C. R. Palevol 11 (2012) 595–602

Contents lists available at SciVerse ScienceDirect

Comptes Rendus Palevol

www.sciencedirect.com

Human palaeontology and prehistory (Prehistoric archaeology)

The character and use of the Soros Hill Obsidian source, Antiparos (Greece)

Caractérisation et utilisation de l'obsidienne de la source de Soros Hill, *Antiparos (Grèce)*

Tristan Carter[a,*], Daniel A. Contreras[b]

[a] *Department of Anthropology, McMaster Archaeological XRF Lab, McMaster University, CNH 524, 1280, Main Street West, Hamilton, ON L8S 4L9, Canada*
[b] *Institute for Ecosystem Research, Kiel University, Olshausenstr. 75, 24118 Kiel, Germany*

ARTICLE INFO

Article history:
Received 10 May 2012
Accepted after revision 4 June 2012
Available online 22 August 2012

Presented by Yves Coppens

Keywords:
Obsidian
Characterisation
Antiparos
Aegean
EDXRF

Mots clés :
Obsidienne
Caractérisation
Antiparos
Égée
EDXRF

ABSTRACT

This article details the geological and elemental character of the obsidian from the Soros Hill source on the Cycladic island of Antiparos, Greece. EDXRF was used to analyse 40 geological geo-referenced samples. The products are clearly chemically discriminated from those of the other Aegean sources, and those from the Carpathians and central Anatolia. While the obsidian is of excellent tool-making quality, the small size of its nodules seems to have made it a less attractive raw material, attested at only a handful of prehistoric sites in the central Cyclades.

RÉSUMÉ

Cet article aborde en détail les caractéristiques géologiques et élémentaires de l'obsidienne de la source de *Soros Hill*, située sur l'île cycladique d'Antiparos (Grèce). L'EDXRF a été utilisé ici pour analyser 40 échantillons géologiques géo-référencés. D'un point de vue chimique, les produits sont clairement discriminés de ceux des autres sources égéennes, mais aussi de ceux des Carpates et d'Anatolie centrale. Bien que l'obsidienne y soit d'une excellente qualité pour la fabrication d'outils, la petite taille de ses nodules semble en avoir fait une matière première moins attractive, seulement attestée dans une poignée de sites des Cyclades centrales.

1. Introduction

This article details a new characterisation study of obsidian from the small Soros Hill source at the south-eastern end of Antiparos, one of the Cycladic islands of the southern Aegean sea, Greece (Fig. 1). The samples' collection and subsequent analysis by energy-dispersive

* Corresponding author.
E-mail addresses: maxlab@mcmaster.ca (T. Carter), dcontreras@ecology.uni-kiel.de (D.A. Contreras).

1631-0683/$ – see front matter © 2012 Académie des sciences. Published by Elsevier Masson SAS. All rights reserved.
doi:10.1016/j.crpv.2012.06.005

