materials, trade, seasonality, and temporary vs. long term occupation. A general comparison will be made between the Fallen Eagle Site lithics and those of other Formative sites in the Great Basin and Intermountain West.

*Obsidian Quarry Workshop – Source of Butte Valley Group B Located.*

Hafey, Robert

This paper discusses the discovery of the source of Butte Valley Group “B” obsidian during site reconnaissance in Sand Spring Valley, southeastern Nevada. The existence of this material was first noted in 1988 by Richard Hughes, Charlotte Beck, and George T. Jones as present in their assemblages from Butte Valley, north of Ely, Nevada. Reconnaissance of the area surrounding the source location further revealed three additional sites that contained this material. Obsidian source and hydration studies are reflective of a long time span of land usage and possible trading and hunting patterns within the Great Basin.

*Evidence for Early Holocene Acquisition and Production of Bodie Hills Obsidian*

Halford, Kirk (Bureau of Land Management)

Data recovered at CA-MNO-3126, Bridgeport Valley, California, indicate that the site was utilized during the past 10,000 years, with the most intensive periods of use occurring during the Mojave/Early Archaic periods (ca., 10,000 – 3,500 B.P.). Surface and subsurface evaluations indicate that the primary activity at the site was the acquisition of obsidian tool stone material from extant secondary deposits of Bodie Hills obsidian. Hydration data from the site display a bimodal production curve with peak use periods occurring during the early (ca., 10,000 – 3,500 B.P.) and later Holocene (ca., 650 B.P. to historic). These data are contrary to regional production curves, which exhibit normal distributions with peak production between 3,000 and 1,000 years B.P.

*Geochemical Analysis of Volcanic Glass from the Obsidian Butte Are, Southern Nevada*

Hughes, Richard (Geochemical Research Laboratory) and Lynn Haarklau (Nellis Air Force Base)

In 1998, Nellis Air Force Base Cultural Resources Program made a commitment to sponsor a major

archaeological research project to trace through-out the south-central Great Basin and adjacent area the spatial and temporal distributions of artifact obsidians from Nevada Test & Training Range and Nevada Test Site, southern Nevada. The first phase of reconnaissance, field collection and x-ray fluorescence analysis of geologic obsidian from Obsidian Butte, Nevada, was completed in 2000. This paper reports research results, as well as ongoing field and laboratory studies completed over the past year in which several “new” chemical varieties of obsidian have been identified.

*The Temporal Significance of Mono Craters Obsidian and Pumice Exploitation*

Hull, Kathleen (University of California, Berkeley)

Recent archaeological investigation of contact-era sites in Yosemite National Park indicate that Mono Craters obsidian was subject to more intensive exploitation during the last 500 years than in the more distant past. Additional evidence from this region suggests that this same temporal pattern may apply to the use of pumice from this geologic source. These observations are supported by previous research on contact-era deposits in the Mono Basin, and the regional chronological and economic significance of this trend is discussed.

*Stratigraphy and Chronology at the Connley Caves (35LK50), Central Oregon*

Jenkins, Dennis (University of Oregon)

New investigations at the Connley Caves (35LK50) are expanding and clarifying the picture of occupations at this pivotal site in the Fort Rock Basin of south-central Oregon. While much analysis remains to be done, initial results have identified seven strata in the four meters of deposits at the site with chronological controls provided by 31 radio-carbon dates (10 new dates), obsidian source characterization for 350 tools and debitage, and 182 obsidian hydration measurements.

*Impostor No More: Obsidian Studies in Death Valley National Park.*

Johnson, Lynn (California State University, Sacramento)

The Saline Range, located within Death Valley National Park, is the source area for at least three archaeologically significant obsidian varieties, one of which is the previously “unknown” glass type termed

"Queen Imposter". X-ray fluorescence analyses were conducted on obsidian artifacts recovered from archaeological contexts in Death Valley National Park during the 1950s and 60s by William J. Wallace, Alice P. Hunt, and others in order to identify spatio-temporal trends in the acquisition and use of obsidian derived from the Saline Range. These data also shed light on general patterns of obsidian procurement and use in the Death Valley region.

