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Obsidian Exchange Networks in Prehistoric Anatolia: New Data from the Black Sea Region

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Résumé

L’étude des réseaux d’échanges de l’obsidienne constitue l’un des plus beaux succès des recherches en archéologie. Toutefois les travaux menés depuis une cinquantaine d’années ont mis l’accent sur des réseaux d’échanges bien documentés, et donnent ainsi une image incomplète des contacts qui lient les communautés préhistoriques. Nous proposons dans cet article de nouveaux résultats pour le nord de l’Anatolie occidentale, une région qui a été relativement peu étudiée à ce jour. Ceux-ci apportent un nouvel éclairage sur les réseaux d’échanges de cette région côtière de la mer Noire et illustrent l’intérêt d’y mener des recherches plus systématiques.

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OBSIDIAN EXCHANGE NETWORKS IN PREHISTORIC ANATOLIA: NEW DATA FROM THE BLACK SEA REGION

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Abstract: *The reconstruction of obsidian exchange networks has been one of the success stories of archaeology. However, despite over five decades of research on this topic, investigations have focussed predominantly on a number of well documented exchange networks, creating an incomplete understanding of Prehistoric interactions. In this paper the focus is on an ephemeral obsidian exchange network in Northern Anatolia that has been little investigated. On the basis of new data from the Western Turkish Black Sea Region, the broader exchange network in the north is re-evaluated and new research avenues are opened up.*

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Keywords: *Anatolian Prehistory; Black Sea Region; Obsidian Exchange Networks; Obsidian Characterisation.*
Mots-clés : *Préhistoire de l'Anatolie ; Mer Noire ; Obsidienne ; Réseaux d'échanges ; Analyses élémentaires.*

INTRODUCTION

Starting with the seminal publication by Renfrew and colleagues (Renfrew *et al.* 1965; 1966 and 1968), the reconstruction of obsidian distribution networks in the Epipalaeolithic and Early Neolithic of the eastern Mediterranean has without any doubt been one of the great success stories of scientific archaeology in the 20th century (Williams-Thorpe 1995). Obsidian is a volcanic glass with fracture properties that make it very useful for producing chipped stone artefacts (Ercan *et al.* 1994: 505). In terms of mineral composition, each obsidian source is unique. This unique chemical 'fingerprint' makes it possible to identify the source of obsidian artefacts and debitage (Willams-Thorpe 1995; Yeğingil *et al.* 1998).

There are a substantial number of obsidian sources in Anatolia, but only a few appear to have been exploited in Prehistory (Yeğingil *et al.* 1998: 825-826). Amongst the most important investigated sources of Asia Minor (West Anatolia and Cappadocia) that were exploited in Prehistory are (fig. 1): first, those in Cappadocia, in particular the sources at Göllüdağ, Nenezidağ, and Acıgöl, and, second, those in the Galatean Massif, including sources at Sakaeli, Yağlar, and Galatia-X (Keller and Seifried 1990; Yeğingil *et al.* 1998). For East Anatolia we have the sources of the Taurus-Lake Van area (Bingöl, Nemrut Dağ, Süphan Dağ, Meydan Dağ, Tendürek, and Mus Ziyaret), the Erzurum-Kars region (Sarıkamış, Pasinler, Yağlıca, and West Erzurum), and the Erzincan source (Keller and Seifried 1990; Cauvin 1996; Bigazi *et al.* 1998; Gratuze 1999). In the Aegean, obsidian sources were exploited on the islands of Melos and Giali (Williams-Thorpe 1995; Yeğingil *et al.* 1998; Kobayashi *et al.* 2003). Melian obsidian is found in Aegean sites in Asia Minor, such as Çoşkuntepe, Morali and Aphrodisias (Renfrew *et al.* 1965: 238, and 1966: 37; Blackman 1986; Bigazzi *et al.* 1998; Herling *et al.* 2008; Perlès *et al.* 2011).