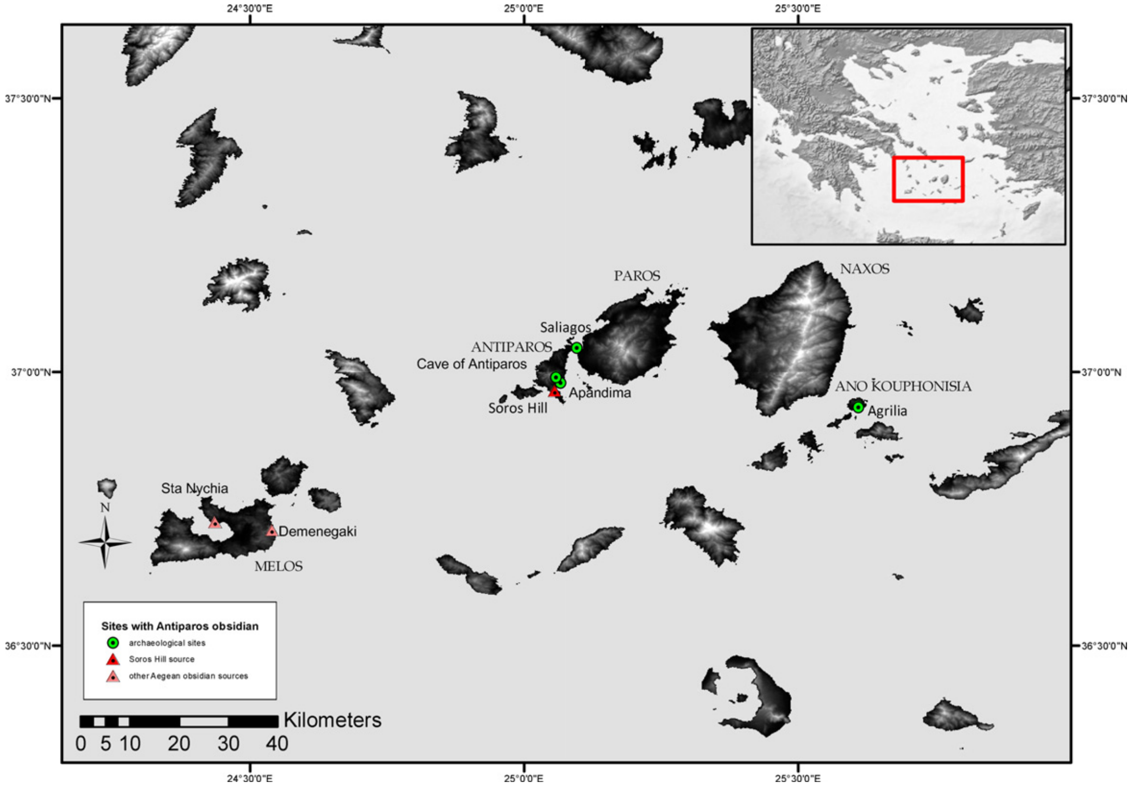

Fig. 1. Major obsidian sources and sites mentioned in the text.

Fig. 1. Principales sources d'obsidienne et sites mentionnés dans le texte.

X-ray fluorescence spectrometer (EDXRF) formed part of the *McMaster Obsidian Procurement Expedition* (MOPE), a larger project dedicated to the collection of Aegean and Anatolian source materials to produce an elemental databank for archaeometric analysis at the McMaster Archaeological XRF Lab (MAX Lab). While there have been previous compositional analyses of Antiparos obsidian, these only ever involved handfuls of material (Table 1); our study aimed to produce a more solid evidential basis for the elemental characterisation of this source by analysing 40 geo-referenced samples. This paper also describes the obsidian's tool-making and other physical properties, plus its geological context. Finally, we review the limited evidence for this obsidian's use by past populations, its minor role in Aegean prehistory arguably the result of the nodules' small size, with the nearby sources on Melos representing the primary outcrops exploited by Upper Palaeolithic to Bronze Age peoples (Carter, 2009).

Table 1
Details of prior elemental characterisation of Soros Hill obsidian.
Tableau 1
Détails des précédentes caractérisations élémentaires de l'obsidienne de *Soros Hill*.

Study	Method	Samples
Renfrew et al., 1965	Optical emission spectroscopy	3
Aspinall et al., 1972	Neutron activation analysis [NAA]	3
Gale, 1981	Strontium isotope analysis	7
Kilikoglou et al., 1997	NAA; inductively coupled plasma emission spectrometry	5
Liritzis, 2008	Portable energy-dispersive X-ray fluorescence spectroscopy	1

2. Background

The Soros Hill source was first reported towards the end of the 19th century as part of an early archaeological investigation of the Cyclades (Bent, 1884: 52). It represents one of the four major obsidian sources of the Aegean (Figs. 1 and 2), alongside Sta Nychia and Dhemenegaki on nearby Melos, plus Giali to the east in the Dodecanese islands. Renfrew et al. (1965) provided the source's first detailed report as part of a larger study of eastern Mediterranean obsidian, and analyzed three geological samples as part of the Old World's first major obsidian characterisation project. Using a bivariate Barium vs. Zirconium contents plot, they were able to discriminate the Antiparos obsidian from the products of other Aegean sources, together with those of the western Mediterranean, Carpathians and central Anatolia. The Soros Hill obsidian comprised the sole constituent of their source Group 3b (Renfrew et al., 1965: Figure 4, Table 1). Antiparos obsidian has subsequently been characterised by a number of other studies using various analytical techniques, though no project involved more than seven source samples (Table 1). It should be noted

