

## Original Study

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# A Compositional Study (pXRF) of Early Holocene Obsidian Assemblages from Cyprus, Eastern Mediterranean

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**Abstract:** This paper presents the results of the geochemical characterisation of complete obsidian assemblages dating to the Early Aceramic Neolithic (8200–6900 Cal BC) and located in Cyprus, eastern Mediterranean. Obsidian artefacts have over the years been recovered from a number of Early Holocene archaeological sites on the island of Cyprus. As there are no obsidian sources on Cyprus, the presence of obsidian island-wide indicates long-distance sea transport/distribution, central Anatolia usually considered as the main supplying region. Portable XRF technology (X-ray Fluorescence Spectrometry) was applied to determine numbers of obsidian sources represented in complete archaeological assemblages and address research questions concerning the social landscape Cyprus was part of during the Early Holocene, a time of significant change in the broader eastern Mediterranean region.

**Keywords:** obsidian, elemental characterization, pXRF, Cyprus, Eastern Mediterranean, Early Holocene, social interactions

## 1 Introduction

The Early Holocene is a time of significant change in the wider eastern Mediterranean region with the development of farming technology and the first permanent settlements (Balkan-Atli, 1994; Colledge, Conolly, & Shennan, 2004; Zeder, 2008). Cyprus has, until recently, been regarded peripheral to these new developments as a result of the dominant view of islands as marginal, isolated environments to be avoided at all costs (Cherry, 1981, 1990). Recent research (Waldren & Ensenyat, 2002; Broodbank, 2006; Dawson, 2014) is now altering this perception of ‘islands as closed systems’ and obsidian research has proven to be fundamental in this debate. Since the development of analytical techniques for the characterisation and provenancing of lithic resources, raw material studies have been used to discuss aspects of human behaviour, particularly movement, networking and social communication (e.g. Torrence, 1986; Moutsiou, 2014; Carter, 2016). Obsidian has been particularly useful in this respect as its rarity, homogenous nature and distinctive chemical signature per source allow researchers to clearly distinguish geological sources and accurately link artefacts to them. Determining the elemental composition of complete obsidian assemblages can provide useful insights into source exploitation and raw material distribution patterns.

Over the past few decades, a number of field projects on Cyprus have recovered obsidian artefacts from Early Holocene contexts island-wide (Peltenburg, 2003; Todd, 2005; Simmons; 2003, 2010; Guilaine, Briois, &

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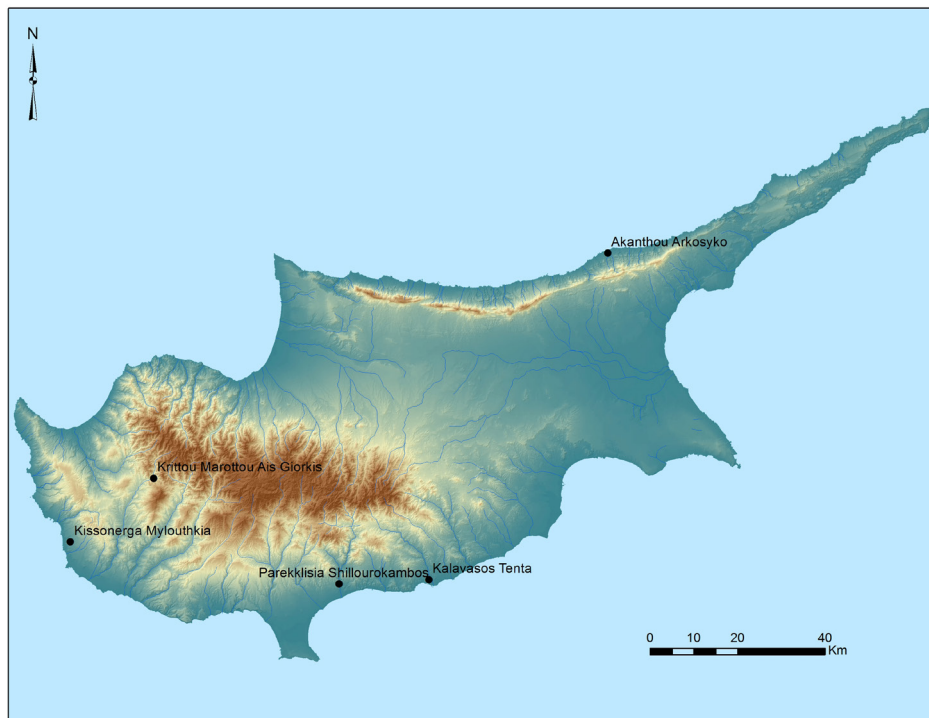
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Vigne, 2011). The earliest known Cypriot obsidian examples (three blades) date to the Initial Aceramic Neolithic period (ca. 10,000–9500 Cal BC) and derive from Ayios Tychonas *Klimonas*, on the southern coast of the island (Vigne, Briois, Zazzo, Carrère, Daujat, & Guilaine, 2011); obsidian use continues well into the Late Aceramic Neolithic (6800–5200 Cal BC), albeit in decreased quantities. It is, however, during the Early Aceramic Neolithic that the exploitation of obsidian on Cyprus is mostly common. In 2015, an intensive analytical programme (*Social networking and raw material selectivity in early prehistoric Mediterranean seascapes*, acronym PRENET) was initiated, with the author as principal investigator, to investigate the presence and use of rare and exotic lithic resources in Cyprus during this period. In this paper, I present the results on the geochemical analysis of complete obsidian assemblages dating to the Early Aceramic Neolithic (8200–6900 Cal BC) and located island-wide on Cyprus. I then use this data to discuss the patterns of obsidian circulation on the island and over the eastern Mediterranean Sea. By doing so, I envisage to gain a better understanding of the broader social landscape Cyprus was part of at the time of the earliest permanent settlements on the island.