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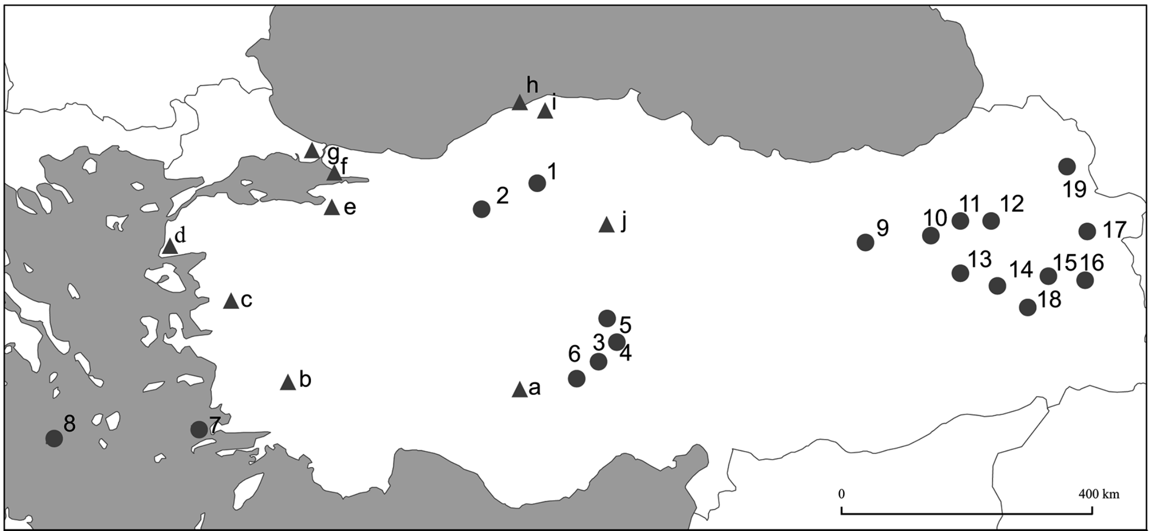

● Obsidian sources: 1: Sakaeli; 2: Yağlar; 3: Nenezidağ; 4: Göllüdağ; 5: Acıgöl; 6: Hasan Dağ; 7: Giali; 8: Melos; 9: Erzincan; 10: West Erzurum; 11: Pasinler; 12: Sarıkamış; 13: Bingöl; 14: Mus Ziyaret; 15: Süphan Dağ; 16: Meydan Dağ; 17: Tendürek; 18: Nemrut Dağ; 19: Yağlıca.

▲ sites: a: Çatalhöyük; b: Aphrodisias; c: Morali; d: Çoşkuntepe; e: Ilıpınar; f: Pendil; g: Fikirtepe; h: Okçular; i: Aybasan; j: Çamlıbel Tarlası.

Fig. 1 – *Obsidian sources and sites mentioned in the text.*

The study of obsidian exchange networks in the eastern Mediterranean has been undertaken for over five decades. Through this research, a great deal has been discovered concerning various obsidian sources, the extent of exchange networks in which obsidian from particular sources was distributed, the proportion of obsidian in the lithic industries in relation to distance to the source, and changes in exchange networks over time. In recent years, investigations of obsidian exchange networks have expanded beyond determining the origin and spread of obsidian as a material, and have addressed issues such as transportation costs (Cessford and Carter 2005): for example it has been argued that a walking distance of 14 hours obsidian is the threshold for direct procurement of obsidian, and that beyond this threshold the material is obtained *via* exchange or in the course of transhumance and that there is a rapid decline in the proportion of obsidian in the lithic industries beyond this threshold (Barge and Chataigner 2003: 178). Finally there has been a new focus on the manner in which obsidian was mined and processed at the sources (Cauvin et Balkan-Atlı 1996; Balkan-Atlı et Binder 2001). Some of the Cappadocian workshops can be dated to specific periods in Prehistory, and can be linked with particular sites or regions where obsidian from these sources has been found, with specific knapping technologies that are linked to specific exchange networks (Düring 2011: 52-58). At Çatalhöyük, a shift in chipped stone industries occurring around level VII coincides with a change in the obsidian source that supplied the site: whereas in earlier levels the obsidian had derived from Göllüdağ, from level VII onwards most material came from Nenezidağ (Carter and Shackley 2007: 443). For the new world it has been argued that in some cases the distribution of obsidian reflects social strategies and links between groups (Peterson *et al.* 1997), and this could apply also to the situation at Çatalhöyük. Such results provide previously unexpected hints of the dynamics of past exchange systems. Finally, increasingly exchange networks are studied not simply from the perspective of production and transport, but from the perspective of consumption patterns (Carter *et al.* 2005; Robb and Farr 2005).