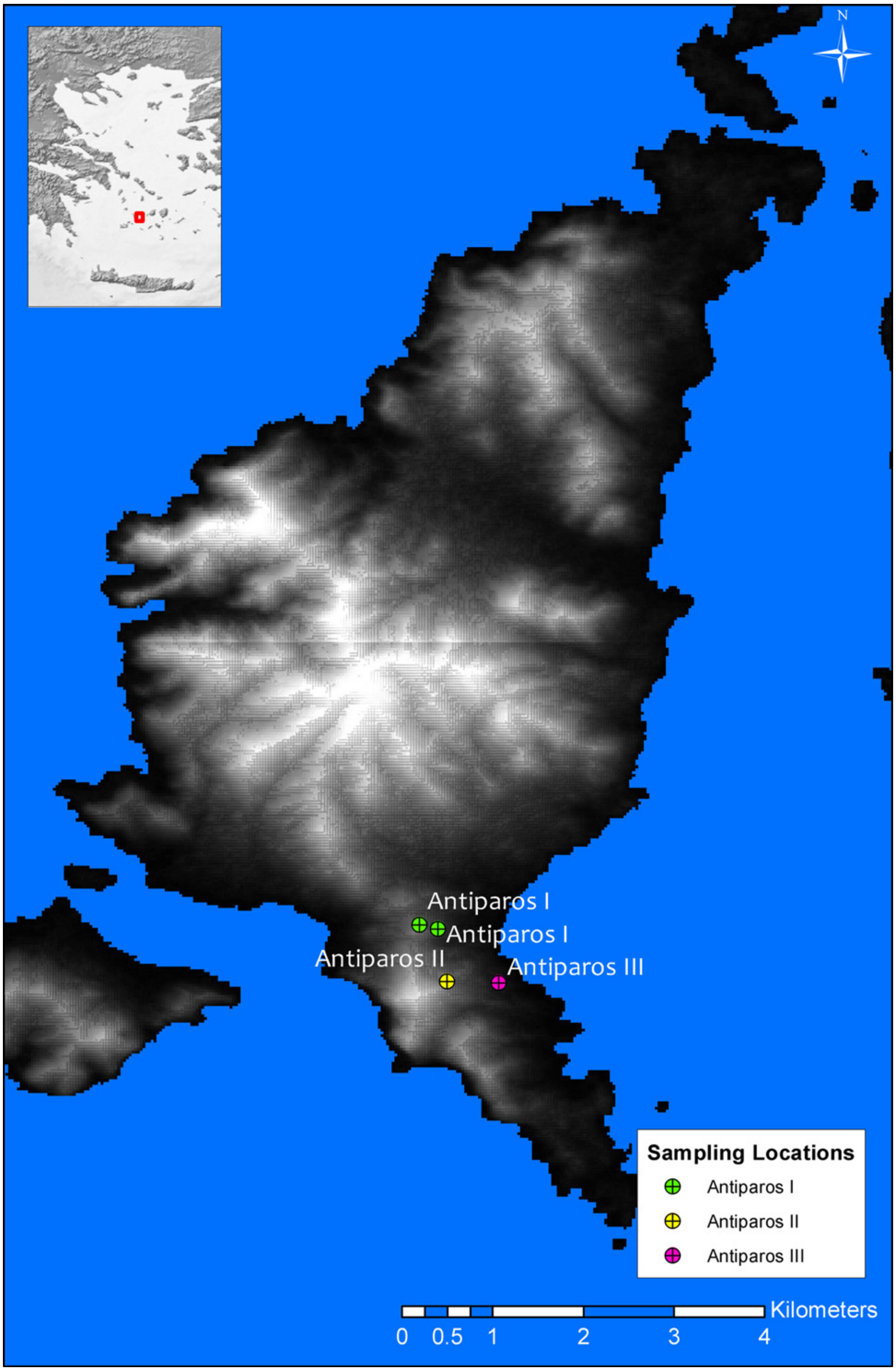

Fig. 2. Sampling locations on the Soros Hill obsidian source, Antiparos.

Fig. 2. Localisation des prélèvements sur la source de *Soros Hill*, Antiparos.

that with the exception of portable EDXRF, each of the techniques employed was destructive. Antiparos obsidian has also been analyzed for its thermoluminescent properties; the results show that it had a relatively low natural saturation peak of 350 °C (low compared to Melian and western Mediterranean obsidian), with a ten times brighter TL intensity (Göksu et al., 1988). TL has yet to be applied to Aegean obsidians for characterisation purposes, unlike K-Ar and fission track dating (Arias et al., 2006; Durrani et al., 1971).

Archaeologically, it has long been appreciated that Soros Hill obsidian was fairly insignificant, arguably because while the material fractures conchoidally, the raw nodules were mainly in the form of "small lumps" less than 5 cm in length (Renfrew et al., 1965: 232). Instead, Sta Nychia and Dhemenegaki on Melos represented the primary Aegean obsidian sources (Carter, 2009). The preference for Melian obsidian by prehistoric tool makers is perhaps most clearly evidenced at the Late Neolithic (5th millennium cal BC) site of Saliagos (Fig. 1). While today Saliagos is situated on a small islet between Antiparos and Paros, these three landmasses were originally part of a single island, whereby the Soros Hill source was only a few kilometres to the south across dry land, yet the vast majority of the community's chipped stone assemblage was made from Melian obsidian (Cann et al., 1968).

