

## 1.2. THE CONTRIBUTION OF OBSIDIAN CHARACTERIZATION STUDIES TO EARLY PREHISTORIC ARCHAEOLOGY

### Résumé

Cet article détaille le rôle caractéristique que peut jouer l'obsidienne dans les études d'archéologie préhistorique ancienne. Nous allons tenter d'examiner l'apport des débats récents sur le développement cognitif de l'hominidé archaïque, la complexité sociale, la question de la mobilité néandertalienne et comment l'approvisionnement en obsidienne met en lumière le processus de colonisation à l'échelle globale. Méthodologiquement, on pense qu'en adoptant un cadre global pour la chaîne opératoire, intégrant les données élémentaires des artefacts avec leurs caractéristiques technotypologiques, on pourra maximiser le potentiel interprétatif de nos données et fournir des moyens plus puissants pour reconstituer les réseaux passés d'interactions, ou de 'communities of practice'.

### Abstract

This paper details the interpretative role obsidian characterisation studies can play in earlier prehistoric archaeology. It reviews recent contributions to debates on early hominin cognitive development and social complexity, the question of Neanderthal mobility, and how obsidian sourcing is shedding light on colonisation processes globally. Methodologically it is suggested that by adopting a more holistic *chaîne opératoire* analytical framework, which integrates an artefacts' elemental data with its techno-typological attributes, we can maximise the interpretative potential of our data, and provide a more powerful means of reconstructing past networks of interaction, or 'communities of practice'.

**Keywords:** obsidian characterisation, Palaeolithic, hominins, Neanderthals, cognition, mobility, colonisation, communities of practice

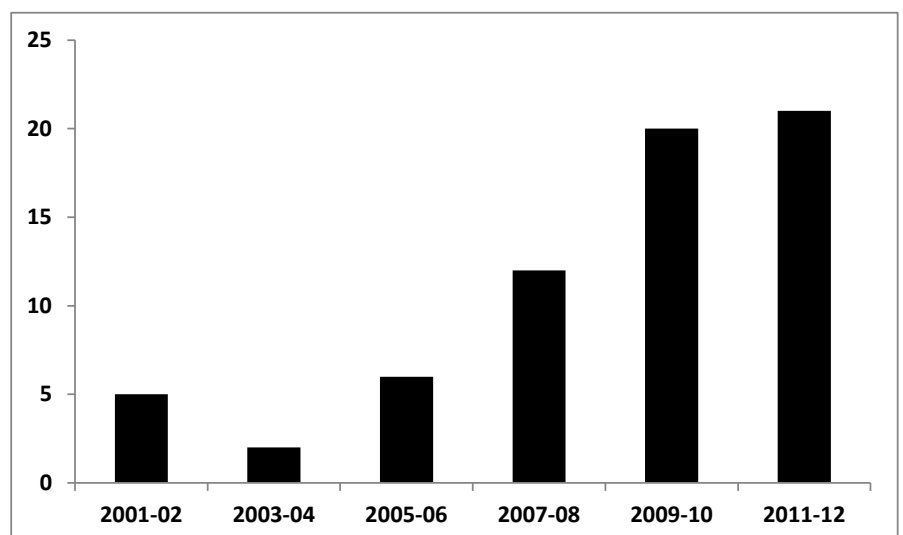
### 1 – Obsidian characterisation studies in the 21<sup>st</sup> century

Over the past 50 years obsidian sourcing has become a well established method, one of the great success stories of archaeological science (Carter *in press*; Freund, 2013). In the Old World scholars the studies of Colin Renfrew and colleagues in the 1960s represents the field's seminal work, not only for their methodological innovations, but also for the fact that they were using this technique to ask some major research questions of global archaeological significance (Renfrew *et al.*, 1965, 1966, 1968, *inter alia*). This is a hugely important point to remember, namely that obsidian sourcing for Renfrew was a *means to an end*. The work was not just about reconstructing source histories and raw material distributions, but to use these data to interrogate emergent societal complexity and to propose society-specific modes of behaviour (Renfrew 1975). Ultimately however, there were problems with the claim that different distribution patterns could be equated with distinct modes of exchange, and by extent different types of society (Hodder and Orton 1976: 138). This led to something of a lull in sourcing studies, with few large scale projects in the region during the 1970's and 80's (though see Williams-Thorpe *et al.*, 1984a, 1984b). This radically changed in the 1990's with a new wave of Eurasian projects whose results provide us with rich histories of raw material exploitation, and the ability to chemically discriminate the products of the region's major obsidian sources (Cauvin *et al.*, 1998; Chataigner *et al.*, 2003; Cherry *et al.*, 2010; Delerue 2007; Frahm 2012; Gratuze 1999; Le Bourdonnec 2007; Oddone *et al.* 1999; Poupeau *et al.*, 2010; Tykot 1996, *inter alia*).