In light of the increasing sophistication in the study of obsidian exchange networks, it is all the more remarkable that this research has focused only on some of the obsidian sources and exchanges networks, and that others remain poorly investigated, if at all. In particular, the obsidian exchange networks originating in the Cappadocian sources and the island of Melos have been systematically investigated (Cauvin et Balkan-Atlı 1996; Balkan-Atlı et Binder 2001; Perlès *et al.* 2011). By contrast, the obsidian exchange network emanating from the Galatean Massif, including sources at Sakaeli, Yağlar, and Galatia-X (Keller and Seifried 1990; Yeğingil *et al.* 1998) remains very poorly investigated and understood, and does not feature in many publications (Williams-Thorpe 1995; Cauvin 1996; Perlès *et al.* 2011).

GALATEAN MASSIF OBSIDIAN EXCHANGE NETWORKS

Notwithstanding the lack of research focus on Galatean Massif obsidian exchange networks, various investigations have provided some evidence for reconstructing this exchange network. Three chemically distinct obsidian sources have been identified in this area: first, one at Sakaeli, located in the Orta district of Çankırı; second, a source at Yağlar, located 20 km north-west of the town of Kızılcahamam; and, third, an unidentified source called 'Galatia-X' that must be located somewhere in the Galatian Volcanic Massif of north-central Anatolia (Keller and Seifried 1990; Keller *et al.* 1996a). Obsidian from the Sakaeli and Yağlar sources has been identified in Neolithic sites of the Marmara Region, such as Ilıpınar, Pendik and Fikirtepe, where they co-occur with obsidian from the Cappadocian sources (Bigazzi *et al.* 1995 and 1998: 80-86). So far, obsidian from the Galatian sources has not been identified at sites in southern central Anatolia, the Aegean, or Thrace, and as such this material seems restricted in distribution to northwestern Anatolia (Chataigner 1998: 275-277). The artefacts from Ilıpınar come from levels X and IX, and can be dated to approximately 6000 BC. Those from Pendik in all likelihood predate Ilıpınar X, and can be tentatively assigned to the second half of the 7th millennium BC (Özdoğan 1999: 213). Apart from the Marmara Neolithic, obsidian from the 'Galatia X' source has been found near the town of Güdül, located within the Galatean Massif (Keller *et al.* 1996a). Thus, the distribution of Galatian obsidian is restricted at present to northwestern Anatolia, and to a short time period in the Early Ceramic Neolithic, *ca* 6500-5800 BC. Remarkably, recent excavations at Late Chalcolithic Çamlıbel Tarlası, located not far from the Galatean sources, have produced obsidian deriving from four distinct Cappadocian sources, but not from Galatean sources (Schoop 2011: 64). This suggests that by the Late Chalcolithic, the Galatean sources were no longer the centre of an obsidian exchange network. It is in this context

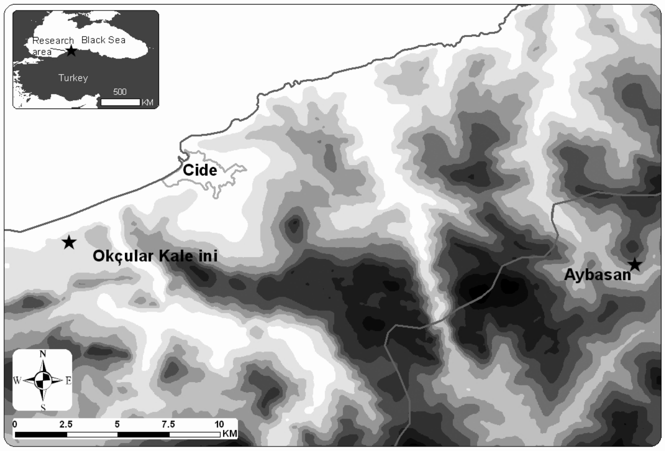

Fig. 2 – *Location of sites where obsidian samples discussed were found.*

of this understanding of this exchange network that we would now like to introduce three obsidian samples from the Western Turkish Black Sea Region.