2.1. *Geological background*

Most Cycladic islands represent submerged mountain peaks, the Aegean Sea itself being the result of subsidence of the land between what today is Greece to the west and Turkey to the east (Keller, 1982). Antiparos forms part of the older northern section of the Hellenic Volcanic Arc system, a zone of volcanism dating from the Pliocene to the present that runs roughly east-west from the Greek mainland through the Aegean into western Anatolia; the obsidian sources on Melos and Giali relate to the younger southern arc (Shelford et al., 1982: 74–75). Antiparos is a relatively small island, approximately 45 km^2, and is comprised primarily of a metamorphic basement with gneisses and schists intercalated with marbles (Anastopoulos, 1963); Pliocene volcanic rocks are only exposed in the southern part of the island. Obsidian is in some cases part of the often vesiculated lava flows of these rhyolitic domes (Hannappel and Reischmann, 2005: 309, fig. 2; Innocenti et al., 1982: 88); our field observations however only located obsidian included in volcanic tuff. K-Ar dating of associated volcanic deposits produced ages between 4.0 and 5.4 Ma, i.e. relating to the beginning of the Pliocene (Innocenti et al., 1982: 90–91, table 1).

3. The obsidian of Soros Hill: occurrence, nature and sampling

In August 2010, we procured 44 samples from three collection areas on Soros Hill (Fig. 2). The hill, rising approximately 200 m from the Aegean at the southern end of Antiparos, is dissected by multiple shallow drainages and covered with scrub vegetation (Fig. 3); obsidian is available both in colluvium superficially mantling the slopes and exposed in eroding deposits of tuff with clasts of perlite and small obsidian nodules (Fig. 4). Obsidian is sparsely but relatively consistently available over an area of roughly 50 ha, but rarely were nodules larger than 4 cm in their long dimension observed (Fig. 5). The three collection areas were spaced approximately 500 m apart in this area, spanning an elevational range of 0–110 masl in order to capture potential variability between exposures of distinct flows. Each collection area was described in the field, documented with a recreational GPS (Garmin 60csx with an accuracy of ±6 m), and photographed. Sampling focused on in situ

Fig. 3. View across the eastern flank of Soros Hill, looking south.
Fig. 3. Vue sur le flanc est de *Soros Hill*, en direction du sud.

Fig. 4. Obsidian and perlite exposed in eroding tuff matrix, sampling location Antiparos I.
Fig. 4. Obsidienne et perlite exposées dans une matrice de tuf érodée, site d'échantillonnage Antiparos I.

Fig. 5. Nodules of Soros Hill obsidian.
Fig. 5. Nodules d'obsidienne de *Soros Hill*.

Fig. 6. Flakes of Soros Hill obsidian in natural and transmitted light.
Fig. 6. Éclat d'obsidienne de *Soros Hill* en lumière naturelle et transmise.

rather than colluvial obsidian so that the specific geospatial provenience of each sample could be confidently recorded.

Antiparos I – 36.9714N, 25.0528 E and 36.9719N, 25.0509 E. The first sample location was on the western slope of Soros Hill, where obsidian was both available in the colluvium mantling the slope and in inclusions of perlite and obsidian within exposures of tuff (Fig. 4). Inclusions of fragments of banded flows of rhyolite, perlite, and obsidian are also visible, but only up to 30 cm in their long axis and clearly reworked within the tuff deposit. The largest intact nodules of obsidian reached only 4 cm on their long axes. Eleven nodules were collected, weighing between 9 – 123 g (mean 38 g) and 1.9–4.3 cm long.

Antiparos II – 36.9662N, 25.0537 E. Approximately 0.5 km south of Antiparos I. Sixteen nodules were collected, weighing between 7–138 g (mean 19 g) and 1.3–6.8 cm long.

Antiparos III – 36.9661N, 25.0588 E. Approximately 1 km to the south-east of Antiparos I, in a modern roadcut at the foot of Soros Hill; another exposure of what appears to be the same deposit of tuff, likely the second exposure reported by Renfrew et al. (1965: 232). Obsidian nodules eroding out of this tuff matrix are predominantly less than 3 cm, but occasionally larger (one reaching 7 cm). Sixteen nodules were collected, weighing between 4–13 g (mean 8 g) and 1.4–2.8 cm long.