The aims of the paper are twofold; first, to determine the elemental composition of obsidian assemblages *in toto* and use this data to define numbers of obsidian sources exploited on the island. The second objective of the study is to investigate potential provenance sources for the Cypriot obsidians by comparing the new pXRF data with primary and previously published datasets of sources in Anatolia and Greece. Where geological reference material is not available for analysis, legacy datasets may be the only means of addressing the provenance of museum collections (see also Forster & Grave, 2012), thereby including such data in the analysis will enable us to gain a better understanding of obsidian circulation in the eastern Mediterranean.

## 1.1 Background

Cyprus (Figure 1) is rich in good quality raw material resources for human exploitation, such as ochre, umber and chert (Stewart, 2004; McCartney, Manning, Sewell, & Stewart, 2010), but obsidian is not one of them. In the Troodos Ophiolite Complex, but also the Arakapas Sequence, it is possible to observe thin (ca.

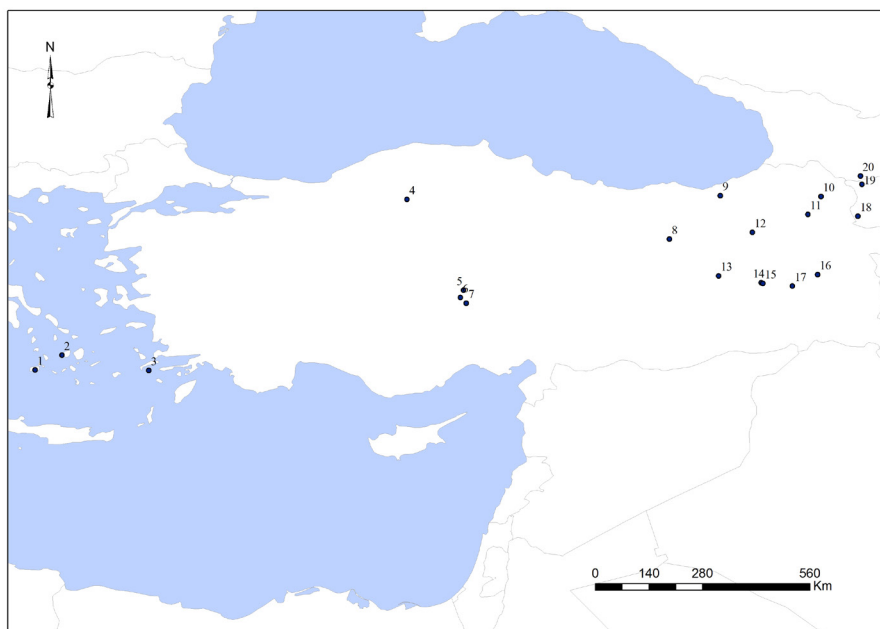


**Figure 1.** Map of Cyprus depicting the location of the Early Aceramic Neolithic sites with obsidian artefacts discussed in the text. Map generated by the author.

