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NEWS AND INFORMATION

Student Paper Award

We are seeking nominations for the 2012 Student Paper Award. This award is open to any student who has presented a paper at an academic conference in 2012. Self-nominations are also accepted. Please send your nominations to Ellery Frahm at e.frahm@sheffield.ac.uk

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 cdillian@coastal.edu Thank you for your help and support!

From the IAOS Webmaster:

NEW IAOS ONLINE LIBRARY AVAILABLE FOR A SNEAK PREVIEW

Please see the IAOS Home Page for news about our new online PDF library at http://members.peak.org/~obsidian/library_index.html. We're assembling a rapidly-growing collection of obsidian-related literature and have so far put together a fairly random group of articles, papers, monographs, theses, and dissertations. If you have Adobe Acrobat versions of any of the above to contribute to the library, please contact me, Craig Skinner, at cskinner@obsidianlab.com (or simply attach the PDF's to the email) and I'll get them posted promptly.

NOTES FROM THE PRESIDENT

Summertime (or wintertime for those in the Southern Hemisphere) greetings to everyone! I am excited to be writing as the new President of IOAS after taking over the leadership from Tristan Carter at the Society for American Archaeology conference in Memphis, Tennessee. The official IAOS President's sceptre is actually heavier than Tristan made it look, and of course, TSA did not let me carry it onto the plane -- something about the inlaid obsidian blades.

IAOS had a strong presence at the SAA conference this year. Mike Glascock organised the oral session "A World of Obsidian: Sourcing, Dating, and Beyond." with nine presentations as well as two discussants. Eight of the presentations came from archaeologists working in the New World, Northeast Asia, and the islands between (and I was the odd Old World participant). Ana Steffen organised a poster session called "Obsidian Studies across the Americas: Alaska to Argentina and Beyond" with twelve posters. Thus it was the year of the Americas for IAOS sessions! In other sessions, I noted at least 30 additional talks and posters involving obsidian sourcing, dating, and technology from around the world. With more than 50 posters and talks to see and hear, there was much for obsidian enthusiasts to do at SAA this year.

Additionally, SAA featured the IAOS-sponsored "pXRF Shootout" organised by Jeff Speakman, Steve Shackley, Mike Glascock, and Arlen Heginbotham. Usually analytical round-robins involve sending out subsamples from characterised specimens to laboratories scattered around the world. In this case, however, the instruments could be brought to one set of 12 obsidian specimens. As noted in the advertisement for the shootout, its purpose was "to evaluate the current state of inter-laboratory reproducibility when conducting quantitative portable XRF analyses of obsidian." This shootout was essentially a sequel to the round-robin organised by Mike Glascock in 1996-1999 – in which subsamples of two obsidian specimens were analysed by eight laboratories around the world, and the results were tabulated and published as a special report in *IAOS Bulletin* #23 (online: http://members.peak.org/~obsidian/iaos_bulletin_23.pdf). I encourage those who have never examined this report to do so and consider the data and their implications.

Regarding the shootout, I have argued previously (*Geoarchaeology* 27:166-174) that assessment standards are critical as researchers increasingly propose compiling obsidian data from numerous laboratories, using various techniques and procedures, into a core repository for sourcing purposes (e.g., the "obsidatabase" advocated by Varoutsikos and Chataigner at last year's SAA). Much like the proverbial bad apple spoiling the whole bunch, inclusion of low-quality data, if unrecognised, could lead to source-assignment errors, invalidating the entire endeavour. A systematic evaluation framework should be adopted before there are serious efforts to aggregate such databases. Is this, though, a common (or desirable) practice? How frequently do we analyse obsidian artefacts using one instrument or technique and compare them to data from another? One advantage of pXRF, in my mind, is that geological specimens can be so easily analysed over and over again, which could alleviate much of the reliance on legacy data. That being said, the "big four" labs (i.e., MURR, the Geoarchaeological XRF Laboratory, the Northwest Research Obsidian Studies Laboratory, and the Geochemical Research Laboratory) have analysed more than 100,000 artefacts and specimens, and we should strive for compatibility with their vast databases (although not necessarily at the expense of one's research goals). That's more than enough philosophising for now, and we can leave such methodological reflections for another venue, perhaps a roundtable at SAA.

I have been asked many times about the outcome of the pXRF shootout, for which I have no answer yet. Fortunately the *Journal of Archaeological Science* has expressed their interest in publishing the results, so there will be widespread access to the organisers' final report. Until then, I can share my data as a teaser (Figures 1 and 2). On these scatterplots, the twelve obsidian specimens, on each of which three measurements were taken, are represented by unique colour/shape combinations. With just six elements (Sr, Rb, and Zn on one plot and Ba, Nb, and Zr on the other), their twelve different compositions are clearly distinguished. Assuming these specimens are representative of the sources from which they came, it seems there would be no issue in assigning artefacts to them. Precision is most important for any individual sourcing study, so an assessment (or however much is possible based on just three measurements) of precision for the various participants' instruments would be of interest. The accuracy assessments should be insightful as well. Accuracy is, of course, the product of instrument-specimen-analyst interactions, and how the instrument converts raw X-ray counts into elements' concentrations is the primary factor in its accuracy. That is, accuracy is largely dependent on an analyst's empirical choices about calibration, and I think we'll see that in the shootout results. Like everyone else, I am eager to learn the results, and I thank Jeff, Steve, Mike, and Arlen for their initiative and for taking a lead in furthering a discussion in which there is great interest not only in the realm of obsidian sourcing but also in our larger archaeological community.