In each instance, the obsidian is recovered in the form of small lustrous jet-black nodules (Fig. 4). The raw material has a good conchoidal fracture habit and tends to be very homogenous, but most pieces are under 3 cm long. Moreover, we saw precious little evidence for the material having been knapped at the source, with the exception of one blade-like piece (not collected, being an archaeological artefact), that neatly illustrates the obsidian's grey

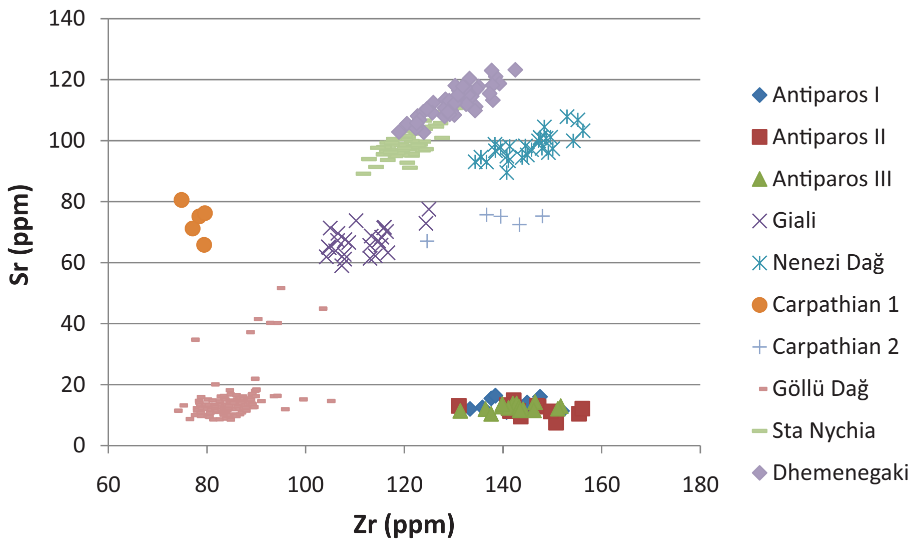

Fig. 7. Bivariate Sr v. Zr contents plot for obsidian from Aegean, Carpathian and central Anatolian sources.
Fig. 7. Diagramme binaire Sr vs. Zr pour les sources d'obsidienne de l'Égée, des Carpates et d'Anatolie centrale.

Table 2
Elemental composition of Soros Hill obsidian as determined by EDXRF.
Tableau 2
Composition élémentaire de l'obsidienne de *Soros Hill* déterminée par EDXRF.

Sample	Ti	Mn	Fe	Cu	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
Antiparos I.001	909	564	9695	6	32	14	406	11	22	150	37	−8	66	61
Antiparos I.003	951	521	9183	6	28	19	378	13	18	136	33	−13	63	51
Antiparos I.004	943	484	8967	3	22	15	354	11	22	141	31	7	63	57
Antiparos I.005	876	507	9132	13	31	23	379	12	21	133	36	−19	63	49
Antiparos I.010	1048	515	9280	14	24	19	379	15	18	138	32	13	64	53
Antiparos I.011	934	559	9559	3	32	17	400	13	22	146	37	29	65	60
Antiparos I.012	942	544	9232	4	25	11	379	16	23	147	37	−14	63	50
Antiparos I.013	914	499	9247	5	31	19	380	11	20	152	34	18	62	59
Antiparos I.014	838	553	9466	10	43	21	369	16	19	138	37	86	74	62
Antiparos I.015	959	514	9527	6	30	17	384	14	18	145	33	26	62	60
Antiparos II.001	898	526	9179	5	26	10	385	13	20	147	36	19	64	50
Antiparos II.002	966	511	9056	4	29	20	374	8	20	151	37	8	58	55
Antiparos II.003	1020	558	10101	3	29	21	402	10	21	155	37	−4	71	51
Antiparos II.004	1089	571	9896	14	35	22	398	12	20	156	36	−11	62	54
Antiparos II.005	850	529	9378	3	28	20	383	15	20	142	36	18	62	60
Antiparos II.006	875	522	9030	3	31	17	375	13	20	142	35	15	62	59
Antiparos II.007	1083	498	9322	10	31	12	360	11	19	141	38	41	57	52
Antiparos II.008	912	488	8698	6	31	13	343	12	19	141	32	27	52	56
Antiparos II.009	841	475	8820	3	31	19	357	13	16	131	36	6	59	49
Antiparos II.010	1011	551	9488	10	31	17	391	13	20	141	35	8	66	61
Antiparos II.011	949	540	9477	3	31	17	399	13	18	147	39	37	66	56
Antiparos II.012	914	469	8859	15	35	16	362	12	23	142	36	0	58	57
Antiparos II.013	962	491	9046	5	31	15	373	11	17	143	37	33	60	55
Antiparos II.014	1022	570	9794	8	61	16	414	11	20	150	33	40	74	63
Antiparos II.015	864	529	9170	3	32	17	370	10	24	144	36	23	63	62
Antiparos III.001	1098	509	9352	3	35	13	352	12	20	136	36	6	62	53
Antiparos III.002	867	458	9119	14	29	15	374	14	22	142	38	−5	62	55
Antiparos III.003	917	501	9318	9	44	17	370	13	20	140	36	24	56	59
Antiparos III.004	1025	570	9585	7	34	18	371	14	17	143	37	12	62	51
Antiparos III.005	892	454	8896	8	25	17	364	12	22	141	34	10	54	55
Antiparos III.006	891	520	9228	3	31	13	387	13	23	152	36	28	62	58
Antiparos III.007	857	537	9442	3	39	18	379	14	23	147	38	39	60	56
Antiparos III.008	874	488	8964	13	34	19	364	10	21	138	34	38	60	55
Antiparos III.009	881	482	8886	3	26	13	366	12	22	151	38	12	57	52
Antiparos III.010	938	548	9404	15	45	14	387	13	20	143	36	1	69	56
Antiparos III.011	966	459	8514	8	35	15	333	11	21	131	31	2	50	50
Antiparos III.012	923	501	9074	9	26	20	381	12	20	144	34	13	61	60
Antiparos III.013	878	500	9170	6	35	17	378	12	20	143	37	17	62	58
Antiparos III.014	941	538	9117	4	29	15	377	12	20	146	36	18	55	49
Antiparos III.015	933	502	9065	13	25	17	376	14	18	140	37	13	59	51
RGM-2	1566	335	13956	14	40	17	146	106	27	231	8	785	20	9
RGM-2	1442	357	13996	16	42	13	148	102	22	231	12	842	27	17
RGM-2	1538	309	13987	10	37	21	146	107	23	226	8	778	22	11
RGM-2	1580	346	14027	8	37	15	142	105	23	232	11	836	24	18
RGM-2	1471	297	13928	12	44	14	146	106	25	228	7	806	23	15

