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

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

Tristan Carter, Daniel A. Contreras

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.

Keywords: Obsidian, Characterisation, Antiparos, Aegean, EDXRF

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...
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 archaeological 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).

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

Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>Method</th>
<th>Samples</th>
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<tr>
<td>Renfrew et al., 1965</td>
<td>Optical emission spectroscopy</td>
<td>3</td>
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<tr>
<td>Aspinall et al., 1972</td>
<td>Neutron activation analysis [NAA]</td>
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<td>Gale, 1981</td>
<td>Strontium isotope analysis</td>
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<td>Kilikoglou et al., 1997</td>
<td>NAA; inductively coupled plasma emission spectrometry</td>
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<td>Liritzis, 2008</td>
<td>Portable energy-dispersive X-ray fluorescence spectroscopy</td>
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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 Dhemegakia 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 land-masses 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 km², 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
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

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**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.

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**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.
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. Dhemegaki 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 Klikoglou, 2007; Klikoglou 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 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 Kouponi in the central Cyclades (Zapheiropoulos, 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 elements 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.

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References