*Understanding Obsidian Hydration: Induced Hydration Experiments*

Jones, Ted and Tom Origer (Tom Origer & Associates)

In the 1980s archaeologists attempted to calculate hydration rates and temperature adjustments, with data collected from induced hydration experiments. Later induced hydration data were used to calculate source comparison ratios to allow hydration rates for known obsidian sources to be applied to sources with unknown rates. Neither of efforts resulted in broad application. This paper explores the reasons for the limited success of these approaches, discusses the key questions that must be answered before induced hydration can be applied, and proposes fruitful research still to be conducted in the induced hydration laboratory.

*Iron Valence in the Hydration Layer of Obsidian: Characterization by X-ray Absorption Spectroscopy*

Lytle, Farrel (EXAFS Company), Nicholas Pignatore Jr. (University of Texas at El Paso), and Mark Giambastiani (Albion Environmental)

We used combined fluorescent X-ray and electron yield measurement of the Fe K-edge X-ray absorption near edge structure of Casa Diablo and Modena obsidian artifact collections to determine that the original valence, Fe(II), changed to Fe(III) during atmospheric hydration. The chemical free energy associated with this reaction is greater than that estimated for the hydration of obsidian and may be the driving force for the formation of the hydration layer. The technique promises to be useful as a non-destructive technique for age-dating archaeological specimens of obsidian.

*Characterization of Volcanic Glass Tool Stone from Southeastern Idaho*

Plager, Sharon, Richard Holmer (Idaho State University), and Richard Hughes (Geochemical Research Laboratory)

Recent XRF analysis has characterized samples from 60 outcrops of volcanic glass which are geographically separated within an arc extending 250 km across the eastern Snake River Plain. Several exposures, previously considered unique tool stone sources, are the Walcott Tuff geochemical type associated with the Blue Creek caldera. These include American Falls, Gibson Creek, Packsaddle, Reas Pass, and Deep Creek. In the past, correlation of artifacts to these sources generally led to the interpretation that consumers were using locally available tool stone. However, outcrops of a single glass material occurring at far greater distance makes the estimation of procurement strategies difficult.

*Lithic Terranes of the Great Basin Paleoarchaic: an Eastern Nevada Example*

Stoner, Edward (Western Cultural Research Management)

Paleoarchaic stone tool assemblages at sites located in eastern Nevada were primarily made from three materials: chert, fine-grained volcanic rocks (andesite, dacite, basalt), and obsidian. The distribution of these material types across tool categories is strongly patterned indicating that they were selectively used. For Western Stemmed Tradition projectile points at the sites, fine-grained volcanic rocks, and obsidian were used interchangeably and almost exclusively even when cherts of suitable quality and package size were locally available. Depicting known sources of toolstone at various scales on geologic maps has the potential to inform us about mobility patterns and technological organization including procurement strategies and has important planning and management implications.

*Middle Holocene Projectile Points from Catlow Valley, Southeastern Oregon*

Thomas, Scott, Brian McCabe (Bureau of Land Management) and Tobin Bottman (University of Oregon)

A collection of mid-Holocene projectile points was recently recovered from sites on relic Catlow Lake shorelines. The points were analyzed for obsidian source identification and hydration band measurement(s). In addition, their use histories and typological classifications were studied. The authors intend to present a synthesis of this data and suggest mid-Holocene cultural patterning in the northern Great Basin.

“ Natural Glasses 4 ” Lyon (France), August 29-31  
Abstracts and Annotations  
Submitted by G. Poupeau

During three days in August the International Conference “Natural Glasses 4 ” (<http://natglasses.univ-lyon1.fr/>) was held in Lyon. Sixty four papers were presented, sixteen of which held bearing both on natural and archaeological glasses, including glazed potteries. The abstracts have been compiled as a special issue of the Bulletin de Liaison de la Société Française de Minéralogie et de Cristallographie, vol. 14, 1, p. 1-32. Full papers will be published in a special issue of the Journal of Non-Crystalline Solids. Obsidian was the subject of eight papers related to provenance studies in the Mediterranean and Near East regions. Eight others were concerned with obsidian glass structural studies, physical properties and alteration.