hue and translucency when flaked (Fig. 6). Noteworthy is the fact that even the exterior surface is shiny, i.e. it lacks the coarser matte cortical surface that one associates with many obsidian source materials, as for example on Melos. Renfrew et al., 1965 (1965: 232) report that similarly lustrous nodules are to be found on some of the Slovakian nodules (Zemplin Hills, "Carpathian 1"), while we have seen similar small lustrous pieces from Erzincan in north-eastern Anatolia.

3.1. *The elemental analyses*

A total of 40 geological samples were elementally characterised at the MAX Lab using a Thermo Scientific *ARL Quant'X* EDXRF spectrometer. While the technique is non-destructive, it was necessary to prepare a freshly flaked surface for the X-ray beam, as post-depositional processes have been shown to result in outer cortical or weathered surfaces having diminished concentrations of certain elements, Na in particular, K and Fe to a lesser extent (Poupeau et al., 2010: 2712). The nodules were thus knapped, or cut with a diamond saw, then cleaned in an ultrasonic tank with distilled water for ten minutes. The analytical protocols and methods follow those devised by Shackley (2005: appendix).

The spectrometer is equipped with an ultra-high flux peltier air cooled Rh X-ray target with a 125 micron beryllium (Be) window, an X-ray generator that operates from 4 to 50 kV/0.02 to 1.0 mA at 0.02 increments and a 2001 min-1 Edwards vacuum pump for the analysis of elements below titanium (Ti). Data are acquired with a pulse processor and analog to digital converter. The major elements titanium (Ti), manganese (Mn) and iron (Fe) are analyzed as well as trace elements copper (Cu), zinc (Zn), gallium

(Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), barium (Ba), lead (Pb) and thorium (Th). In order to evaluate these quantitative determinations, instrument data were converted to concentration estimates through reference to various standards, including those certified by the US Geological Service and Geological Survey of Japan (AGV-2, BCR-2, BHVO-2, BIR-1a, GSP-2, JR-1, JR-2, QLO-1, RGM-2, SDC-1, STM-2, TLM-1 and W-2a). In turn, the standard RGM-2 (USGS) is analyzed during each sample run to check machine calibration and accuracy. The data are then translated directly into Excel for Windows software for manipulation and analysis. Any piece exhibiting anomalous values was re-run to ensure accuracy and precision.

4. Results

The homogeneity of the elemental composition of the various geological samples indicates clearly that we are, perhaps unsurprisingly, dealing with the products of a single flow (Table 2). In turn, through a bivariate Sr vs. Zr contents plot, the obsidian of Soros Hill can clearly be discriminated from the products of the other major sources of the Aegean, central Anatolia and the Carpathians (Fig. 7), i.e. Dhemenegaki and Sta Nychia on Melos (Cyclades), Giali (Dodecanese), Göllü Dağ and Nenezi Dağ (Cappadocia), Zemplin Hills/Carpathian 1 (Slovakia) and Tokaj Mountains/Carpathian 2 (Hungary). We aimed to discriminate these raw materials in particular as each has been attested in chipped stone assemblages of the prehistoric Aegean (Bellot-Gurlet et al., 2008; Carter and Kilikoglou, 2007; Kilikoglou et al., 1996). Notable characteristics of the Antiparos obsidian are its enriched Th (47–63 ppm) and Rb counts (333–414 ppm), and depleted levels of Sr (8–16 ppm) and Ba (< 86 ppm, most below 41 ppm (Table 2)); these have been noted as defining features of Antiparos rhyolites more generally, along with high levels of Cs, U and Nb (Clapsopoulos, 1998).