FIND LOCATIONS OF THE OBSIDIAN SAMPLES

The three obsidian samples under consideration here were collected as part of the Cide Archaeological Project: a surface survey undertaken between 2009 and 2011 in the Cide and Şenpazar districts of Kastamonu province in Northern Turkey. This project, in which both fieldwalking and targeted inspection of promising spots in the landscape were utilized, explicitly aimed to find data pertaining to ephemeral period in Northern Turkey: such as the Early Holocene and the 2nd millennium BC (Düring and Glatz 2010; Glatz *et al.* 2011; Düring *et al.* 2012). In the survey we found obsidian artefacts in various localities. Here we will focus on the two sites from which the samples were taken.

In the mountainous interior district of Şenpazar we found a remarkably large cluster of chipped stone artefacts and debitage on the surface of a steep meadow halfway downslope from the village of Aybasan Mahallesi (fig. 2). At this locality (S82/S98), a total of 73 pieces of chipped stone were found, and these are rather diverse in nature. Among these were four obsidian pieces, the remainder consisting of various types of flint. The chipped stone pieces include mostly debitage, such as large flakes, and chips. There are a few blades and bladelets, but in general little that can be described as tools *sensu stricto*. There are unipolar cores, as well as irregular cores that were worked from various angles. Some large flakes were retouched along the edge to function as scrapers. Among the most exciting finds in the assemblages are three obsidian flakes, as well as an exhausted unipolar obsidian bladelet core. Given the preponderance of debitage and the presence of cores, this site is most plausibly interpreted as a cluster of *in situ* knapping debitage.

The area in which these pieces of chipped stone pieces were found was carefully gridded in five by five metres squares which were inspected with great care. Nonetheless, not a single piece of associated ceramics was found. While an absence of ceramics is not evidence of absence, especially in the Cide-Şenpazar region where Prehistoric ceramics was only found in caves (Düring and Glatz 2010; Glatz *et al*. 2011; Düring *et al*. 2012), this absence makes it possible that this assemblages predates the earliest use of ceramics. Likewise, there are no chipped stone pieces from Aybasan that are clearly Palaeolithic or Mesolithic, such as for example microliths. However, the presence of bladelets and a bladelet core fits broadly in a time span that can be labelled 'the Early Holocene', that is somewhere in the time range of 10,000 to 6000 BC. Some scholars might prefer to use terms such as Aceramic Neolithic for an assemblage such as that found at Aybasan, but the existence of such a phase in Asia Minor remains problematic outside Central Anatolia, as is the definition of the characteristics of the associated lithic industries (Düring 2011: 125-127), and is here therefore avoided. In the Middle Chalcolithic of Northern Turkey, best known from the site of Orman Fıdanlığı, the sort of bladelets and bladelet cores found at Aybasan—which have good parallels in the earlier Marmara Neolithic—are absent (Baykal-Seeher 2001; Gatsov 2001). Thus, circumstantial evidence suggest that the Aybasan material can be dated to the Early Holocene.

From the Aybasan chipped stone cluster, which included a total of four obsidian pieces, we were allowed to select and export two small obsidian flakes (L136 and L224) for source analysis.

The third piece of obsidian analysed is another small obsidian flake, which derives from a cave site near the village of Okçular in the Cide district, located on a shoulder near the coast. Here, a cave was explored that is located in a steep rock outcrop on top of which are the remains of a Byzantine castle. At the back end of the cave we came across a section created in an illicit excavation through a midden-type deposit full of ash and charcoal, but also containing large amounts of pottery and a few chipped stone artifacts (S24). It seems that we are dealing with a former cave entrance that was being used as a garbage dump in Prehistory. The density of deposits and the extraordinary amount of stratified Prehistoric pottery suggest a substantial occupation and contrasts markedly with the almost complete absence of Prehistoric pottery finds from our surface investigations in the same landscape. The Prehistoric pottery found in Okçular Kale İni is finely burnished to a high lustre, has wall thicknesses below five millimetres, a mineral tempered matrix and grey cores. Surface colours range from brownish red to jet black. The forms include open coarse bowls with flat bases and vertical burnishing, a fine ware holemouth shape, one beaded rim, and a large handle with a false twist (Düring and Glatz 2010: 210). Two recent radiocarbon dates on bone samples taken from the section suggest a date of *ca* 4800 BC for these assemblages (table 1).