The Conference was organized at the Claude Bernard University of Lyon by Professor Bernard Champagnon ([champ@pcml.univ-lyon1.fr](mailto:champ@pcml.univ-lyon1.fr)), head of “Glasses Nanostructures and Geomaterials” in the Laboratoire de Physico-Chimie des Matériaux Luminescents associated with CNRS.

The “Natural Glasses 5” Conference (title still provisional) is planned for 2005. It will be hosted by the Centre de Recherche en Physique Appliquée à l’Archéologie of CNRS/University Michel de Montaigne-Bordeaux 3. For any information contact Gérard Poupeau ([gerard.poupeau@montaigne.u-bordeaux.fr](mailto:gerard.poupeau@montaigne.u-bordeaux.fr)).

*Jerf el Ahmar (Euphrate Valley, Syria) :  
obsidian industry and provenance*

Abbès (1) F., Bellot-Gurlet (2) L., Cauvin (3) M.-C., Delerue (4) S., Dubernet (4) S., Poupeau (4) G., Stordeur (3) D.

The Jerf el Ahmar village is one of the oldest Neolithic permanent settlements known in the Middle Euphrate Valley. It was occupied during Recent Pre-Pottery Neolithic A (PPNA) cultural period (9,500-8,700 av. J.-C.). Obsidian, which represents only a very small part of the collected lithic artefacts, was partially knapped in the site. We analysed 42 obsidians collected in various parts of the site, of which 22 by ICP-AES/MS in conventional (destructive) mode (Martinetto, 1996, Bellot-Gurlet, 1998) and 20 by PIXE and SEM-EDX, of which 4 non-destructively. They all fell into two geochemical groups, with respectively 40 and two samples. The analysis of geological obsidian samples by ICP-AES/MS, PIXE and SEM-EDX show that 40 of the Jerf el Ahmar obsidians came from the Göllü Dag Est obsidian source, while the remaining two have their origin in Eastern Anatolia (Bingöl or Lake Van area).

Anatolian obsidians are known in the Near East since about 12,000 av. J.-C. and for a long time their provenance was limited to Cappadocia, essentially

from the Göllü Dag volcanic massif. It is only during the Recent PPNA, with the NE progression of the Neolithisation process, that Eastern Anatolia obsidians started to reach the Middle Euphrate Valley (Cauvin and Chataigner, 1998). In this sense, Jerf el Ahmar, which testifies of this still limited contribution, is a typical Recent PPNA site.

From a methodological point of view, we show for the PPNA period the equivalence of the ICP, PIXE and SEM-EDX approaches in obsidian provenance studies.

Cauvin M.-C. and Chataigner C. (1998) in Cauvin et al., Eds., *L’obsidienne au Proche et Moyen Orient. Du volcan à l’outil*, BAR Intern. Series, 325-350.

Martinetto P. (1996) Master Dissertation, University Bordeaux 3, pp. 8

Bellot-Gurlet L. (1998) Ph. D. thesis, University Grenoble 1, pp. 290.

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*The procurement of obsidian: Factors influencing the choice of deposits*

Barge O. , Chataigner C. (1)

More than twenty sources of obsidian which were extensively exploited in prehistory are scattered across Armenia. Chemical analyses and fission-track dating have enabled characterisation of these sources and determination of the origin of more than 600 artefacts found on sites of between the 4th and 1st millennia BC.

The large number of available obsidian sources throughout the country and the distribution of the archaeological sites permits analysis, on a methodological level, of factors which could have influenced the choice of deposit. The study of the distribution of obsidian shows that there is no simple model: the villages were supplied sometimes from one source, sometimes from several, and in the latter case the nearest deposit was not necessarily the one preferred. The factor of distance as the crow flies, which is often considered a determinant in the choice of sources ("law of monotonic decrement"), is thus often irrelevant.