4.1. History of use

The obsidian of Antiparos appears to have been used rarely by prehistoric populations and only then by relatively local communities. It is thus far only attested geochemically at Late Neolithic Saliagos (5th millennium cal BC), today a small islet between Antiparos and Paros (Fig. 1), but at the time part of a single large island (Morrison, 1968). The artefacts comprised two flakes, one part-cortical and retouched; the rest of the site's large assemblage otherwise seemed to be made of Melian obsidian (Cann et al., 1968: 106). On the basis of visual characterization alone, single pieces of Antiparos obsidian are also claimed to have been found in two Cycladic burial assemblages of Early Bronze Age [EB] date, i.e. the first half of 3rd millennium BC. The first was a "pebble" from an EB II cist grave in the small burial ground of Apantima/Agios Sostis on Antiparos, less than 2 km north-east of the source (Bent, 1884: 52), "obviously buried as an attractive curiosity" (Renfrew et al., 1965: 239). The second piece comes from the late EB I Agrilia cemetery on Ano Kouphonisi in the central Cyclades (Zapheiropoulou, 2008); with Tomb 65 containing an un-worked nodule of lustrous jet-black obsidian 0.78 cm in diameter (Carter, 1999: Appendix Two). It is also likely that some of the Late Neolithic and EB implements from the recent excavations at the Cave of Antiparos were also made of Soros Hill obsidian, however, preliminary publications provide no description of the material (Mavridis, 2011).

5. Conclusion

This article contributes to eastern Mediterranean obsidian characterisation studies by producing a robust elemental data-set for the Soros Hill source on Antiparos. It confirms that the products of this source:

- are relatively homogenous in terms of their chemistry, size, knapping quality, colour, texture and translucency;
- can be easily discriminated from other obsidian from sources in not only the Aegean, but also the nearby Carpathians and central Anatolia;
- are exclusively available as small nodules, likely accounting for the material's limited history of use.

Acknowledgements

Fieldwork was funded by a Standard Research Grant of the *Social Sciences and Humanities Research Council, Canada*, while the MAX Lab was created by a *Canada Foundation for Innovation Leader's Opportunity Fund/Ontario Research Fund*. We thank Drs. Irene Zananiri, Alexandra Zervakou and the Institute of Geology and Mining Exploration, Greece for a permit to sample Soros Hill; Dr. Stathis Chiotis provided initial advice and support. Marina Milić gave us the Carpathian source samples. Dr. Jennifer Birch, Kyle Freund and Sarah Grant worked in the field, the latter taking the photographs. Dr. François-Xavier Le Bourdonnec prepared some of the samples, while Marie Orange undertook some analyses.

References

Anastopoulos, J., 1963. Geological study of Antiparos island group. Geol. Geophys. Res., ISGR 7, 231–375.
Arias, A., Oddone, M., Bigazzi, G., Di Muro, A., Principe, C., Norelli, P., 2006. New data for the characterization of Milos obsidians. J. Radioanal. Nucl. Ch. 268 (2), 371–386.
Aspinall, A., Feather, S.W., Renfrew, C., 1972. Neutron activation analysis of Aegean obsidians. Nature 237, 333–334.
Bellot-Gurlet, L., Pelon, O., Séfériadès, M.L., 2008. Détermination de provenance d'une sélection d'obsidiennes du palais minoen de Malia (Crète). C.R. Palevol. 7, 419–427.
Bent, J.T., 1884. Researches among the Cyclades. J. Hellenic Stud. 5, 42–59.
Cann, J.R., Dixon, J.E., Renfrew, C., 1968. Appendix IV: the sources of the Saliagos obsidian. In: Evans, J.D., Renfrew, C. (Eds.), Excavations at Saliagos near Antiparos, British School at Athens, SupplementaryVolume 5. London, pp. 105–107.
Carter, T., 1999. Through a Glass Darkly: Obsidian and Society in the Southern Aegean Early Bronze Age. Ph.D. thesis, Institute of Archaeology, University College London.
Carter, T., 2009. L'obsidienne égéenne : caractérisation, utilisation et culture. In: Moncel, M.-H., Fröhlich, F. (Eds.), L'Homme et le Précieux. Matières Minérales Précieuses de la Préhistoire à Aujourd'hui. BAR International Series 1934, Archaeopress, Oxford, pp. 199–212.
Carter, T., Kilikoglou, V., 2007. From reactor to royalty? Aegean and Anatolian obsidians from *Quartier Mu*, Malia (Crete). J. Mediterr. Archaeol. 20.1, 115–143.