1 cm) veins of volcanic glass along cooling fractures and surfaces of the pillow lavas and lava breccias (Zomeni pers. comm. and pers. obs.). These veins are occasionally referred to as obsidian sources but they can by no means be considered a resource. The absence of good obsidian outcrops on Cyprus indicates that the raw material reached the island via sea transport, since Cyprus was never connected to any mainland (Sondaar, 2000).

Earlier analyses on Cypriot obsidian from this period have invariably pointed to a central Anatolian (Cappadocia) provenance for the Cypriot obsidian artefacts (previously analysed artefacts are marked as such in Supplementary Material<sup>1</sup>). For example, the analysis of 64 *Shillourokambos* obsidian artefacts by Gratuze (Briois, Gratuze, & Guilaine, 1997 and more recently Gratuze & Boucetta, 2011) using Laser Ablation Induced Coupled Plasma Spectrometry or LA-ICP-MS (31 artefacts) and Neutron Activation Analysis or NAA (33 artefacts) linked the raw material to the Göllüdağ volcanic complex in Anatolia. Eight obsidian artefacts from *Mylothkia* that were also analysed by Gratuze (2003) using LA-ICP-MS were found to originate from the same central Anatolian source. Gomez, Glascock, Blackman, & Todd (1995) fingerprinted six obsidian artefacts from *Tenta* to Göllüdağ using NAA. Finally, Şevketoğlu and Hanson (2015) and Şevketoğlu (2008) link the obsidian artefacts from *Arkosyko* to central Anatolian sources, primarily Göllüdağ and to a lesser extent Nenezi Dağ. The assignment of the *Arkosyko* obsidians to these sources is based primarily on stylistic criteria and limited chemical analysis on only ten obsidian artefacts from the site for which, however, no details are provided.

Based on these earlier results, researchers working in the Mediterranean region have assumed an Anatolian origin for all the obsidian found on Cyprus. Albeit statistically valid, this method overlooks the crucial factor that raw material movement is the result of human agency and active choice. With regards to obsidian specifically, it has been shown that material from more than one source is often present in lithic assemblages of a given region (e.g. Milić, 2014; Kuzmin, 2014; Moutsiou, 2014) with significant social implications. The attribution of all obsidian artefacts found on Cyprus to a central Anatolian source needs to be assessed rather than assumed (Figure 2). The possibility that some obsidian came from elsewhere – potentially, eastern Anatolia or the Aegean – cannot be ruled out a priori but needs to be established through detailed analysis of complete assemblages.



**Figure 2.** Map showing the location of the main geological sources of obsidian in the eastern Mediterranean region neighbouring the island of Cyprus. [Note: 1=Melos, 2=Antiparos, 3=Giali, 4=Sakaeli, 5=Acigöl, 6=Nenezi Dağ, 7= Göllüdağ, 8=Erzincan, 9=İkizdere, 10=Kars, 11=Sarikamis, 12=Erzurum, 13=Bingöl, 14=Mus, 15=Meydan Dağ, 16=Suphan Dağ, 17=Nemrut Dağ, 18=Arteni, 19=Ashotk, 20=Chikiani]. Map generated by the author.

<sup>1</sup> See online Supplementary Material.

## 2 Materials and Methods

### 2.1 Materials

A total of 577 obsidian artefacts, representing complete obsidian assemblages (including previously analysed artefacts where possible), were analysed from five Early Aceramic Neolithic sites in Cyprus (Figure 1). All sites are located on the south-western part of the island and, with the exception of Krittou Marottou *Ais Giorkis*, are coastal. *Ais Giorkis* is one of very few inland and upland (480 m asl) sites known from Cyprus with architectural remains, cobbled ‘platforms’ and large pits that have no direct parallels elsewhere on the island or, in fact, the mainland (Simmons, 2012). An assemblage of nearly 200,000 lithics was recovered on site of which only 67 are made of obsidian. The Early Aceramic Neolithic period of occupation at Kissonerga *Mylothkia* is primarily known from a number of wells unearthed on site; it is in one of them (well 116) that the majority of *Mylothkia* obsidians were discovered with only one piece coming from well 133 (Peltenburg, 2003). A similarly small quantity of obsidian was found in Kalavasos *Tenta* where from a lithic assemblage of over 105,000 pieces only 36 are made of obsidian (Todd, 2005). Six of these artefacts were destructured during earlier NAA analyses (Gomez et al., 1995) and, thus, were not available for the present study. Parekkklisia *Shillourokambos* is a large multi-period site with evidence for obsidian use dominating the earlier phases of the Early Aceramic Neolithic (Briois et al., 1997; Briois, 2011; Guilaine et al., 2002; Guilaine et al., 2011). By far the largest obsidian assemblage on Cyprus is that from Akanthou *Arkosyko* (Şevketöğlu, 2008; Şevketöğlu & Hanson, 2015) with ~5000 recorded pieces. Unfortunately, *Arkosyko* does not form part of this study as the recorded obsidian material was excavated after 1974 when archaeological research on the northern part of the island became illegal under international law (UNESCO Conventions 1954 and 1970). However, four obsidian artefacts were retrieved in the archival collections of the Cypriot Museum, collected during early field surveys (1930s–40s) in the area (Gjerstad, 1934; Stanley Price, 1979). They were analysed and will be presented here for documentation purposes although I am aware of their limitation to provide information for the rest of the excavated assemblage.