The obsidian flake (L197) derives from the same deposit. In total 12 chipped stone pieces were found at this site, of which two were obsidian chips.[1] The remaining pieces consisted of blade fragments and large flakes that are similar to the contemporary lithic industries from Orman Fidanlığı (Baykal-Seeher 2001).

Table 1 – *Radiocarbon dates from Okçular Kale İni (S24). Dates from Groningen laboratories.*

Sample number	Uncalibrated date	Calibrated date (Oxcal 4.1)
GrA-51787	5890 +/- 35 BP	4840-4692 BC (95%)
GrA-51788	6005 +/- 35 BP	4991-4799 BC (95%)

OBSIDIAN ANALYSES: METHODOLOGY

The obsidian fragments were analysed at the Centre Ernest-Babelon, IRAMAT (CNRS / Université d'Orléans) by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) with an Element XR mass spectrometer from Thermofisher Instrument and a VG UV microprobe ablation device (Astruc *et al*. 2007; Chataigner and Gratuze 2013).

LA-ICP-MS is widely used to determine the elemental composition of obsidian and causes minimal damage to the specimen (Barca *et al*. 2007; Giussani *et al*. 2009). The LA-ICP-MS operates as follows. The object placed in the ablation cell is

1. In total six pieces of obsidian were found in the three years of survey work in the Cide-Şenpazar region, of which we were allowed to export three samples for sourcing.

sampled by the laser beam, which is generated by an Nd YAG pulsed laser. Its frequency is quadrupled allowing it to operate in the ultraviolet region at 266 nm. The diameter of the ablation crater ranges from 60 to 100 µm, and its depth is around 250 µm. An argon gas flow carries the ablated aerosol to the injector inlet of the plasma torch, where the matter is dissociated, atomised and ionised. The ions are then injected into the vacuum chamber of a double focusing magnetic sector field, which filters the ions depending upon their mass-to-charge ratio. The ions are then collected by a dual mode secondary electron multiplier (SEM), associated with a Faraday detector. This combination allows to increase the linear dynamic range of the mass spectrometer by an additional three orders of magnitude, when compared to single SEM.

Standard reference materials Glass SRM 610 from the National Institute for Standards and Technology and glass B from the Corning Glass Laboratory are used for external standardization. The isotope ^{28}Si is used as an internal standard to normalise the measured signal.

The concentration of thirty-eight elements is determined for each sample, including zirconium, yttrium, niobium, barium, strontium, cerium, lanthanum and titanium, which in our experience are the most useful elements for discriminating between obsidian outcrops (Gratuze 1998). Attribution to a source is determined by comparing the composition of archaeological obsidian with the composition of the reference source outcrops dataset.

OBSIDIAN ANALYSES: RESULTS

The comparison of the artefacts composition (table 2) with the source reference dataset shows that the only sources that match the composition of the three artefacts closely (by combining successively the Ba-Zr, Y/Zr-Nb/Zr and Fe-Ti contents or ratios) are those from the Sakaeli/Orta-Yağlar region (figs. 3, 4 and 5). In particular, the composition of the two artefacts originating from the Aybasan area (L136 and L224) matches the composition of the Sakaeli/Orta group (fig. 6). Comparison with data published by Keller and colleagues (Keller and Seifried 1990; Keller *et al.* 1996b; Poidevin 1998) shows that the third one, recovered in the Okçular area (L197), probably derives from the Yağlar source (fig. 6), located about 50 km west of Sakaeli/Orta. None of these artefacts match the composition of the 'Galatia X' source defined by Keller with the artefacts recovered at Güdül (Keller *et al.* 1996a).

Table 2 – *Composition in part per million (ppm) of the three studied Cide region artefacts and average compositions and standard deviations for the Sakaeli/Orta obsidian group.*