In order to better understand the criteria which could have influenced these choices, we have examined the different deposits by studying the quality of the material (its suitability for knapping), the quantity (the extension of domes and flows), the possible presence of secondary sources (blocks displaced by rivers), and the accessibility of sources in relation to space (altitude...) and to time (months not covered by snow).

Thanks to a Geographic Information System which has been established for Armenia, we have been able to create a model of "time-distance" between the deposits and the villages. The gradients map indicates areas of

constraint, on which the time needed to go from one point to another (the village and the source) is a function of the distance and the relief (Gorenflo, Gale, 1990). We have thus been able to establish maps of accessibility to the different sources of obsidian from each of the archaeological sites. When several sources are available, a threshold appears which corresponds to the maximum time accepted by the populations for direct procurement; beyond this threshold, the quantity of obsidian is reduced and appears to be related to gradual redistribution.

Gorenflo L., Gale N. (1990), Mapping regional settlement in information space, *J. of Anthropological Archaeology*, 9, 240-274.

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*Obsidian characterisation by Raman micro-spectrométrie. Glass structural properties as a possible signature for provenance studies of prehistoric artefacts*

Bellot-Gurlet L.(1), Milleville A.(2) and Champagnon B.(3)

Obsidians have been widely used in the Neolithic stone industry. Numerous studies use the uniqueness of their chemical composition to identify the geological source of archaeological artefacts. However, there is cases where with the geochemical characterisation it is difficult to propose a source without ambiguity, and also difficult to define a finer localization of artefact provenance in a large source as asked by some archaeological problems.

Alternative approaches based upon the structure of glasses are developed. Raman micro-spectroscopy is a versatile technique for these studies. It allows non destructive characterisation dealing with glass structure at short and medium range order. Results of a program in progress on obsidian characterisation by Raman spectroscopy will be presented.

As a test in a given area, we analysed geological samples from the four western Mediterranean sources (Sardinia, Lipari, Pantelleria and Palmarola) and to extend the study we also analysed some Turkish sources (Göllü Dag massif, Cappadocia). Raman spectra were compared between various sources and spectral characteristics are interpreted as structural differences (mainly the state of the silica network) in relation with variation of chemical compositions determined by PIXE or ICP-AES/-MS. On the other hand, even if our obsidians are highly vitreous some micro-crystals are present in the glassy matrix. Micro-Raman allows identification of various phases, which surprisingly did not affect the macro-homogeneity of chemical composition, and may characterize some sources.

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### *Provenance studies of obsidian artefacts from Armenian archaeological sites using the fission-track dating method*

CHATAIGNER C.(1), BADALIAN R. (2), BIGAZZI G. (3), CAUVIN M.-C. (1), JRBASHYAN R.(4), KARAPETYAN S.G.(4), NORELLI P.(3), ODDONE M. (5), POIDEVIN J.-L.(6)

Obsidian was widely used by our ancestors for tool making. In Georgia and neighbouring Armenia this natural glass was recognised in several volcanic complexes distributed over wide areas. In the frame of an INTAS research project, 44 samples from the obsidian occurrences of these complexes were analysed using the fission-track (FT) dating method in order to (1) better constrain the history of Plio-Pleistocene volcanism of this region and (2) to create a reference data-set for identification of the source of archaeological obsidian artefacts. According to geological expectation, most of the studied obsidian occurrences yielded Pleistocene ages. Only two volcanic complexes have Pliocene age. The determined formation ages cluster into restricted groups: 0.042 – 0.120 Ma, 0.25 – 0.40 Ma, 0.43 – 0.56 Ma, 1.17 – 1.38 Ma, 1.53 Ma, 2.34 – 2.63 Ma and 4.26 – 4.56 Ma. These data indicate that volcanic activities characterised by obsidian eruptions developed during short time spans.