### 2.2 Methods

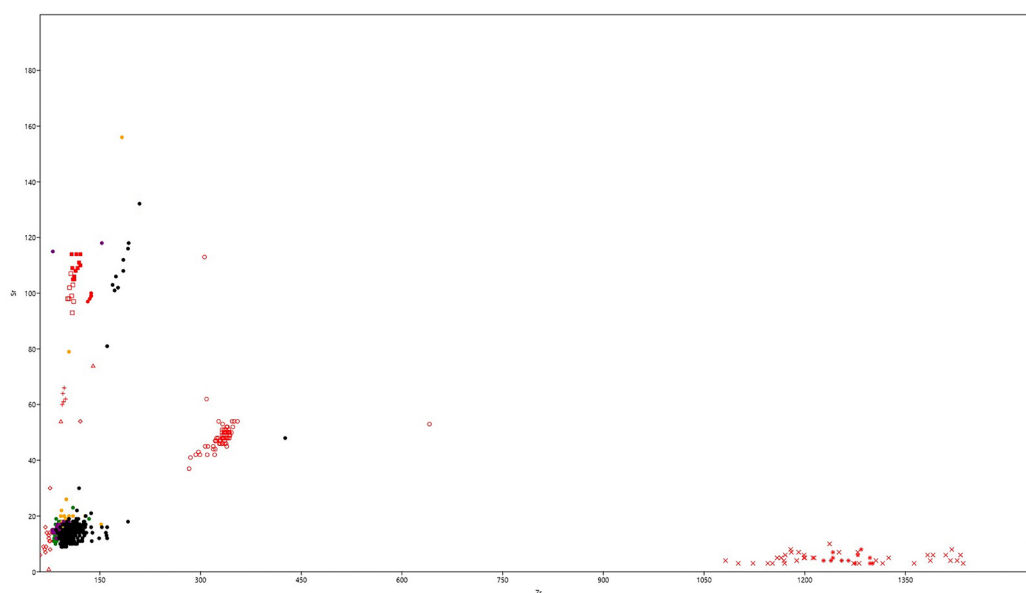
Given the goal of this research has been to analyze entire obsidian assemblages as close to *in toto* as possible and keeping in mind strict bureaucratic criteria (analysis was only possible within museum premises and sampling was prohibited), pXRF was chosen as the best suited method for this study. X-ray Fluorescence Spectrometry (XRF) has long been identified as an ideal method for the elemental characterization of obsidian (Williams-Thorpe, 1995; Keller & Seifried, 1990; Gratuze, 1999; Milić, 2014; Campbell & Healey, 2016) producing precise, reliable and highly reproducible results despite its limitations to lab-based analytical equipment (Shackley, 2011). In addition, it is fast and completely non-destructive, which makes it ideal for mass sampling.

The analyses were undertaken using a handheld Olympus Innov-X Delta XRF device (HH pXRF). The model operates at 40 kV and is equipped with the Delta Tantalum (Ta) anode X-Ray tube, and uses a Silicon Drift Detector. The ‘Soil’ mode, which captures elements ranging from P and higher (the preferred range for obsidian) were chosen for the analyses (see also Milić, 2014). Each artefact was analysed for 80s of total exposure in ‘Soil’ mode. The artefacts were positioned to completely cover the pXRF detector window, usually with their most flat surface (Davis, Jackson, Shackley, Teague, & Hampel, 2011). In the rare cases where the artefact was smaller than the pXRF detector window, it was placed in a way as to cover/overlay the maximum diameter of the X-ray beam. The Innov-X Delta instrument has a detector window about 20 mm in diameter, while the X-ray source excites a target circle with a 3 mm diameter. In order to maximise precision, the artefacts were placed on the manufacturer provided test stand and controlled through a computer and camera. The accuracy of the applied mode was ensured through the USGS RGM-2 and NIST612 certified standard reference materials (SRMs). All data was processed in Excel. The quantification is based on a Fundamental Parameters algorithm designed by the manufacturer (Innov-X), with results given as ppm.