Clapsopoulos, I., 1998. Origin of the Antiparos island rhyolites, Greece, by subduction-related anatexis of a granulitic source possibly located in the middle to lower continental crust. Bull. Geol. Soc. Greece 8, 355–366.

Durrani, S.A., Khan, H.A., Taj, M., Renfrew, C., 1971. Obsidian source identification by fission track analysis. Nature 233, 242–245.

Gale, N.H., 1981. Mediterranean obsidian source characterisation by strontium isotope analysis. Archaeometry 23, 41–51.

Göksu, H.Y., Regulla, D.F., Vogenauer, A., Wieser, A., 1988. Dose dependent TL fading of obsidians. International Journal of Radiation Applications and Instrumentation. Part D. Nucl. Tracks Rad. Meas. 14 (1/2), 143–147.

Hannappel, A., Reischmann, T., 2005. Rhyolitic dykes of Paros island, Cyclades. In: Fytikas, M., Vougioukalakis, G.E. (Eds.), The Southern Aegean Active Volcanic Arc. Elsevier, San Diego, pp. 305–327.

Innocenti, Kolios, F., Manetti, N., Rita, P., Villari, F.L., 1982. Acid and basic Late Neogene volcanism in Central Aegean Sea: its nature and geotectonic significance. Bull. Volcanol. 45 (2), 87–97.

Keller, J., 1982. Mediterranean island arcs. In: Thorpe, R.S. (Ed.), Andesites. Orogenic Andesites and Related Rocks. Wiley, New York, pp. 307–326.

Kilikoglou, V., Bassiakos, Y., Doonan, R.C., Stratis, J., 1997. NAA and ICP analysis of obsidian from Central Europe and the Aegean: source characterisation and provenance determination. J. Radioanal. Nucl Ch. 216 (1), 87–93.

Kilikoglou, V., Bassiakos, Y., Grimanis, A.P., Souvatzis, K., Pilali-Papasteriou, A., Papanthimou-Papaefthimiou, A., 1996. Carpathian Obsidian in Macedonia, Greece. J. Archaeol. Sci. 23 (3), 343–349.

Liritzis, I., 2008. Assessment of Aegean obsidian sources by a portable ED-XRF analyser: Grouping, provenance and accuracy. In: Facorellis, Y., Zacharias, N., Polikreti, K. (Eds.), Proceedings of the 4th Symposium of the Hellenic Society for Archaeometry. BAR International Series 1746, Tempus Reparatum, Oxford, pp. 399–406.

Mavridis, F., 2011. Salvage excavation in the Cave of Antiparos, Cyclades: Prehistoric pottery and miscellaneous finds. A preliminary report. Aegean Archaeol. 9, 7–34.

Morrison, I.A., 1968. Appendix I: Relative sea level changes in the Saliagos area since Neolithic times. In: Evans, J.D., Renfrew, C. (Eds.), Excavations at Saliagos near Antiparos, British School at Athens, Supplementary Volume 5. London, pp. 92–98.

Poupeau, G., Le Bourdonnec, F.X., Carter, T., Delerue, S., Shackley, M.S., Barrat, J.A., Dubernet, S., Moretto, P., Calligaro, T., Milić, M., Kobayashi, K., 2010. The use of SEM-EDS, PIXE and EDXRF for obsidian provenance studies in the Near East: A case study from Neolithic Çatalhöyük (central Anatolia). J. Archaeol. Sci. 37 (11), 2705–2720.

Renfrew, C., Cann, J.R., Dixon, J.E., 1965. Obsidian in the Aegean. Ann. British School Athens 60, 225–247.

Shackley, M.S., 2005. Obsidian: Geology and Archaeology in the North American Southwest. University of Arizona Press, Tucson.

Shelford, P., Hodson, F., Cosgrove, M.E., Warren, S.E., Renfrew, C., 1982. The sources and characterisation of Melian obsidian. In: Renfrew, C., Wagstaff, M. (Eds.), An Island Polity: the Archaeology of Exploitation on Melos. Cambridge University Press, Cambridge, pp. 182–191.

Zapheiropoulou, P., 2008. Early Bronze Age cemeteries of the Kampos Group on Ano Kouphonisi. In: Brodie, N., Doole, J., Gavalas, G., Renfrew, C. (Eds.), Horizons: A Colloquium on the Prehistory of the Cyclades. McDonald Institute Monographs, Cambridge, pp. 183–194.