In other SAA-related news, after about 15 years of trying (thanks largely due to Rolfe Mandel at the University of Kansas), SAA has agreed to become an affiliated society with the Geological Society of America (GSA). This means that SAA members will be able to attend GSA conferences at much lower prices, purchase GSA publications at member prices, and so forth. I am told that SAA will be putting a full-page advertisement in a forthcoming *GSA Today* issue, publicising the society to GSA members. Furthermore, this gives us an in-road for similar efforts and join-ventures. If you are not familiar with GSA, in 1977, George "Rip" Rapp (under whose guidance I first studied native copper and eventually obsidian) founded the Archaeological Geology Division (AGD). The AGD has long been a *de facto* sister society of SAA's Geoarchaeology Interest Group, but now that will be official. Each

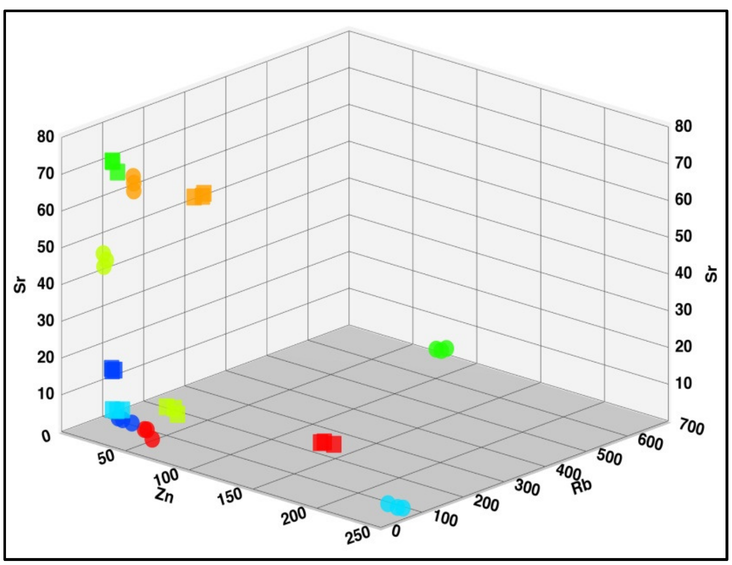

Figure 1: Sr, Rb, and Zn.

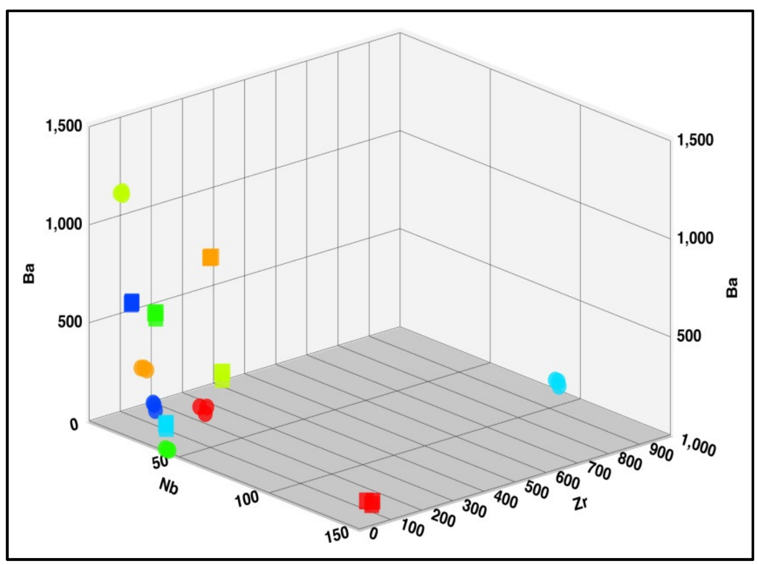

Figure 2: Ba, Nb, and Zr

year at the annual GSA conference, the AGD sponsors numerous sessions -- this fall there will be seven sessions involving the interfaces of archaeology and geology.

Speaking of upcoming conferences, we are already talking about next SAA in Hawaii. Two current proposals discussed at SAA are (1) an oral session in which invited experts, who work in the "Ring of Fire," would discuss the state-of-the-art in obsidian studies in their respective regions around the Pacific and (2) a poster session with a yet-to-be-identified overarching theme that demonstrates the types of archaeological questions for which obsidian sourcing is highly insightful. We are hopeful that, in Hawaii, we can attract obsidian researchers from New Zealand, Japan, and other countries, especially if the oral session becomes a "who's who" of Pacific archaeology. I am also hopeful we can keep in mind, perhaps at future SAAs, Tristan's suggestion that we devise a session that draws lithic technologists who investigate obsidian from techno-typological viewpoints. The Prehistoric Quarry and Early Mines (PQEM) Interest Group has done so in the past, and their sessions have, in my view, greatly benefited from the lithicists' perspectives.

Attracting lithic technologists to a session involves the larger issue of IAOS visibility. Ana Steffen did a fantastic job ordering and distributing IAOS ribbons at SAA. I was asked many times about my distinctive vertical black and silver ribbon. These ribbons were a great success (and I think we may have unleashed a floodgate of mischief regarding custom ribbons at SAA), but we need to do more to keep IAOS healthy and active. Among the issues discussed at the IAOS business meeting (and the bar afterward) were having a booth at future SAA meetings (like groups such as Forensic Archaeology Recovery) and having visibility-enhancing IAOS merchandise, including a low-cost compendium of "best of" *IAOS Bulletin* articles and/or a cheeky calendar of IAOS members. Any additional suggestions from the membership are most welcome.