## 3 Results

### 3.1 Elemental Characterisation

Previous studies on eastern Mediterranean obsidians (e.g. Cann & Renfrew, 1964; Carter & Shackley, 2007; Binder, Gratuze, Mouralis, & Balkan-Atli, 2011; Milić, 2014) have shown the elements Zr, Sr, Rb, Y and Nb are important geochemical markers for obsidian provenancing. Similarly, the analysed Cypriot obsidians can be reliably distinguished into geochemical groupings based on the values for Zr and Sr (see Figure 3), following Carter, Grant, Kartal, Coşkun, & Özkaya, 2013.



**Figure 3.** Bivariate plot of Sr vs. Zr for Cypriot obsidian artefacts from Early Aceramic Neolithic assemblages and geological sources from the circum-Mediterranean region. [Note: Sources are in red colour Diamond=Göllüdağ, Dot=Nenezi Dağ, Square=Melos Adamas, Filled square=Melos Demenegaki, Plus=Giali, Triangle= Acigöl, Circle=Bingöl B, Cross=Bingöl A, Star=Nemrut Dağ and Sites are *Tenta*=purple, *Mylouthkia*=orange, *Ais Giorkis*=green, *Shillourokambos*=black, *Arkosyko* (covered by the *Shillourokambos* main cluster)=pink].

It was previously suggested that all Cypriot obsidian originates from central Anatolia, and particularly, the Cappadocian sources of Göllüdağ and to a lesser degree Nenezi Dağ (Gratuze, 1999; Chataigner & Gratuze, 2014a, 2014b). In order to test this assumption, I compared the pXRF results on the archaeological artefacts with those generated using the same technique/equipment on a series of geological samples of obsidian with known provenance. The samples from geological sources in Anatolia were aliquots of samples from the source data set held in the University of Manchester and were provided by Professor Stuart Campbell and Dr. Elizabeth Healey, whereas samples from the Aegean sources derive from the author's own reference collection (see Supplementary Material).

### 3.2 Comparison with Legacy Source Obsidian Datasets

Recent advances (e.g. Ibañez, Ortega, Campos, Khalidi, & Méndez, 2015; Chataigner & Gratuze, 2014a, 2014b; Chataigner, 1998) in the characterisation of Near Eastern obsidian occurrences, in particular, demonstrate that the geological history of obsidian in the area is extremely complex and our knowledge of specific sources areas remains quite variable (Healey & Campbell, 2018). In order to account for this complexity, I opted to

complement my modest geological dataset with reference data sourced from published data on obsidian outcrops (Keller & Seifried, 1990; Gratuze, 1999; Binder et al., 2011; Carter et al., 2013; Chataigner & Gratuze, 2014a, 2014b; Milić, 2014). This data is taken from different studies using a variety of analytical techniques (pXRF or LA-ICP-MS) focusing on the main Anatolian and Aegean obsidian sources. The capability in source determination by comparing pXRF data to other analytical techniques has received substantial interest in the literature (Craig et al., 2007; Hancock & Carter, 2010; Millhauser, Rodríguez-Alegría, E., & Glascock, 2011; Shackley, 2011; Frahm, Doonan, & Kilikoglou, 2014). Legacy (published) data has the potential to expand the reference material available to archaeological provenance studies, especially when it is the only means of interrogating an archaeological collection. PXRF data can be reliably compared to published datasets when their geochemical composition is significantly different (Forster & Grave, 2012).