This increase in obsidian characterisation studies is a global phenomenon, with the

Figure 1

Number of obsidian characterisation papers published in *Archaeometry* and the *Journal of Archaeological Science* over the past decade.



**Table 1** – Obsidian distribution in early prehistory by units of social networking (ESA/MSA = Earlier/Middle Stone Age; L/MP = Lower/Middle Palaeolithic [adapted from Moutsiou 2011: Table 7.4, 2012: Figure 1, with data added from Golovanova *et al.*, 2010; Le Bourdonnec *et al.*, 2012]); \*depending on HLK-East, Olduvai Gorge obsidian source.

	Local	Mesolocal	Regional	Extended	Exotic
	0-10 km	10-50 km	50-100 km	>100 km	>200 km
ESA East Africa	5	3		2(1)*	0(1)*
LP Eurasia	2	2	1	2	
MSA East Africa	9	8	9	2	
MP Eurasia	2	7	3	4	2

production of a significant number of journal articles over the past decade (Fig. 1 [see also Freund, 2013, Figure 1]), in part relating to the development of portable XRF instruments that enable the analysis of museum-based collections and much larger samples (Nazaroff *et al.*, 2009; Golitko *et al.*, 2010; Phillips and Speakman 2009; Sheppard *et al.*, 2011, *inter alia*). There are also powerful new means of geo-spatially analysing our data, through GIS and Social Network Analysis (Chataigner and Barge 2008; Contreras 2011; Golitko *et al.*, 2012; Tripcevich 2007; Taliaferro *et al.*, 2010, *inter alia*). These methodological developments are opening new areas of research and a return to questions of old. Here I shall focus on this work’s contribution to our understanding of earlier prehistoric societies.

## 2 – Obsidian characterisation and early hominin studies

Stone tools of course represent one of our primary forms of evidence for reconstructing early human behaviour (Braun and Hovers 2009). Technological studies, use-wear and cut-mark analyses shed light on Australopithecine and early *Homo* subsistence (McPherron *et al.*, 2010), while the study of flaking techniques and raw material choice have allowed scholars to re-evaluate early hominin cognitive skills, showing Oldowan hominids to be more much more complex characters than originally thought (Roche *et al.*, 1999; Stout *et al.*, 2010, *inter alia*; Toth, 1985). In this context obsidian sourcing studies is providing crucial information on not only the range of these early hominins’ movement / home-range, but also their cognitive development in terms of planning, forethought and curation *vis-à-vis* raw material choice, procurement and use (cf. Braun and Hovers 2009; Goldman-Neuman and Hovers 2009).

Recent studies by Ambrose (2012), and Moutsiou (2011, 2012), provide important new insights into Earlier Stone Age / Lower Palaeolithic raw material procurement practices in Africa and Eurasia (for a non-obsidian perspective see Braun *et al.*, 2008). These obsidian sourcing data enable us to reconstruct early hominin mobility and provide indices of behavioural complexity. For Moutsiou (2011: 64), a major issue concerning the earliest use of obsidian was to understand whether the transport distances involved fell “within the daily foraging radii of hunter-gatherer life, or if its acquisition required specially organised trips.” Drawing on data from anatomy, primatology and ethnography, Moutsiou defines five spatial units of hominin networking: local, mesolocal, regional, extended and exotic, measured at distances of 0-10 km, 10-50 km, 50-100 km, >100 km, and >200 km respectively (Tab. 1). The earliest data suggests that late Australopithecines, *Homo habilis* and *Homo erectus/ergaster* tended to only procure relatively local raw materials. For the Oldowan, maximum site-to-source distances are usually in the range of 15-20 km, and 11-17 km for the Acheulean (Ambrose 2012: 64 [see also Braun *et al.* 2008; Moutsiou 2012: 86]). For example, at the Olduvai Gorge most stone tools were made from igneous and metamorphic rocks that were available within 2-4 km of the site, suggesting that at this early date we are primarily dealing with very small territorial ranges, with largely self-sufficient and introspective social groups. Obsidian thus tends only to be found at those early hominid sites close to a volcanic source. For example, at Melka Kunture in Ethiopia obsidian is well represented in the Oldowan stone tool assemblages, the material characterised as coming from the Balchit source only 7 km distant (Negash *et al.*, 2006; Piperno *et al.*, 2009). Similar patterns are noted amongst Acheulean assemblages from Kenya and the Caucasus, with raw material transport usually in the 15-30 km range, as for example at the Armenian sites