Keeping in mind my campaign promise to increase international membership and visibility, I have increased our international membership by moving across the Atlantic. In January I concluded my postdoctoral research position in the Department of Earth Sciences at the University of Minnesota, and I started a Marie Curie Experienced Research Fellowship in the Department of Archaeology at the University of Sheffield in England. Led by the University of Cyprus, the international project is the New Archaeological Research Network for Integrating Approaches (a.k.a. NARNIA) to ancient material studies, focused primarily on the Eastern Mediterranean. I am happy to be working now in Cyprus and bringing copper production to regional exchange models that also involve obsidian. In addition, I will be working to develop field applications of portable X-ray fluorescence (pXRF), and I am interested to collaborate with anyone conducting (or who wants to conduct) obsidian studies in Cyprus (or elsewhere in the Eastern Mediterranean) and who wishes to try a pXRF approach.

This summer I will also be continuing my research project in Armenia, where I am endeavouring to reconstruct Palaeolithic Armenian landscapes through obsidian sources' use-histories. I should use this opportunity to acknowledge/thank/embarrass my collaborators on the project: Daniel Adler and the Palaeolithic Studies Laboratory, University of Connecticut; Boris Gasparian, Armenian Institute of Archaeology and Ethnology; and (IAOS member) Khachatur Meliksetian and Sergei Karapetian, Armenian Institute of Geological Sciences. I am looking to expand the spatial and temporal ranges of archaeological sites in this project, and I will be bringing one of our pXRF analysers to Armenia, so also feel free to contact me regarding possible collaborations there.

My new home, Sheffield, has several

claims to fame. One is the film *The Full Monty* (which came up somehow during the IAOS calendar discussion). Another is steel production and metallurgy. A number of important metallurgical developments occurred in Sheffield: the crucible steel technique, silver plating of copper, stainless steel, modern high-strength steels, etc. Amongst its steel products is cutlery, and every museum has at least a small Sheffield cutlery display. At one museum, though, their cutlery collection has expanded, and I was particularly pleased to see an obsidian dagger from Papua New Guinea, circa 1850 to 1930, on display (Figure 3). The other relevant claim to fame (at least for the IAOS members) is that, from 1965 to 1972, Colin Renfrew held the position of lecturer in the Department of Prehistory and Archaeology at the University of Sheffield, and he is primarily responsible for the strong Aegean focus of our department. If one searches around the department, one will find the occasional shrine with offerings, usually candy (Figure 4).

If you have not visited the IAOS website recently, please do so. Craig Skinner has been working on the PDF library -- look for it under the "IAOS Resources" heading on the left side of the main page. There one can find a variety of obsidian-focused articles, reports, manuscripts, theses, dissertations, and more for download as PDFs. Please also send Craig any resources you wish to contribute -- his email address can be found at the top of the library page.

Many thanks for your votes, and I look forward to my role as IAOS President. Please feel free to contact me at any time with whatever comments or suggestions you have.

Warmest regards,

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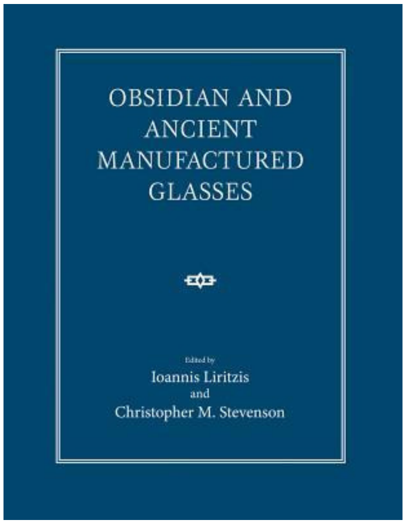
Department of Archaeology
The University of Sheffield

Figure 3: Obsidian dagger, Papua New Guinea.

Figure 4: Renfrew shrine (with offerings)

NEWS AND NOTES: Have announcements or research updates to share? Send news or notes to the *Bulletin* editor at cdillian@coastal.edu with the subject line "IAOS news."



NEW BOOK:

Obsidian and Ancient Manufactured Glasses
Ioannis Liritzis and Christopher M. Stevenson (eds.)

University of New Mexico Press (2012)
ISBN 082635159X $75.00

This edited volume offers archaeologists and archaeometrists the latest technical information, the fundamentals of provenance studies, instrumentation used in these investigations, and strategies for the dating and interpretation of archaeological materials in glass studies. The contributors discuss recent advances in obsidian hydration dating, secondary ion mass spectrometry, and infrared photoacoustic spectroscopy, focusing on the application of these technologies to a variety of glass forms and incorporating studies that look at the social and economic strategies of past cultures. With examples from Greece, the Middle East, Italy, Peru, Bolivia, Russia, Africa, and the Pacific region, provenance studies look at regional patterns of glass acquisition, production, and exchange, providing examples that use one or more instrumental methods to characterize materials from ancient societies. Extensive figures and tables included.

FIFTY YEARS OF OBSIDIAN SOURCING IN THE NEAR EAST: CONSIDERING THE ARCHAEOLOGICAL ZEITGEIST AND LEGACIES OF RENFREW, DIXON, AND CANN

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Two illustrations from the 1968 *Scientific American* article by John Dixon, Joseph Cann, and Colin Renfrew are, without doubt, the most frequently reproduced figures in all of obsidian sourcing. Their map generalising the spatial distribution of obsidians across the Neolithic Near East and their graph of the "fall-off curves" for obsidian abundance in the corresponding flaked-stone assemblages are, amongst many other venues, included in Colin Renfrew and Paul Bahn's textbook *Archaeology: Theories, Methods, and Practice*. The book, now in its sixth edition, has been used by more than 200,000 archaeology students since 1991. Like most of those students, my first exposure to obsidian sourcing was that part of the "Trade and Exchange" chapter (soon followed by Kent Flannery's *The Early Mesoamerican Village*). The figures, which represented the research of Renfrew, Cann, and Dixon (hereafter RDC for simplicity) so succinctly, had core roles in popularising obsidian sourcing. Approaching 50 years old, their work still represents the largest single regional-scale obsidian-sourcing study in the Near East. Today, however, obsidian sourcing in Near East archaeology lags behind that in the New World (where the largest regional-scale study included over 9000 obsidian artefacts from over 130 Pacific Northwest sites; Skinner 1995). What was the archaeological backdrop that led RDC to start their obsidian work in 1962? What led a lull in Near Eastern obsidian sourcing during the 1980s and 1990s until a recent "new wave"? What can the past and present of obsidian sourcing tell us about its future?