Element in ppm	Aybasan area, Şenpazar district		Okçular area, Cide district	Sakaeli-Orta obsidian source	
	L 136/S64	L224/S62	L 197/S63	Average	Standard deviation
Li	57,1	57,2	80,2	59	1
B	30,1	34,1	43,2	33	8
Na_2O	3,64%	4,71%	3,96%	3,72%	0,21%
MgO	0,10%	0,12%	0,09%	0,11%	0,010%
Al_2O_3	17,8%	18,3%	15,8%	17,5%	0,3%
SiO_2	72,1%	70,4%	73,4%	72,0%	0,3%
K_2O	4,39%	4,28%	4,85%	4,54%	0,09%
CaO	0,75%	0,79%	0,64%	0,82%	0,04%
Sc	7,5	7,8	6,6	8,1	0,9
TiO_2	0,13%	0,17%	0,11%	0,13%	0,004%
Ti	762	645	1001	760	26
Mn	430	444	393	433	8
Fe_2O_3	0,92%	1,10%	0,90%	0,96%	0,03%
Fe	6443	6272	7705	6681	240
Zn	37	42	38	39	3
Rb	150	161	147	153	2
Sr	81	58	90	86	5
Y	8,8	6,8	6,8	8,7	0,5
Zr	104	74	138	109	4
Nb	24	23	29	25	1
Cs	7,5	8,6	10,3	7,7	0,2
Ba	381	279	343	399	15
La	42	31	36	42	1
Ce	73	62	57	75	1
Pr	6,2	4,8	4,2	6,3	0,2
Nd	18,7	14,6	12,3	20	1
Sm	3,1	2,2	1,5	2,7	0,2
Eu	0,56	0,31	0,32	0,50	0,05
Gd	2,5	1,7	1,6	2,5	0,3
Tb	0,29	0,22	0,17	0,31	0,03
Dy	1,6	1,2	0,94	1,5	0,1
Ho	0,30	0,21	0,18	0,33	0,02
Er	0,83	0,57	0,70	0,87	0,06
Tm	0,11	0,10	0,10	0,13	0,01
Yb	0,95	0,80	0,88	0,96	0,05
Lu	0,11	0,11	0,12	0,13	0,02
Hf	3,1	2,3	3,6	3,0	0,2
Ta	1,6	1,5	1,8	1,6	0,1
Th	22,6	18,7	23,8	22	1
U	6,7	7,5	9,8	6,8	0,2

We can thus conclude that the three artefacts come from the Yağlar-Sakaeli/Orta region. It has to be noticed however, that little data is available on the western Anatolian obsidian outcrops, compared to Cappadocia and Eastern Anatolia. Further systematic sampling and a new set of analyses of the

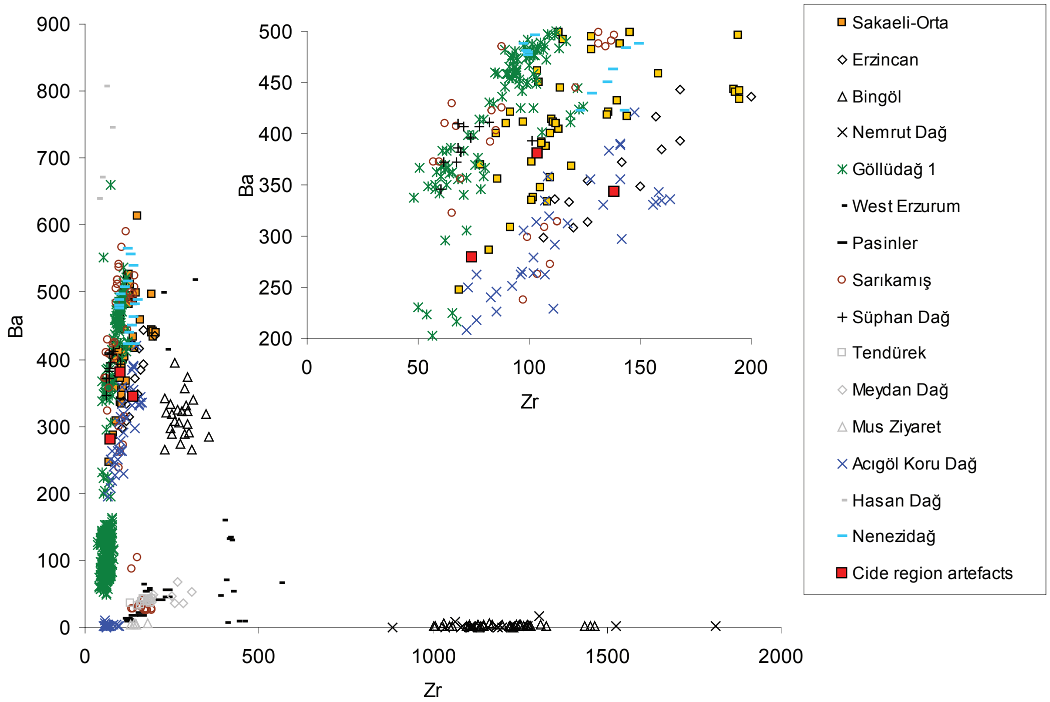

Fig. 3 – *Binary diagram of Zr-Ba contents for the main Anatolian obsidian outcrops and for the three studied artefacts. The Zr-Ba contents of the artefacts are similar with those of obsidian originating from Sakaeli/Orta-Yağlar, Erzincan, Göllüdağ, Acıgöl, Sarıkamış and Süphan Dağ volcanoes.*