of Arzni and Dzhraber (Moutsiou 2011: 168, Table 3.13), while at Kaletepe- Deresi in central Turkey, the occupation sits directly atop an obsidian source (Slimak *et al.*, 2008)

Characterisation studies do however provide us with limited evidence for obsidian having been moved over significantly larger distances (Tab. 1). Arguably the most striking evidence comes from the HWK-East site, Olduvai Gorge where two pieces of obsidian were recovered from strata associated with *Homo habilis* remains dated 1.9 – 1.7 million years old (Leakey 1971: 89, 264). This represents the earliest evidence for obsidian use in the world, yet the closest sources are thought to be at least 100 km away in Kenya (Moutsiou 2011: 256); indeed the original excavators claimed it may have come from over 270 km (Hay 1976: 185). Of slightly later date is the Acheulean site of Gadeb in Ethiopia where there handaxes made of obsidian that came from at least 160 km away (Clark and Kurashina 1979; Moutsiou 2011: 313), while at Kudaro I in Georgia obsidian was similarly transported over 100 km, presumably by *Homo erectus* (Moutsiou 2011: 308).

To summarise, for the Earlier Stone Age and Lower Palaeolithic of Africa and Eurasia, most cases involved early hominins accessing obsidian from sources no further than 7 – 30 km away, i.e. at the local and mesolocal levels to use Moutsiou's terms. The data suggests that obsidian procurement was a relatively straightforward process, accomplished within general hunting and foraging practices, i.e.; there is no need to believe that it was either a special activity or one that involved exchange (Ambrose 2012: 64). That said, these are not insignificant data, because even when operating at the local and mesolocal level, they still indicate that early hominins were capable of recognising that the tool they had just made in one location would be useful at a later time and carried with them, or while moving through the landscape they could appreciate that a stone would be useful at a future date to make tools. In both instances we are talking about curation, i.e. foresight and planning, a level of behavioural intelligence quite above that of modern chimpanzees (Toth 1987: 781-782), or other tool making/using apes (cf. Mercader *et al.*, 2002; Toth *et al.*, 1993).

So what is the significance of those few cases where obsidian was transported at the extended and exotic level, as at the Olduvai Gorge, Gadeb, and Kudaro I? In these instances Moutsiou (2011: 316-323, 2012: 88-94) argues that the acquisition of raw materials required something far more behaviourally complex than the 'embedded procurement' of obsidian within habituated subsistence hunting and foraging practices. Instead, it is argued that the tools or materials could only have circulated over such distances via exchange, and by extent interaction with members of other social groups. For Moutsiou (2011: 316) these practices – the distant movement of raw materials via exchange networks, and the curation of such exotic resources – represent "a signature of hominins behaving in an essentially modern way", i.e. engaging in activities that had hitherto only been associated with *Homo sapiens*. The ability of these early hominins to create and maintain social networks to access distant materials, and to retain feelings of relatedness to these other characters '*in absentia*', implies a far greater behavioural complexity than many had previously accorded *Homo habilis* and *Homo erectus/ergaster*. Moreover, Moutsiou (2012: 93) claims that at this point the obsidian would have played just as much of a role in mediating these social relations, as it represented a resource for tool-making. These claims are quite radical, as the idea of exchange, and materials acting as media for establishing social relations, are themes that until recently we again would only have associated with modern human behaviour, i.e. something we could only really talk about from the later Middle Stone Age onwards. Here we view an area of early prehistoric research, where obsidian characterisation studies are clearly making an enormous impact.