The Archaeological Backdrop

The 1960s research of RDC in the Mediterranean and Near East is often cited as the start of obsidian sourcing. Their collaboration is surely the most well-known obsidian sourcing work; however, the idea of obsidian as evidence of exchange and mobility was not new. For example, John Lloyd Stephens, in his 1843 book *Incidents of Travel in Yucatan*, describes a ceramic vessel filled with obsidian points, and he concludes, "as there are no volcanoes in Yucatan from which obsidian can be produced, the discovery of these proves intercourse with the volcanic regions of Mexico" (232). In the Mississippi Valley, Squier and Davis (1847) discussed the occurrence of obsidian points in burial mounds, and they proposed that comparing these artefacts to geological obsidian occurrences "might serve to throw some degree of light upon the origin and connections of the race of the mounds" (212).

Various intellectual trends in archaeology inspired the work of RDC as well. Grahame Clark, one of Renfrew's professors at Cambridge, published *Prehistoric Europe: The Economic Basis* in 1952. In this book, he argued archaeologists can explore cultural elements of ancient societies, such as their social organisation or perhaps even more abstract ideas, by studying the sources of the societies' materials and their movement. In particular, he focused on stone axes in Neolithic Europe, and this continued to be a topic of interest to Clark into at least the 1960s (e.g., Clark 1965). Clark, and likely Renfrew, would also have been familiar with other early sourcing studies, as covered by Pollard and Heron (1996:3-6), including

Thomas' petrographic studies to determine the sources of the Stonehenge bluestones (Thomas 1923). Additionally, interest in the transportation and storage of raw materials was gaining momentum as Lewis Binford formulated the concept of space utility (1965): "Space utility is gained when energy and matter can be put to work over a greater geographical area by transporting them beyond the geographical area from which procured" (Binford 1967). Kroeber's cultural diffusionism was another central influence.

Melos and Cultural Diffusionism

The earliest research of RDC was an endeavour to confirm or refute the widespread belief that the Aegean island of Melos was the origin of most obsidian artefacts discovered around the Mediterranean and Near East. This belief was strongly influenced by Alfred Kroeber's cultural diffusion hypothesis: just as ideas or cultural elements such as religion and language can diffuse outward from one source area into surrounding regions, so too can technologies or materials like obsidian spread from a core to other areas and cultures. Thus the occurrence of Melian obsidian at a site could be interpreted as a proxy for the spread of Aegean culture.

Some early studies of obsidian in the Mediterranean and Near East seemed to support the Melian origins for many widespread artefacts. For example, in 1909, Thomas Eric Peet, known principally as an Egyptologist, explained that circulation of obsidian across the Italian mainland and Mediterranean islands "is a question of great interest and importance" (150). The obsidian flakes and cores found at an archaeological site in southern Italy, he argued, appeared, "judging from its transparency and lustre, to be from Melos and not Italian" (150). Cornaggio-Castiglioni, Fussi, and D'Agnolo (1962, 1963) used wet chemical analyses, as Georgiades (1956) had earlier, and they concluded, based on their manganese and phosphorous measurements, that obsidians at Italian archaeological sites primarily originated from Melos.

There were also advocates for local obsidian use, including Jean-Jacques de Morgan, a French archaeologist and mining geologist. For a period in the late nineteenth century, he was the Director of Antiquities in Egypt, and he excavated at the sites of Susa and Persepolis in Iran. He also became the manager of a copper mine in Armenia, where he continued his archaeological fieldwork. In the 1880s, de Morgan surveyed the obsidian outcrops of Mounts Ararat and Alagöz along the current Turkey-Armenia border. It is not clear what other obsidian sources with which de Morgan was familiar, but he proposed, based on his inspection of their colours, that obsidian found in Mesopotamia originated from these, or nearby, sources and arrived there via exchange from Armenia and Turkey (de Morgan 1927). His work in the 1880s is among the earliest efforts to source obsidian in Mesopotamia and the Caucasus.

In 1904, in a report on excavations at the Bronze-Age settlement of Phylakopi on Melos, archaeologist R.C. Bosanquet wrote:

> Melos, being the principal if not the only source from which [obsidian] could be obtained by the peoples of the Aegean, seems from very early days to have had commercial relations not only with the neighbouring islands and the Greek mainland, but with the coast of Asia Minor and even with Egypt. This regular intercourse and the prosperity resulting from it must have done much to foster the vigorous local civilisation revealed by the excavations at Phylakopi (216).

He expressed disappointment that, at the time, it was not possible to differentiate obsidians from Melos and other sources. Therefore, he concluded that "it is only in the Eastern

Mediterranean that we may safely treat obsidian as evidence of trade-relations with Melos" (229). He suggested that Lipari, Sardinia, and Pantelleria islands were the obsidian sources used in the Mediterranean whereas "the Caucasus and Russian Armenia for any found in the Black Sea and in eastern Asia Minor" (229). Bosanquet warned, though, that "petrological examination is necessary before the connection can be regarded as proved" (229). He speculated: "Some day, when more evidence has been collected, it may be possible to map the Obsidian Routes of the ancient Aegean world and to show in detail how during 3,000 years or more the traffic flowed in the same immemorial channels" (233).