The statistical analysis of all 577 obsidian artefacts (Figure 3) shows that most of the Cypriot obsidians can be attributed to one specific source based on their geochemical signature. The *Ais Giorkis* obsidians cluster very closely together suggesting a single source and their geochemical signature indicates this to be the central Anatolian source of Göllüdağ. The *Mylouthkia*, *Tenta* and *Shillourokambos* obsidians also seem to predominantly fall within the Göllüdağ range, although in each assemblage there are several artefacts that fall outside this range. The four *Arkosyko* obsidians cluster within the Göllüdağ expected ranges, which supports earlier claims for a central Anatolian origin for the assemblage (Şevketoğlu, 2008). However, as the results of this new study indicate it is essential to investigate complete assemblages before attribution to a given source is determined, so further analyses are definitely required before attributing all of the *Arkosyko* assemblage to a single Anatolian source.

The new pXRF data support the results of earlier work (e.g. Briois et al., 1997; Gratuze, 1999; Peltenburg, 2003), which identified central Anatolia as the sole region supplying obsidian to Cyprus. Indeed, the geochemical composition of the majority of the obsidian artefacts points towards the Göllüdağ complex (Binder et al., 2011). However, there still remain a number of unsourced artefacts whose elemental composition is beyond the expected ranges for Göllüdağ or the other main central Anatolian sources that need to be addressed. In fact, three out of four examined assemblages, namely *Shillourokambos*, *Tenta* and *Mylouthkia*, consist of a number of artefacts whose elemental composition points towards the exploitation of additional obsidian sources. These artefacts (Figure 4 and Table 1) underwent additional investigation to ensure that the values are not the result of machine-induced errors. With the exception of samples KMYL1227 (*Mylouthkia*), 5038-95-46 and 5038-92-17 (*Shillourokambos*) that are on the smaller scale for the pXRF all other artefacts are large enough to disregard size as a factor in the generated values.

The outliers are high in Sr indicating one of the central and/or eastern Anatolian sources, such as Nenezi Dağ, Acigöl, Erzincan or Erzurum (e.g. Gratuze, 1999; Chataigner, Işikli, Gratuze, & Çil, 2013), as the originating source. However, at this stage these samples remain unsourced. The KMYL1982 and KMYL1227 outliers from *Mylouthkia* show additional high Fe and Ti values, excluding most of the central/eastern Anatolian sources, with the exception of Erzurum (Gratuze, 1999). A consideration of legacy data also suggests that the Aegean sources should be excluded on the basis of Zr, Rb and Fe values that are consistently lower compared to those of the artefacts. According to Figure 3 the outliers may be further distinguished to potentially four distinct groups: (a) *Mylouthkia* KMYL1227 and *Shillourokambos* 5038-98-2 (similar to Acigöl), (b) one artefact from *Tenta* (KT119) similar to Melos but most likely not of an Aegean origin due to its low Zr and Ti and high Fe values, (c) single artefacts from *Mylouthkia* (KMYL1982) and *Tenta* (KT188) with the nine *Shillourokambos* outliers, and, (d) one *Shillourokambos* artefact (5038-99-225) alone. In fact, artefact 5038-99-225 from *Shillourokambos* has a very high Zr reading (over 400 ppm) pointing towards a non-central Anatolian where Zr is consistently lower. A possible match on this basis might be Bingöl B. The similarity of this artefact to Bingöl B is also suggested by the Sr and Zr values (Figure 3) and makes for an exciting discovery as it documents the presence of eastern Anatolian obsidian on Cyprus for the first time.

Anatolian obsidians are the result of extremely complex volcanism with multiple and often overlapping outcrops whose elemental characterisation is the subject of ongoing research. Good results have been achieved with the application of LA-ICP-MS, the destructive nature of this technique unfortunately prohibited application of this technique to the assemblages discussed in this paper. Additional analyses are definitely necessary before fingerprinting for these outliers is achieved.



**Figure 4.** The fourteen artefacts whose elemental composition is beyond the expected ranges for Göllüdağ, the main supplier of obsidian to Cyprus, suggesting additional obsidian sources are represented in the assemblages. [Note: a=5038-95-46 (*Shillourokambos*), b=5038-97-1 (*Shillourokambos*), c=5038-98-2 (*Shillourokambos*), d=5038-95-6 (*Shillourokambos*), e=5038-99-225 (*Shillourokambos*), f=KMYL1982 (*Mylouthkia*), g=5038-92-17 (*Shillourokambos*), h=KMYL1227 (*Mylouthkia*), i=5038-97-297 (*Shillourokambos*), j=5038-92-10 (*Shillourokambos*), k=5038-97-299 (*Shillourokambos*), l=5038-97-28 (*Shillourokambos*), m=KT119 (*Tenta*), n=KT188 (*Tenta*)].