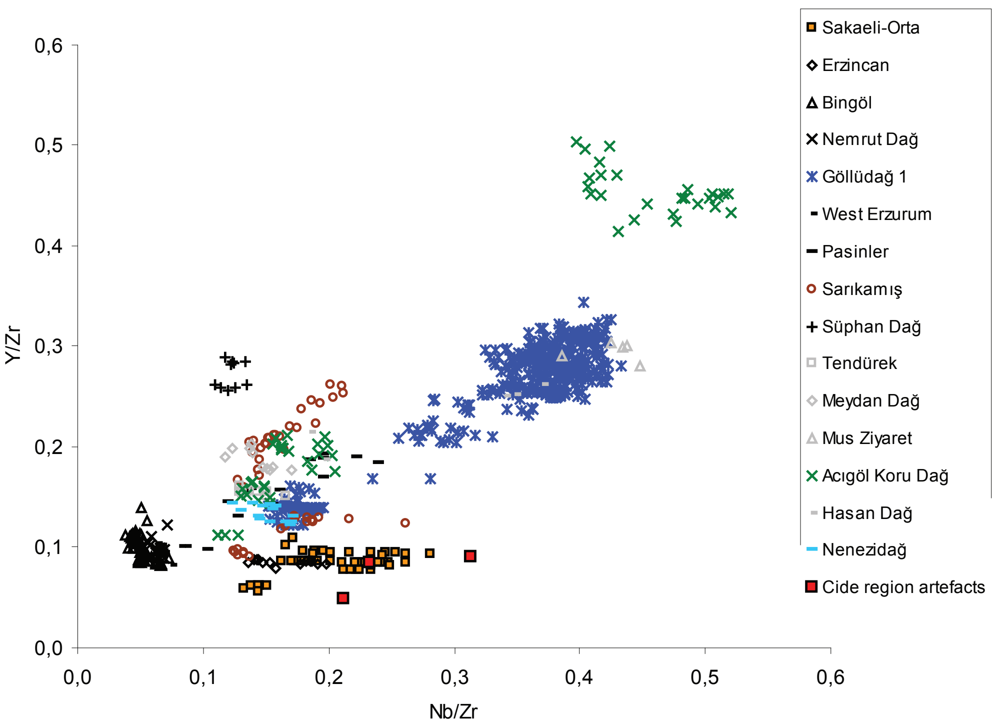

Fig. 4 – *Binary diagram of Nb/Zr-Y/Zr ratios for the main Anatolian obsidian outcrops and for the three studied artefacts. The Nb/Zr-Y/Zr ratios of the three artefacts are similar with those of obsidian originating from Sakaeli/Orta, Yağlar and Erzincan volcanoes.*

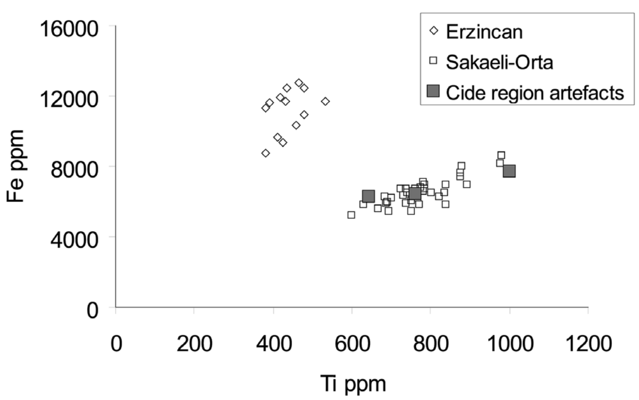

Fig. 5 – *Binary diagram of Ti-Fe contents for Erzincan and the Yağlar and Orta/Sakaeli obsidian outcrops and for the three studied artefacts. Artefacts come from the Sakaeli/Orta and Yağlar region.*