In 1927, Near Eastern archaeologist Gerald Wainwright considered the obsidian artefacts used by ancient Egyptians, and he wrote:

> the presence of obsidian objects in a non-volcanic country is proof of trade with some centre of volcanic activity. Unhappily the scientific identification of any given piece of obsidian with specimens from any one deposit is beset with difficulties, so that it is at present impossible to say categorically that the given piece did, or did not, come from a certain locality. (77)

He discussed current thought about obsidian exchange across the Near East and maintained that a preoccupation with "Melian obsidian trade has so engrossed archaeologists' attention as to blind them generally to other possibilities" (77). Wainwright contended:

> when obsidian is found to be in such common use as it is in Armenia and Mesopotamia, it is hardly possible to refer so vast a trade to an island so small and so remote as Melos until all possibilities of a nearer provenance have been exhausted. As a matter of fact there is a great obsidian field close at hand in Armenia itself upon which the Near East may have drawn without the necessity of going all the way to the farther side of the Aegean. (78)

Thus, popular opinion, chemical evidence (Cornaggio-Castiglioni et al. 1962, 1963), and at least one visual investigation (Peet 1909) proposed that Melian obsidian (and, with it, Aegean culture) had diffused throughout the Mediterranean and Near East. On the other hand, some argued that local sources were more likely used (e.g., de Morgan 1927, Wainwright 1927).

It was within this archaeological *zeitgeist* that Colin Renfrew approached Joseph Cann about characterising and potentially sourcing Melian and other obsidians:

> There was an important obsidian source on the Cycladic island of Melos. When I began to think about the Cyclades, I saw that this presented a fascinating problem and that it ought to be possible to do something with it technically. An old school friend of mine, Joe Cann… was a fellow of St. John's College at that time and a research worker in the Department of Mineralogy and Petrology. It seemed very natural to discuss the problem with him, and we looked together at things like refractive index and specific gravity, which turned out to be no use at all, and it was he who suggested the optical emission spectroscopy approach. Then we did it very much together. We selected the material systematically and sat there grinding up the samples with pestles and mortars. A senior technician in their department ran the samples through the spectroscope, and Joe read off the data from the resulting photographic plates. (Renfrew in

Bradley 1993:74)

Thus the research of RDC was not initially conceptualised as an anti-diffusionist model:

> the obsidian work arose out of the specific wish to characterize the Aegean material. Then when the result came through, it did prove to be anti-diffusionist in the sense that there was no Aegean obsidian in the West Mediterranean and no so-called liparite in the Aegean through the Bronze Age and into the Neolithic… so it did undermine the idea of very long-distance links in the Neolithic period. But that came as the result of the study; it was not an *a priori* belief. (74)

Hence their research started as a way to investigate the Cycladic culture of the Early Bronze Age. The Cycladic culture, a mixture of Anatolian and Greek influences, reached its height during the third millennium BCE before its assimilation into Minoan culture during the second millennium. Their later publications (Renfrew et al. 1965; Renfrew 1972, 1975) used their obsidian sourcing results to investigate development of the Minoan state and Mycenaean Greece and their roles in Bronze-Age Aegean exchange systems.

From the Aegean to Mesopotamia

Although first developed for studying the Bronze-Age Aegean, obsidian sourcing has been rarely applied to Bronze-Age Mesopotamia. Instead, the Neolithic revolution in the Near East, especially the origin of urbanism and agriculture, was an emerging topic of interest. It was hoped that the distribution of obsidian across the Near East reflected the spread of agriculture in the Fertile Crescent. Archaeologists, especially those at the University of Chicago Oriental Institute, sought to identify the Neolithic villages where agriculture developed and the mechanisms by which this invention spread from village to village, which were thought, at this time, to have been fairly isolated. The spread of obsidian throughout the Near East, even during the Neolithic, showed that these settlements were not isolated and hinted that, as obsidian moved, so too could have ideas, such as agriculture. Large Neolithic villages, such as Çatalhöyük, soon were interpreted to be obsidian trading centres, as proposed by Mellaart. Obsidian sourcing was also seen as a way to explore Gordon Childe's theories about nomads versus sedentary farmers. He had already proposed that the long-distance spread of exotic materials like obsidian could be explained by nomadism and the mobility of pre-agriculturalists.

The excitement about obsidian sourcing in the Near East and Aegean (which has been likened to a "gold-rush" by Özdoğan 1994) was due to existing topics of great archaeological interest in those regions. In the Aegean region, it was the development of the Minoan state and Mycenaean Greece and their roles within exchange systems, notably the circulation of Melian obsidian, during the Bronze Age. In the Near East, it was the rise of agriculture and the mobility of human groups during the transition from pastoral nomadism to sedentary agricultural villages. The interconnectedness of the Neolithic villages could also be explored using obsidian sourcing. It seems, as these topics were "answered," there was less interest from Near East archaeologists in the tool used to do so (i.e., obsidian sourcing). Thus, particularly for post-Neolithic contexts, obsidian sourcing has seen relatively little recent use in the Near East.

An Overview of Renfrew, Dixon, and Cann's Research

In 1962, RDC started their research after settling on optical emission spectroscopy

(OES), which required 60 mg of powdered material, as their analytical technique. The analysed artefacts outnumbered their geological specimens. In fact, the obsidian spatial distributions in Renfrew et al. (1966) are based on: (1) chemical analyses of 33 Anatolian geological obsidian specimens and 132 artefacts from 42 Near Eastern sites, (2) the abundance of obsidian in the lithic assemblage of 14 sites, and (3) the fraction of green obsidian at 12 sites. Another 28 artefacts from 11 sites were added in Renfrew et al. (1968). In other words, their model is built largely upon chemical analyses of 160 artefacts from 53 sites, and colour reports from 12 sites.