**Table 1.** The table summarises metrical (weight and maximum dimensions) and elemental data (in ppm) for each of the fifteen outliers discussed in the text. With the exception of KMYL1227, 5038-95-46 and 5038-92-17 all artefacts are large enough to disregard machine-induced errors.

Artefact	Site	Weight (gr)	Length (mm)	Width (mm)	Zr	Sr	Rb	Fe	Ti	Mn
KT119	Tenta	1.530	35	15	80	115	225	7211	548	601
KT188	Tenta	3.490	45	18	153	118	191	9993	765	670
KMYL1982	Mylouthkia	0.073	10	12	183	156	284	19124	1379	1187
KMYL1227	Mylouthkia	0.026	5	8	104	79	331	17957	1169	1322
5038-98-2	Shillourokambos	0.463	19	12	161	81	194	6614	458	366
5038-97-297	Shillourokambos	0.716	20	15	185	112	206	8311	613	467
5038-99-225	Shillourokambos	0.556	19	10	426	48	263	13200	1180	266
5038-97-299	Shillourokambos	0.935	20	16	177	102	180	6820	601	393
5038-97-28	Shillourokambos	0.949	22	18	169	103	180	6933	529	339
5038-95-46	Shillourokambos	0.215	20	5	192	116	213	9488	769	506
5038-97-1	Shillourokambos	0.722	17	15	174	106	185	7147	652	404
5038-95-6	Shillourokambos	0.899	18	15	172	101	177	6791	690	396
5038-92-17	Shillourokambos	0.064	6	5	209	132	244	10110	1101	587
5038-92-10	Shillourokambos	1.450	25	12	185	108	191	8040	928	436

## 4 Discussion

Although at this stage it is not possible to securely provenance all of the analysed artefacts, the work presented in this paper demonstrates that at least three different obsidian sources are represented in the Early Aceramic Neolithic assemblages of Cyprus. The new data is important in gaining a better understanding regarding the social behaviour of the island's early occupants. The documentation of multiple obsidian sources on Cyprus suggests that the arrival of obsidian on the island was not the result of a single journey or a single network. Rather multiple interaction networks between the island and the mainland are most likely reflected in the distribution of obsidian on Cyprus. Typically such interaction is seen as Cypriots seeking to gain access to resources not available in their 'impoverished environment' (Horwitz, Tchernov, & Hongo, 2004; Watkins, 2004) rather than as evidence for active involvement in a continued two-way interaction (Finlayson, 2004; McCartney et al., 2010). Eastern Mediterranean maritime networks (e.g. Horejs, Milić, Ostmann, Thanheiser, Weninger, & Galik, 2015) are already established during the Epipalaeolithic/Mesolithic or earlier as attested in archaeological sites, such as Ouriakos (Lemnos) and Maroulas (Kythnos) or Stelida (Naxos) in the Aegean (Efstratiou, Biagi, & Starnini, 2014; Sampson, Kozłowski, Kaczanowska, & Giannouli, 2002; Carter, Contreras, Doyle, Mihailović, Moutsiou, & Skarpeis, 2014). Mammalian remains from Aceramic Neolithic Cyprus indicate the occurrence of introduced species, such as wild boar, which was managed and hunted on the island (Vigne, Carrère, Briois, & Guilaine, 2011). Aside from the introduction of domesticated fauna to Cyprus, material culture parallels, such as shaft-straighteners and lozenge points, and obsidian from multiple sources, suggest that the early communities inhabiting Cyprus had an active role in the broader Eastern Mediterranean social landscape.

Different lines of evidence suggest that the earliest occupants of Cyprus in the Early Holocene had detailed knowledge of the island's varied local resources and how best to exploit them. These resources include fresh water, in fact Cyprus boasts some of the oldest wells in the world (Colledge & Conolly, 2007), a varied biomass as well as ochre, microlite and excellent quality chert for stone tool-making (Peltenburg, 2003; McCartney et al., 2010). The Early Aceramic Neolithic inhabitants of Cyprus were also actively involved in the circulation of obsidian on an island-wide scale that ranges from 30 to 220 km. More importantly, the acquisition of obsidian from sources outside the island, as the geochemical data indicates, required long-distance movement (a 300–400 km linear distance from the nearest central Anatolian sources) and it was only possible via costly (in terms of time and energy) sea transport. To understand this choice (obsidian) we need to think beyond subsistence technology (e.g. Lovis, Whallon, & Donahue, 2006) and widen our perspective to view Cyprus within a broader eastern Mediterranean social landscape (McCartney et al., 2010).