The FT data-set on geological samples was used for provenance studies of 109 artefacts from 23 sites representing a large time span, since Chalcolithic up to Early Iron Age, distributed all over Armenia. Most of these artefacts originated from Armenian sources. Two groups of «foreign» obsidians from sites located in the NW and NE corners of Armenia were attributed to sources located in the adjacent regions of Turkey and Georgia.

Results of this study prove that the FT method is (1) an efficient tool for geochronological studies of obsidian-bearing volcanics, also in case of very young rocks and represents (2) a reliable alternative for provenance studies of obsidian artefacts.

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### *Obsidian characterization and obsidian trade in Prehistorical times : An overview of physico-chemical methods*

Poupeau G.

Obsidian is a rare product of volcanic activity. An aphyric rock, its conchoidal fractures are in certain varieties very bright. Generally black, sometimes green or red, it may become transparent when its thickness is limited to a few millimetres. Its excellent knapping qualities added to its aesthetical potentialities made it one of the preferred raw materials for the prehistoric lithic industry.

Obsidian was always used by ancient man. However it is essentially by the end of Palaeolithic times, when populations became sedentarised or had mastered oceanic navigation, that evidences of long distance "trade" from its natural sources developed. Thus, obsidian artefacts can now be found in archaeological sites far from the nearest natural source by more than 1,000 km on continents or 3,000 km in the Pacific Ocean.

To be able to establish an unequivocal relationship between an archaeological obsidian and a potential geological source provides a powerful means to study the circulation of man, goods and ideas in the past. Obsidian provenance studies based on physico-chemical analyses are now a well established research field, which produced a wealth of information on ancient cultures (see f. i. Cauvin et al.). It is the intent of this talk to review the present status of obsidian characterization approaches in sourcing studies.

Cauvin M.-C., Gourgaud A., Gratuze B., Arnaud N., Poupeau G., Poidevin J.-L. et Chataigner C., Eds. (1998) *L'obsidienne au Proche et Moyen Orient. Du volcan à l'outil*, BAR International Series, 738, Hadrian Books Ltd, Oxford, pp. 388.

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*Magnetic properties and <sup>57</sup>Fe Mössbauer spectroscopy of Mediterranean prehistoric obsidians for provenance studies*

Stewart S. J.(1\*), Cernicchiaro G.(1), Scorzelli R. B.(1), Poupeau G.(2), Acquafredda P.(3) and De Francesco A. (4)

About a hundred samples from the Mediterranean source-islands : Gyali, Lipari, Melos, Palmarola, Pantelleria and Sardinia (Monte Arci) were characterized by <sup>57</sup>Fe Mössbauer spectroscopy and magnetization measurements.

Hysteresis parameters at 294 K were deduced from magnetic cycles under a maximum applied field of 12 KOe. The saturation magnetization (Ms) depends on the island of provenance and it reaches a maximum of ~0.2 emu/g for Palmarola obsidians, indicating a higher magnetic phase content in these samples. The coercive force (Hc) ranges from 120 to 370 Oe for respectively Gyali and Palmarola islands. The relative high Hc found in some obsidians might be related to the small grain size of the magnetic phase. Preliminary analyses (Cernicchiaro et al. 2002) showed that in Mr/Ms vs. Hc/Hcr plot the data points accumulate in areas that depend on obsidian provenance (Mr, remanent magnetization; Hcr, remanent coercive force).

The Mössbauer spectra recorded at room temperature are mainly composed by broad asymmetric doublets. They were fitted assuming two different Fe<sup>2+</sup> and Fe<sup>3+</sup> sites. In addition, the obsidians of several sources, located in the islands of Lipari, Melos, Palmarola and Sardinia, present a magnetic component in their spectra attributed to magnetite and/or hematite. In a biplot of discriminant functions calculated from a multivariate analysis including the Mössbauer hyperfine parameters, the relative areas of the magnetic phase and the Fe<sup>3+</sup>/Fe<sup>2+</sup> ratio, the obsidians from different sources occupy discrete areas.