RDC proposed that the observed distribution patterns may reveal exchange mechanisms and, perhaps, whether nomadic bands or settled agriculturalists were involved. This endeavour introduced the concepts of "supply zone" and "contact zone" as well as the use of fall-off curves (which are straight on their logarithmic plot) and the "Law of Monotonic Decrement," that is, the quantity of obsidian decreases at a particular rate as a function of distance from its source. RDC propose that, within a supply zone (where at least 80% of the lithic assemblage is obsidian), the craftspeople themselves, without intermediaries or traders, would have collected obsidian from the source. Beyond the supply zone, within the contact zone, obsidian was acquired via contact with other groups. Therefore, according to RDC, obsidian served as an indicator of "contact" between different Neolithic groups, and one may, in turn, define the range of the groups and their contacts. Çatalhöyük was a major influence on the size of the "supply zones" -- the abundance of obsidian there, at various times, ranged from 89% to 97%, and this site is about 250 km from Göllü Dağ. This one data point had a large effect on the observed fall-off rate, so the supply zone radius, at least for Central Anatolia, is approximately 300km.

Their obsidian distribution patterns covered three basic geographical regions: the Levant, Cappadocia (especially the Konya Plain, where Çatalhöyük is), and the foothills of the Zagros Mountains (eastern Mesopotamia). RDC proposed that, based on the different "fall-off rates" for the two main obsidian source areas and the distribution patterns, Central Anatolian obsidians may have been circulated by sedentary villagers (agriculturalists) whereas Eastern Anatolian obsidians may have been spread by migration of nomadic groups (pastoralists). In particular, RDC offered a model of "down the line" exchange, in which obsidian moved between groups by a series of exchanges, to account for exponential decline in its abundance with distance. One implication of such exchange is that there need not be traders or formal organisation.

Later, additional components were added to the RDC model, such as obsidian interaction zones and the gravity model. An "obsidian interaction zone" is an area within which all the sites have at least 30% of obsidian from a particular source, and a particular site can belong to more than one interaction zone. These overlaps mostly occur at sites in the Levant, like Tell Ramad in the Damascus Basin. These zones were intended to describe the spatial distribution of obsidian, not mechanisms of exchange. The gravity model added an "attractiveness" to particular obsidian sources that would have been related to, for example, material quality. If obsidians from various sources were available at a site, their relative abundances in the lithic assemblage would reflect the inhabitants' perceived "attractiveness" of those obsidians. In other words, it was suggested more attractive obsidians should "outcompete" the less attractive obsidians.

When it was observed that, especially in the fifth millennium BCE and later, the fall-off rate was always non-monotonic, the model was further revised. First, geographic features were added as a component, so distances were revised to include natural barriers such as mountains and deserts. Second, redistribution from a central place was suggested as another explanation. Obsidian could have moved monotonically among central places, from which it could have been redistributed to neighbouring settlements. Development of central place theory in archaeology was closely related to obsidian. This explanation was desirable because the origin of urbanism was another topic of interest, and sites like Çatalhöyük and Jericho were being called the "first cities." Another suggestion was that obsidian followed other raw materials, which had different starting and ending points and which perhaps preceded the circulation of obsidian.

Wright (1969) offered some early criticisms of RDC's techniques. He suggested the mass of artefacts, not simply their counts, would be more insightful regarding the quantity of obsidian present at a site. He also proposed that RDC should not have simply lumped together all of the obsidian abundance data, regardless of time period, onto only one graph to show the fall-off. In addition, Wright argues that the type of site (e.g., permanent farming village, seasonal nomadic settlement) must also be considered. He suggests other factors as well: the availability of chert locally, the uses of obsidian, and whether obsidian arrived as raw material or finished artefacts. The existence of additional obsidian sources in Central Anatolia (i.e., besides Acigöl and Göllü Dağ) was also proposed by Wright as a result of recent field surveys.

Other criticisms primarily involved their fall-off curves, supply and contact zones, and obsidian interaction zones. In Hallam et al. (1976), an obsidian interaction zone was defined as the area within which at least 30% of the artefacts originated from a particular obsidian source. Henderson (2001) pointed out, "by increasing the percentage for the definition of an interaction zone from 30% to 50%, we could produce a rather different, more contracted pattern leading to a different archaeological interpretation" (310). The "down-the-line" interpretation was questioned by Hodder and Orton (1976), who showed simple random-walk patterns, generated by computer simulations, could reproduce the curves reported by RDC. Thus, it seemed that quite different processes could lead to the observed fall-off curves. This determination was made while Schiffer was developing the concept of site formation processes, so it was accepted that a map of obsidian artefacts may not accurately reflect the true nature of exchange systems. Accordingly, Crawford (1978), among others, left out the mathematical component of modelling obsidian circulation and focused on ethnographic approaches to consider exchange.

A Shortage of Data Remains

Chataigner et al. (1998) estimated that, among "the artefacts from the Near East analysed in the past 30 years, there are... a total of 750" (533). According to my tally, there are about 1600 sourced artefacts from all of Mesopotamia and the Northern Levant from the PPNA until the Late Bronze Age. Even if I overlooked a few studies, the point is that relatively few artefacts from the Near East have been sourced compared to the New World. The number of sourced artefacts from New World sites exceeds that from Near Eastern sites by two orders of magnitude.