The efforts exerted in the acquisition of obsidian are hard to explain in purely practical or economic terms. With the exception of *Shillourokambos* (and *Akanthou*), the quantities of obsidian collected from the remaining Early Aceramic Neolithic Cypriot sites are negligible. This was previously taken to mean that obsidian was distributed to Cyprus via one primary network that linked central Anatolia to either *Shillourokambos* or *Arkosyko*, which then functioned as a re-distribution centre within Cyprus (Peltenburg, Colledge, Jackson, McCartney, & Murray, 2001; Şevketoğlu, 2008). The inaccessibility of the *Arkosyko* material, inevitably, limits our interpretative ability. However, the documentation of multiple obsidian sources in Cypriot assemblages whose elemental composition does not mirror the same patterns of use throughout the island could be reflecting distinct, albeit maybe occasionally overlapping, networks between the Early Aceramic Neolithic Cypriot sites and the mainland. The small quantities of obsidian (Table 2) as well as the finished forms (exclusively blades/bladelets) in which the material reached Cyprus suggest that obsidian was of paramount importance to the early occupants of Cyprus for social reasons. Such a socio-symbolic role is usually preserved for 'prestige' items, however, the Cypriot obsidians point towards cultural biographies (see Kopytoff, 1986) rich in social and possibly ideological significance despite their 'mundane' tool form. Made of a material that stands out for its rarity and aesthetic qualities, the obsidian artefacts were favoured by early Cypriots for communicating 'relatedness' at the local and extended social domains. Obsidian artefacts performed an active symbolic role in displaying and maintaining social interactions with populations or places that were highly significant, maybe their own originating ancestral communities and place origins in the mainland or those of their allies.

**Table 2.** The table summarises the quantities and weights of obsidian artefacts recovered from each of the five Early Aceramic Neolithic archaeological sites discussed in the text.

Site	Artefact numbers	% of total lithics	Weights (gr)	Type
Parekklesia <i>Shillourokambos</i>	451	2%	2909	Blades/bladelets, including core shaping blades
Kissonerga <i>Mylouthkia</i>	23	12% (phase 1A), 2% (phase 1B)	5	Blades/bladelets, including 22 formal tools
Kalavassos <i>Tenta</i>	30	<1%	41	Blades/bladelets
Krittou Marottou <i>Ais Giorkis</i>	66	<1%	42	Blades/bladelets, one burin
Akanthou <i>Arkosyko</i>	4* (5000)	?	4	Blades/bladelets, including formal tools

Obsidian provides tangible evidence that the people occupying Cyprus during the Early Holocene maintained multiple and multi-directional active networks (alliances or kin ties) with the mainland, irrespective of distance or presumed sea barriers. These active maritime interactions as evinced by obsidian help disperse earlier ideas of island marginality (e.g. Bar-Yosef, 2014; Cherry, 1981). While maintaining (or developing) elements of a distinct material culture, Cyprus in the Early Aceramic Neolithic was not a marginal region, isolated in the periphery of the eastern Mediterranean world but rather an integral part of it (Watkins, 2004; McCartney, 2010). Through their possession and display obsidian artefacts linked individuals and communities far and wide apart into larger networks of exchange and communication within and beyond the island's boundaries. The Mediterranean Sea, far from being an obstacle to these interactions, was in fact a means of connecting people in the exchange of objects and ideas (see also Finlayson, 2004; Broodbank, 2006; McCartney, 2010).

## 5 Conclusion

The dual objectives of this study were to elementally characterise complete obsidian assemblages from a number of Early Aceramic Neolithic archaeological sites located on the island of Cyprus and, then, use primary and published geological data to infer their provenance as a means of addressing the social interactions between the island and its neighbouring mainland at a time when substantial changes occur in the broader eastern Mediterranean region. The analysis was able to geochemically characterise all 577 obsidian artefacts and accurately fingerprint most of them to their geological sources. The results reported in this study support previous research, showing that central Anatolia supplied the majority of obsidian found in Cyprus. However, the documentation of several obsidian artefacts that cannot be provenanced to central Anatolia suggests that additional obsidian sources, most likely also Anatolian, located further afield may also have reached the island. The new obsidian data require us to reconsider Cyprus within a far wider eastern Mediterranean social landscape than previously envisaged.

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