### 3 – Neanderthal Mobility and Cognitive Development

By extent, sourcing studies are making important contribution to long-standing debates concerning Neanderthal mobility and social complexity. While recently the former issue has been approached via isotopic studies (Richards *et al.*, 2008) and zooarchaeological data (Delagnes and Rendu 2011), it has been lithic procurement studies that have

contributed most to the discussions upon territoriality and cognitive development, as for example the oft-quoted works of Geneste (1989) and Féblot-Augustins (1993; see also Wilson 2007). The fact that Neanderthal tool kits were dominated by local raw materials led many to suggest that they had relatively low mobility, and small daily ranges (Richards *et al.*, 2008: 1251). Conversely, Mellars (1996: 148-151) places greater emphasis on the minority component of tools from these assemblages that were made of raw materials ranging from 20-30 km, up to 80-100 km, data that led him to view Neanderthals as not only far-ranging in their movement, perhaps seasonally moving over long distances, but also engaging in “some form of exchange relationships with neighbouring groups” (see also Kaufmann 2002). This view is now held by an increasing number of scholars based on lithic analyses across Eurasia, with some cases of raw materials/tools moving up to 400 km from their source (cf. Slimak and Giraud 2007; Spinapolice 2012).

Obsidian characterisation studies have provided a number of case studies where such long-distance movement is attested, as for example with the recent analyses of artefacts from the Mezmaiskaya Cave in the Russian Caucasus, and Ortvale Klde in NW Georgia, that demonstrated the procurement of obsidian from sources in excess of 225 and 125 km respectively (Golovanova *et al.*, 2010; Le Bourdonnec *et al.*, 2012). In turn, a late Neanderthal assemblage from the Czech site of Kůlna contained a small quantity of obsidian from the Carpathian sources, almost 400 km distant (Féblot-Augustins 1997; Moutsiou 2011: 155-156). In sum, the Eurasian Middle Palaeolithic provides us with an increased proportion of sites that attest to extended and exotic level scales of obsidian movement compared to what we view in the Earlier Stone Age / Lower Palaeolithic (Moutsiou 2012: 86-87, Figure 1). As before, it can be inferred that here too we are dealing with circulation of obsidian through exchange, with the likelihood that some of the distant material had significance above and beyond its use-value.

While the Middle Palaeolithic data of Eurasia is mainly associated with Neanderthals, the Middle Stone Age assemblages from Africa relate to Anatomically Modern Humans (cf. Ambrose 2012: 64-65; Negash and Shackley 2006; Negash *et al.*, 2011; Vogel *et al.*, 2006). The fact that a number of sites from East Africa (pre 125,000 BP) had small quantities of obsidian from long-distance sources, was at one point viewed as a reflection of significant changes in human behaviour, and by extent an index of the appearance of *Homo sapiens* (Ambrose 2012: 64). Yet as we have detailed above, the distant circulation of raw materials and/or tools has a much older heritage (Moutsiou 2012: 91-94). Admittedly the relative proportion of sites with obsidian from sources in the extended and exotic ranges is greater than that for the preceding Earlier Stone Age (Table 1), but the difference is not that great; nor, importantly, is it radically different from the behavioural patterns of Neanderthal populations in contemporary Eurasia.

#### **4 – Late Pleistocene / Early Holocene Migration and Colonisation**

The final area of early prehistoric archaeology that obsidian sourcing is contributing to, is the study of Pleistocene and early Holocene colonisation processes, both terrestrial, and maritime. Of particular use to this discussion is the work of Civalero and Franco (2003) that employed obsidian characterization to chart the peopling of Patagonia in South America. Focusing on technical strategies and raw material use, they were able to propose a three-phase model, of: exploration, then colonisation, followed by full occupation. This is a particularly helpful means of conceptualising population movements; the idea in part being that an ever increasing quantity of obsidian will begin to circulate as external populations move into a source area. Characterisation studies appear to detail much the same processes in the late Pleistocene / early Holocene peopling of the Aegean islands. The initial stage of maritime forays into the Cyclades from the nearby Greek mainland are attested by tiny quantities of Melian obsidian from the Upper Palaeolithic cave sites of Klisoura, Franchthi and Ulbrich (Galanidou 2003: 107-108; Koumouzelis *et al.* 2003: Table 3; Renfrew and Aspinall 1990). The second phase, represented by the first Early Mesolithic communities in the Cyclades (Sampson *et al.*, 2010) led to a steady increase in the quantity of obsidian being procured by mainland populations during the Early Holocene, after which we

view a major surge in the raw materials' circulation after a full settlement of the islands during the Late Neolithic (Torrence 1986: 13-15, 135-36). Current work is now using obsidian characterisation studies to document the pace and direction of population movement into the same islands from the opposing Anatolian coastline (Milić, 2014). It has long been appreciated that obsidian sourcing studies were a productive line of enquiry for charting prehistoric population movement (Green 1962), a field of inquiry now truly coming into its own as a number of recent case studies attest. These include the analysis of mid-Holocene return migrations from Colorado to New Mexico (Arakawa *et al* 2011), plus a plethora of studies using obsidian sourcing to detail the migration of people, languages and material culture into island SE Asia, the Pacific islands and New Zealand (Kirch 1988; Reepmeyer *et al* 2011; Sheppard *et al* 2011; Specht 2002; Summerhayes and Allen 2007, *inter alia*).