In the 1960s and 1970s already, at Berkeley, Robert Jack and Thomas Jackson analysed over 1500 obsidian artefacts, mostly from California (Shackley 2008). Forty years later, about 100,000 New World obsidian artefacts have been sourced. Three XRF laboratories (Shackley's Geoarchaeological XRF Laboratory, Skinner's Northwest Research Obsidian Studies Lab, and Hughes' Geochemical Research Laboratory) have, over the years, collectively sourced 72,000 obsidian artefacts from the United States (Skinner 2010, personal communication). The University of Missouri Research Reactor Center (MURR) has, under the supervision of Michael Glascock, also sourced 24,000 New World artefacts (Boulanger 2010, personal communication). MURR has sourced 1600 obsidian artefacts from Belize alone, a country approximately the size of Massachusetts -- this is the same number of sourced artefacts from all of Mesopotamia and the Northern Levant in the last 50 years. The abundance of data in the New World, thanks to the fact that obsidian sourcing is considered a nearly routine element of excavation in many regions, has enabled archaeologists to recently develop and test sophisticated models of obsidian acquisition, distribution, and use in the Americas.

Essentially the only site in Southwest Asia where obsidian sourcing approaches this level of sophistication is Çatalhöyük on the Konya Plain of Turkey. This is due, in large part, to there being sufficient data (i.e., artefacts) from the site. In the past decade, over 700 artefacts have been sourced by Tristan Carter and colleagues. This quantity of data has revealed intricate details of obsidian procurement and circulation patterns in this Neolithic settlement (e.g., Carter et al. 2006, 2008; Carter and Shackley 2007). If these researchers had stopped when just one or two dozen artefacts had been sourced and it was clear that the obsidian mainly came from Göllü Dağ and Nenezi Dağ, any nuanced intra-site spatial and temporal patterns would not have been observed. Furthermore, the recently reported obsidian blades from Eastern Anatolia, which are unexpected based on the distribution patterns of RDC and comprise about 0.1% of the obsidian assemblage, would have been missed (Carter et al. 2008). Their discovery moves the Neolithic circulation of Eastern Anatolian obsidian much farther west than is shown in RDC's maps.

Why the 1980s and 1990s Lull?

A few explanations have been offered for why obsidian sourcing has seen relatively little subsequent use in the Near East, particularly in Mesopotamia. Tristan Carter has suggested that criticisms of RDC's research, especially that the observed obsidian distribution patterns were not necessarily explained by their models, basically had a chilling effect and affected "a broad retreat from using sourcing data to address such large-scale questions" (Carter, in prep). Subsequently, Carter points out, obsidian sourcing in the Near East has been primarily limited to single sites or small-scale regional studies. Indeed, most recent studies focus on either one site or on two to four sites in one river valley. Did such criticisms themselves cause a chilling effect on future work, or did archaeologists conclude that large-scale regional economics were too complex to investigate using this approach? Whatever the cause, only recent meta-analyses of sourcing data from prior studies by Chataigner and colleagues have come close to such wide-reaching obsidian research in the Near East (Cauvin and Chataigner 1998, Chataigner et al. 1998, Chataigner 1998).

Mehmet Özdoğan, who specialises in Neolithic Turkey, proposed another explanation: the work of RDC is a very good, albeit flawed, initial study and laid the framework for future studies in the Near East; however, it was presented with, and was perceived to have, such authority that the findings seemed conclusive. Özdoğan (1994) explained that their research...

> could have had a stimulating impact for a more thorough and systematic survey of obsidian sources, and a lot could have been achieved during the last 25 years... [W]hen initial results were presented as final, inevitably

> those who were not well accustomed with the particularities of research in Anatolia accepted the published facts as conclusive and intensified their research on elaborating the exact paths of the trade networks... Accordingly, in the course of these two decades, hundreds of obsidian artifacts were analyzed... in the hope of matching their finds to one of the 'obsidian cluster groupings of Renfrew,' and hence very little had been done for eventual documentation of the sources... We felt agitated at seeing how genuinely surprised some of our colleagues were, on hearing that there was yet no thorough documentation of obsidian sources in Turkey. It is contemptuous even to think how much has been published and debated on trade or exchange systems based on obsidian cluster groups from Anatolia. (425, 427)

Therefore, Özdoğan suggested the results of RDC seemed so definitive that, instead of spurring further development of obsidian sourcing (e.g., seeking new sources, analysing greater numbers of geological specimens and artefacts per archaeological site), time was spent developing models with insufficient data (i.e., sourced artefacts).

Olwen Williams-Thorpe (1995), in an article on the status of obsidian sourcing in the Mediterranean and Near East, showed that the number of published studies increased steadily from the mid-1960s until the mid-1980s. After about 1985, the number of papers decreased precipitously, reaching mid-1960s levels by the mid-1990s. She considered possible reasons:

> The decrease of papers in recent years is probably a reflection of several factors: first, the basic distributions are now established and it becomes rather less exciting to simply 'fill in the gaps.' Second, archaeological science has become increasingly focused on environmental and biochemical studies in recent years; in such a climate, lithic studies may gain less attention. And third, it is probably simply a reflection of fashion: obsidian research was a bandwagon on which many workers (including the present author) jumped with enthusiasm, but it has now lost its initial momentum. (235, 237)

Two hypotheses were offered here: (1) obsidian sourcing in the Near East has fallen out of favour as a popular topic in archaeological science and was replaced by such subjects as environmental archaeology; and (2) obsidian sourcing in the region is viewed as, for the most part, "complete," so future work need only follow a prescribed formula. She continued:

> The increase and now fall-off of archaeological obsidian research papers conforms to a well-established pattern of scientific research, reflecting the initial recognition of a problem, the increasing input to problem solving, followed by the decline in scientific attention as approaches (and interest?) are exhausted. (237)

Again the explanation is that the "problem" of obsidian sourcing had been "solved" to the point where it required little further attention. Williams-Thorpe recognised that this was not actually the case and that critical momentum seemed to have been lost:

> Developing a provenancing basis for obsidian (and other artefacts) produces an initial data base of results which remains valuable. However, a further aim of the development is that provenancing should become a routine

> part of post-excavation work. Without this, much of the point is lost... Obsidian studies in the area under review have become rather static. (237, 240)

Thus Williams-Thorpe identified a likely explanation: obsidian sourcing here is often considered so complete that more data (i.e., sourced artefacts) are rarely collected.