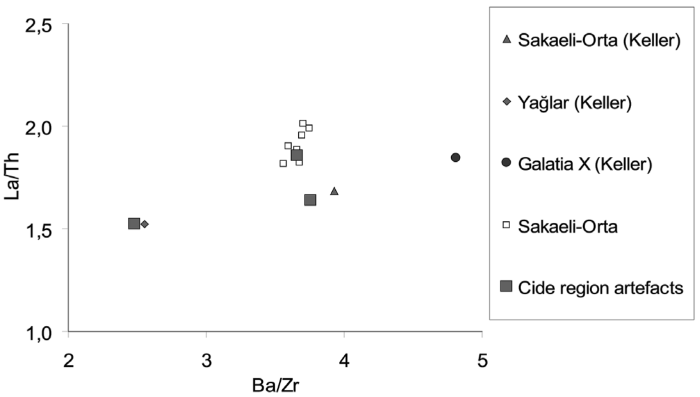

Fig. 6 – *Binary diagram of Ba/Zr-La/Th ratios for the Yağlar and Sakaeli/Orta obsidian outcrops and for the three studied artefacts. One of the artefacts comes from the Yağlar region, while the two others come from the Sakaeli/Orta district.*

obsidian outcrops of this area would therefore be necessary in order to study obsidian distribution on the Western Black Sea Coast region and Western Turkey in more detail.

DISCUSSION AND CONCLUSION

We are far removed from understanding the Galatean Massif obsidian exchange networks in anything but it barest outlines. Nonetheless the data presented here from the Cide region, located in the Western Turkish Black Sea Region, do provide interesting new information on this exchange network.

First, it is clear now that obsidian was exchanged northwards as well as to the Marmara Region. This alone is significant. Transport connections with the Marmara Region are much easier than with the Black Sea littoral to the north. Although the distance between the Galatean obsidian sources and Cide is only about 150 km as the crow flies, there are no natural routes that connect the coast with the interior and the mountains form a formidable obstacle for travelling in this terrain. Thus the presence of obsidian from the Galatean sources suggests that not only was northern Anatolia occupied in the Early Holocene, but that the communities were in contact with each other despite the difficult nature of the intervening terrain. The alternative suggestion would be that the Galatean obsidian was brought to the Marmara Region first, and was then brought to the Cide Region by boats over the Black Sea, but this seems less plausible at the moment. There has been much debate about changes in the Black Sea level during the Early Holocene, and the current consensus seems to be that there was no Black Sea flooding event (Yanko-Hombach *et al*. 2007), and that in the Turkish Western Black Sea Region the sea level might have been *ca* 40 m lower than at present at the start of the Holocene, around minus 20 m at 6000 BC, and that current sea levels would have been reached around 3000 BC (Aksu *et al*. 2002: 88-91). Whatever the precise situation might have been, there is no evidence at present for long distance maritime activities on the Black Sea in the Early Holocene, a situation that contrasts markedly with seafaring taking place in the Mediterranean (Broodbank 2006), a difference that might reflect the fact that the Black Sea is notoriously difficult to navigate (King 2004: 12).

Second, as was indicated previously, the extant evidence for the Galatean Massif obsidian exchange network from the Marmara Region dates to about 6500-5800 BC, after which we have little evidence for the exchange of this material. Further, at the Late Chalcolithic site of Çamlıbel Tarlası, we have no obsidian from the nearby Galatean sources, and obsidian derives from Cappadocian sources. The Cide Archaeological Project obsidian data presented here complement this picture. On the one hand, the two samples from Aybasan hailing from the Sakaeli source fit nicely with the Early Holocene dates of the Galatean Massif obsidian exchange network known from the Marmara Region. On the other hand, the sample from Okçular Kale İni, which we can date with some confidence to the early 5th millennium BC, indicates that this obsidian exchange network might have continued to exist at least in part during the Middle Chalcolithic.

What this discussion shows very clearly is that we have only scratched the surface of the Galatean Massif obsidian exchange network(s) and how it/these change over time. Thus, more research and analysis, both on obsidian sources and archaeological assemblages, are called for to further investigate this obsidian exchange network.

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