Another region where obsidian characterisation analyses stand to make a major contribution to reconstructing colonisation processes is NE Asia, not least the debates surrounding the peopling of Japan, the Kuril Islands and the Americas (cf. Grebennikov *et al* 2010; Kuzmin 2011, Kuzmin *et al.*, 2008; Phillips 2010; Phillips and Speakman 2009, *inter alia*). For example, the recovery of small quantities of Japanese obsidian from Kyushu Island from Upper Palaeolithic sites on the opposing Korean peninsula might be viewed as evidence for early late Pleistocene exploration of the archipelago by mainland peoples c. 25,500 BP (Kim *et al* 2007; Kuzmin 2010: 148; Matsufuji 2003). Finally, it is also important to highlight where obsidian sourcing studies have led to conclusions that argue *against* migration as a means of explaining culture change. For example, Torrence and Swadling (2008) argue that the spread of the Lapita Culture into New Guinea and New Britain involved the introduction of new objects and practices through a pre-existing maritime obsidian exchange system, rather than being the result of an influx of new people as previously claimed.

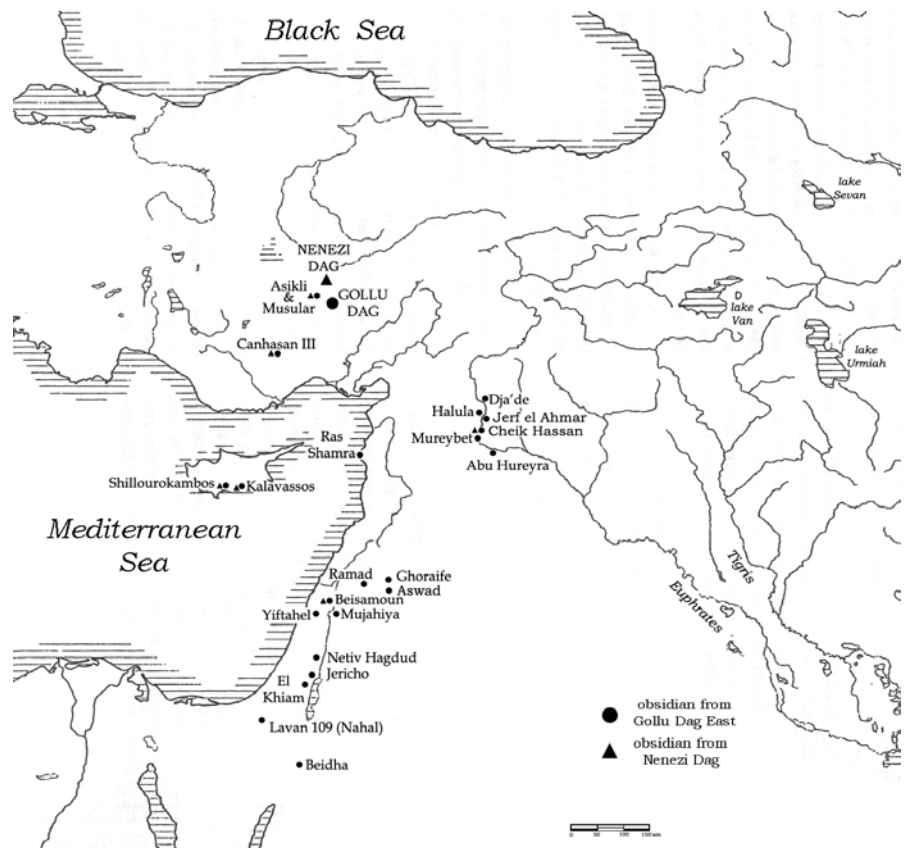
## 5 – From Composition to Character: Integrated Sourcing Studies

While obsidian sourcing studies provide us with a powerful means of contributing to the above debates, I often worry that we are not maximising the interpretative potential of our data. Too often when talking of *characterisation* we are in fact only considering elemental *composition*. Over the past few years I worked with a number of collaborators to produce a more integrated archaeometric approach to characterisation studies, beginning with a series of analyses at the Anatolian Neolithic site of Çatalhöyük (Carter *et al* 2006, 2008; Carter and Shackley 2007, *inter alia*), plus the Cretan site of Malia (Carter and Kilikoglou 2007), and continued today through our work at the *McMaster Archaeological XRF Lab* (MAX Lab [<http://maxlab.ca>]).