Similarly, as I previously mentioned, the excitement regarding obsidian sourcing in the Near East and Aegean likely was due to existing topics of great interest in those regions. In the Near East, it was the rise and spread of agriculture as well as the mobility of human groups and their interconnectedness during their transition from pastoral nomadism to sedentary villages. As these topics became "answered," there was less interest from Near East archaeologists in the tool used to do so. This explanation is closely related to those suggested by Williams-Thorpe (1995) and Özdoğan (1994): the line of investigation was considered "complete."

Regardless of what combination of these explanations is true, there are two more factors to consider. First, there is a cost for the chemical analyses to do obsidian sourcing, and there are many other costs to excavation and investigating the unearthed materials, so chemically sourcing obsidian artefacts may, out of necessity, not be one of the highest priorities. Second, traditionally the requisite analyses have been destructive, and the partial destruction and/or export of artefacts is much less tolerated in Near East archaeology. As a result, visual-based approaches are often considered a low-cost, non-destructive technique to "source" large numbers of artefacts on-site. There are, of course, questions regarding the efficacy of visual-based sourcing of Anatolian and Caucasus obsidians. Visual sourcing has been used recently with success at Çatalhöyük, but this is a special case in which the observers' scheme has been substantiated using chemical analyses. In contrast, at Mezraa Teleilat, Coşkunsu (2007) uses a visual classification scheme for obsidian based on colour, texture, and transparency; however, she reported that "sourcing analysis has not yet been undertaken" (37). There were no chemical analyses to corroborate her scheme or determine the number of obsidian sources or chemical types represented at the site. Hence, there is no way to know if these types represent anything other than appearance. Coşkunsu notes that her visual-based approach is the norm for the region: "It should be noted, however, that no serious counting or chemical laboratory analysis has been done to differentiate eastern from Cappadocian obsidian in many prehistoric sites" (41). Thus, widespread use of visual sourcing is yet another reason for previously low rates of analytical obsidian sourcing in the Near East.

The Future?

The past and present of Near Eastern obsidian sourcing offer three main hints of what the future holds. First, because the obsidian distribution patterns of RDC are based on an average of three artefacts per site, studies involving much larger numbers of artefacts will continue to reveal more nuanced spatio-temporal patterns, including patterns within the site itself, not only regional patterns. Many problems regarding models of obsidian distribution throughout the Near East are a direct result of too little data. New World studies with thousands of sourced artefacts reveal the potential for greater sophistication in Near Eastern obsidian studies.

Second, Near East obsidian sourcing, from the very start, has almost always been based on more artefacts than geological specimens from the sources. Özdoğan (1994) stated that, at the time, most Near Eastern sourcing studies were "still based on the random and hasty collection of source material, either from a few reputed sources or from those that are easily accessible" (423). Similarly, Rapp and Hill (1998) asserted that "considerable research has been devoted to locating Anatolian obsidian sources and determining chemical fingerprints for them... [A]s of 1996, this database may be misleading for two reasons: not all potential source deposits have been sampled, and many deposits were not sampled systematically" (137-138). Robert Cobean (2012) recently called for greater study and characterisation of obsidian sources, and he likened source sampling to astronauts who visit the moon, grab a few specimens from one spot, and leave. Refinement of our knowledge regarding Near Eastern obsidian sources is on-going, as recently demonstrated by further elaboration of the obsidian sources at Göllü Dağ, the most broadly utilised of the Central Anatolian sources (Binder et al. 2011). This study also illustrates that, as sampling strategies and analytical precision improve over time, sources' observed complexity increases. What was once one source for RDC is now a complex with seven compositions of obsidian. Although this issue of source characterisation has improved with the "new wave" of Near Eastern obsidian sourcing, many recent studies still include fewer than a dozen obsidian source specimens. The future also will likely involve a greater return to the field for surveying and sampling.

Finally, the prevalence of visual-based obsidian sourcing, even five decades after the rise of analytical sourcing, indicates a desire to collect more source data and a need for such work to be done on-site and non-destructively with speed and low cost as bonuses. Visual sourcing is not used because researchers consider it better than analytical sourcing; instead it is used as there has traditionally been no other alternative if the artefacts cannot be exported or destructively sampled for chemical analyses and/or if the budget allowed for analyses of 100 artefacts but not the entire assemblage of 1000 artefacts (because analytical costs are traditionally based on either number of specimens or time). Clearly field-portable XRF (fpXRF) is well poised to replace visual obsidian sourcing. A number of recently published obsidian sourcing studies indicate a high potential for great success, particularly regarding the numbers of artefacts now available for sourcing. fpXRF has, of course, been met with debate and scepticism; however, even the most doubtful among us will have to admit that fpXRF has already proven more successful and reliable than visual-based sourcing. Furthermore, because sourcing is our means of study, not its end goal, and because, as discussed here, there remains a lack of data in the Near East after five decades, it is encouraging that, when used sensibly and evaluated carefully, fpXRF can expand the range of individuals who can make compositional measurements of obsidian. This will not necessarily undermine the role of experts in obsidian sourcing. On the contrary, the proliferation of fpXRF analysers will likely raise the demand for expert knowledge to ensure their effective use. It might not be the obsidian expert who actually pulls the trigger, but it will likely be an expert who decides when it is pulled and how the resulting data are used to assign artefacts to sources.

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