In this paper we discuss the complementarity of these approaches in relation to conventional methods in Neolithic obsidian provenance studies in the Mediterranean area.

Cernicchiaro G., Scorzelli R.B., Takeuchi A., Poupeau G. and Bigazzi G. (2002), 33rd Intern. Symposium on Archaeometry.

April 22-26, Amsterdam, Abstract book, p.32.

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*Electron Paramagnetic Resonance of Fe<sup>3+</sup> ion in obsidians from Mediterranean islands. Application to provenance studies.*

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Archaeological artefacts made of obsidian are all the more precious for archaeologists as they are witnesses of cultural, social or "economic" relationships between prehistoric populations. The main obsidian sources reachable in these times have been identified and characterized by chemical analysis and fission track dating. Because of iron presence (from 1 to 10 % expressed in Fe<sub>2</sub>O<sub>3</sub>) it is possible to use Mössbauer spectroscopy and Electronic Paramagnetic Resonance on geological samples to characterize different sources. We studied by EPR about a hundred of obsidians coming from six Mediterranean volcanic islands. The complex spectra are mainly due to iron in different states and site location (and sometimes isolated Mn<sup>2+</sup> ions). X-band (9 Ghz) spectra exhibit a signal at g=4.3 with a shoulder at 9.8 ascribed to isolated Fe<sup>3+</sup> in the glassy matrix with a rhombic environment (C2V), the intensity of which follows a Curie law. Condensed clusters of Fe<sup>3+</sup> ions give rise to a resonance line at g=2.0 whose intensity follows a Curie-Weiss law typical of antiferromagnetic coupling. This signal is sometimes associated with a wider line (1500 Gauss) at g=2.2. In addition to these signals whose position and width do not depend on temperature, broad resonance lines occur and move to weak fields when temperature decreases (from 300 to 5 K), at the same time their width can increase or decrease. These signals are attributed to micro-crystals of oxides (hematite, magnetite, iron silicates, pseudobrookite) as inclusions into the amorphous matrix of obsidian. The contribution of every signal to EPR spectrum is different from a source to the other according to the different thermodynamic conditions that occurred during obsidian formation. It is thus possible to discriminate a priori one geological source from another using EPR spectra. At room temperature the first differences appear at X-band, low temperatures and Q-band experiments allow to remove some ambiguities.

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*A study on the chronological distribution and exchange of Çayönü obsidians by FT dating and INAA techniques*

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In this study we have concentrated on the obsidian artifacts from one of the most reputed Neolithic sites of the Near East, known as Çayönü, located north of the provincial center of Diyarbakir, revealed a unique sequence of occupation from the beginning of the Pre-Pottery Neolithic Period, extending for over 3 thousands years, ranging from 10 000 BP up to 7000 BP.

An interdisciplinary provenance study of the Çayönü obsidian artifacts was carried out using the fission-track (FT) analysis and the instrumental neutron activation analysis (INAA). FT as well as INAA results reciprocally agree and confirm the conclusions of previous studies which are: (1) all artifacts originated from sources located in eastern Anatolia, (2) the main source of the analyzed samples was the wide volcanic field located in the Bingöl – Solhan – Karlioiva triangle, ~ 100 km NE of Çayönü and (3) the Quaternary obsidian-bearing volcanic edifices (such as Mt. Nemrut Dağ) situated along the north coast of Lake Van are also represented.

The identification of the provenience of artifacts contributes to the reconstruction of the ancient exchange network and may provide important information concerning contacts among regions. The available data-set regarding the Anatolian obsidian occurrences potential sources of raw material for tool making is still incomplete, therefore in some cases only a generic attribution can be made. Consequently, our data on artifacts from Çayönü and other Anatolian sites are not yet complete enough to permit a full description of the obsidian prehistoric exchange pattern. However, they represent a solid contribution to a better knowledge of circulation of obsidian in this region.

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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, and;
4. Provide a central source of information regarding the advances in obsidian studies and the analytic capabilities of various laboratories and institutions.

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