First and foremost, the methodology that we employ in the MAX Lab characterisation studies involves the reintroduction of an archaeological aesthetic. Firstly we talk of 'artefacts', not 'samples'. Secondly, we acknowledge that these artefacts have far richer 'characters' than their geo-chemistry, whereby we consider how they were made, their typological form, date, context etc (for a comparable approach see Briois *et al* 1997). Raw material characterisation is thus located within a *chaîne opératoire* analytical framework, because we believe that specific raw material and technical choices were culturally constructed, and by extent will reflect a particular prehistoric group's cultural traditions.

One research question that our lab is currently investigating is to what extent obsidian exchange networks of the late Pleistocene and early Holocene facilitated the spread of agriculture from the Near East into Anatolia. The idea that 'Neolithisation' was articulated via pre-existing obsidian exchange systems is not new (Cauvin 2000); our aim was to try and reconstruct more specifically the inter-community networks through which such new practices might have spread. In order to do this, we were interested in a more nuanced understanding of how obsidian was circulating amongst these people, through considering not only which raw materials were involved, but also the specific modes by which they were 'consumed' (procured-worked-used-discarded).

Previously, representations of obsidian distribution patterns in the Epi-Palaeolithic and earliest Neolithic had simply documented the dissemination of source-specific products across space, an example of which we reproduce in Figure 2 (see also Cauvin and Chataigner 1998; Roaf 1990: 14, *inter alia*). We argue that such maps implicitly lead the viewer to believe that everyone using the same raw materials was somehow linked, yet this need not be the case at all. We can all imagine how different people at the same time could have procured, exchanged and worked obsidian in a number of different ways, yet such distinctions in procurement and consumption are masked if our characterisation studies consider chemical composition alone. One of our recent projects addressed these issues via the characterisation of 120 artefacts from the Terminal Pleistocene – Early Holocene site of Körtik Tepe in southeast Anatolia (11<sup>th</sup> – 10<sup>th</sup> millennia cal BC), a study that melded elemental data with techno-typological attributes and contextual considerations (Carter *et al.*, 2013). When these data were located within a broader consideration of how contemporary (Pre-Pottery Neolithic A) populations were employing the same raw materials, it was possible to distinguish at least two regional traditions within what had hitherto been represented as a singular raw material distribution ‘zone’ (Fig. 3). In essence our research aimed to reveal distinct ‘communities of practice’, i.e. common traditions of raw material choice / technical practice amongst contemporary populations (Knappett 2011: 98-123). Following debates from the sociology of technology it can be argued that such closely shared practices imply a significant level of on-the-ground interaction between populations, traditions that would emerge and be maintained through inter-marriage and other deeply binding socio-economic relations. We feel that it is through these social networks that new ideas – such as farming – would have spread. For instance, in our Near Eastern / southeast Anatolian case study, the pressure-blade tradition most closely related to early agriculturalists, whereas the bladelet technologies were part of a contemporary, neighbouring group of populations who largely retained a hunter-gatherer lifestyle. These distinctions in economic practices and lithic traditions was only truly appreciated through a more detailed and nuanced form of characterisation study, what we would refer to a ‘thick description’ approach (Geertz 1973: 3-30; Hodder 1990: 66-79).



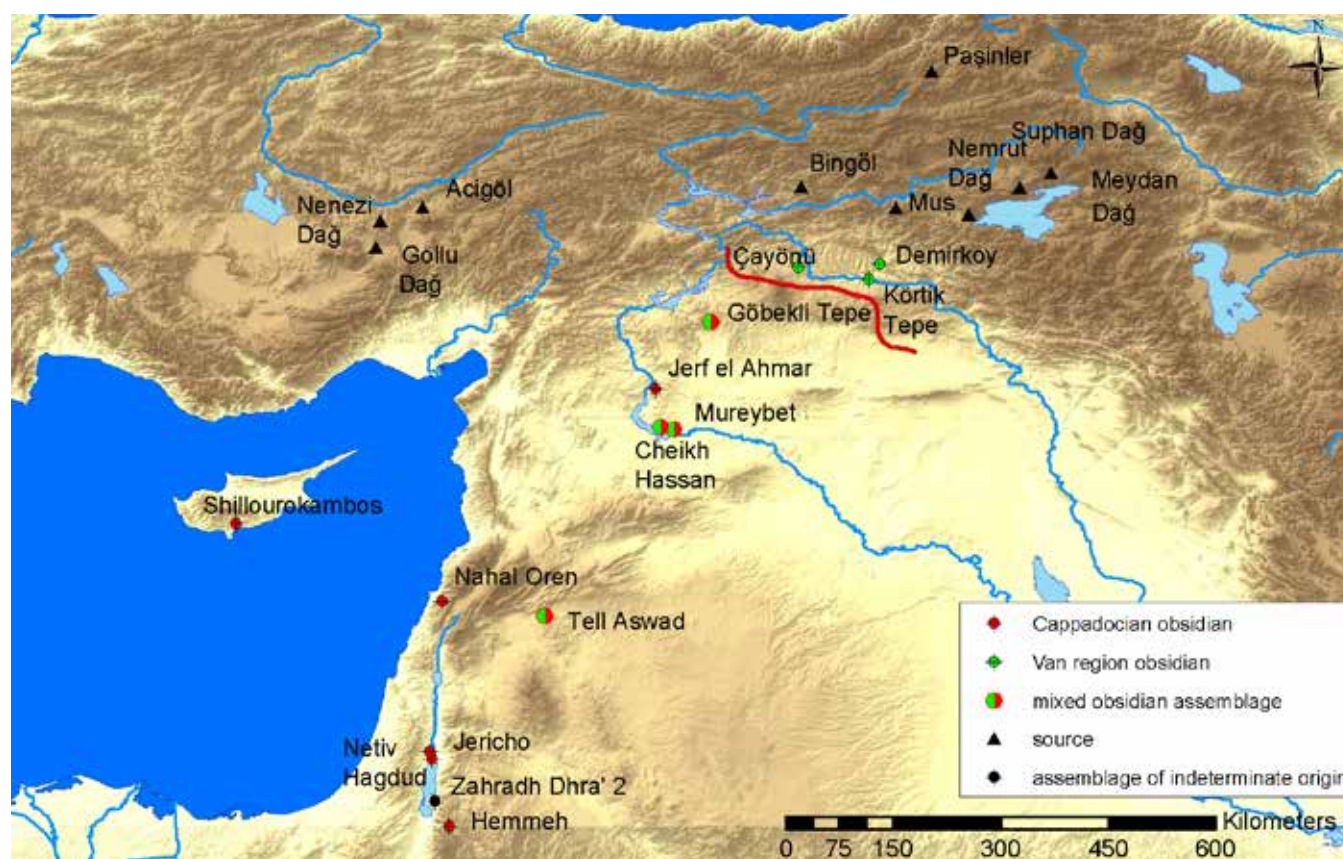
**Figure 2** – Typical source product distribution map: circulation of obsidian from East Göllü Dağ and Nenezi Dağ during the Pre-Pottery Neolithic B, 7,500-7,000 cal BC (reproduced from Carter *et al.*, 2005: Figure 12.6d).

The elucidation of such communities of practice through *chaîne opératoire* characterisation studies also offers a powerful means of engaging with other research questions, not least the aforementioned focus on reconstructing the routes and populations involved in colonisation processes.

## 5 – Endnote

Over the past decade obsidian characterisation studies have finally begun to live up to the intellectual standards set by Colin Renfrew in the 1960's, and are now making a significant impact in the study of early prehistory. Our work can continue to make major contributions to debates on human behaviour, from early hominin social complexity, to Neanderthal mobility, colonisation processes, and the spread of new cultural traditions, but arguably *only* if we meld our hard and social science approaches and shift from a fixation upon composition, to a far richer notion of characterisation.

**Figure 3** – The distribution of Anatolian obsidian during the Pre-Pottery Neolithic A, 10,000-8,300 cal BC; the red line represents the division between communities consuming these raw materials via bladelet traditions (to the north), and those using the obsidian to make pressure-flaked blades (to the south) [from Carter *et al.*, 2013: Figure 10).



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