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Identification and characterization of two new obsidian sub-sources in the Nemrut volcano (Eastern Anatolia, Turkey): The Sıcaksu and Kayacık obsidian

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ABSTRACT

In the framework of the GeObs project (http://geobs.univ-rouen.fr), we performed an exhaustive field study of obsidian lava outcropping of the Nemrut volcano (Eastern Anatolia, Turkey). The macroscopic facies and the chemical characteristics of all sub-sources are presented and compared to each other. The Nemrut sub-sources are distinguishable using microscopic facies and geochemistry (LA-ICP-MS) data. We identify and characterize two previously unknown outcrops (Sıcaksu and Kayacık) both located in the western part of the volcano. Only one of these two sub-sources, which is located near the Sıcaksu village, provides good quality obsidian for knapping. $^{40}Ar/^{39}Ar$ dating of this sub-source reveals an age of 203 ± 18 ka. It thus belongs to the early pre-caldera stage of the Nemrut volcano. Chemical analyses and comparison of datasets composed of results from (i) all Nemrut sub-sources sampled, and (ii) various artefacts presented in Khalidi et al. (this volume) and attributed to the Nemrut volcano, clearly match these artefacts to the Sıcaksu outcrop.
The data obtained from a combination of fieldwork and geochemical analyses demonstrates that the Sıcaksu obsidian outcrop was exceptionally important as a source of obsidian raw material for the production of tools and artefacts by prehistoric populations across the Near East.

1. Introduction

Many Neolithic artefacts made from obsidian are recovered from archaeological sites in the Near East, and sometimes at great distances (exceeding 700 km) from obsidian sources. As a result, several socio-cultural questions arise regarding social organization, technological practices, territorial dynamics, specialization of skills and human group dynamics. It is possible to answer these questions by identifying the location of obsidian sources, the morphology of raw materials extracted and types of quarrying carried out as well as by identifying exchange routes and the modalities of exchange between communities (i.e. Astruc, 2011; Khalidi et al., this volume).

Volcanic areas where obsidian is suitable for artefact production can be found in the acidic volcanic systems of central Anatolia (Cauvin et al., 1998; Erturaç et al., 2010; Binder et al., 2011), eastern Anatolia (Yılmaz et al., 1998) and the Caucasus (Chataigner, 1994; Cauvin and Chataigner, 1998). Geochemical studies reveal that a large number of obsidian artefacts recovered from Near-Eastern archaeological sites have a chemical affinity with eastern Anatolian volcanic products (Cauvin et al., 1998). One of the aims of the GeObs program is to produce a comprehensive geochemical composition database of Eastern Anatolian obsidian outcrops (Fig. 1) and archaeological artefacts in order to better understand obsidian circulation in the region and its relation to other exploited obsidian-rich zones. In the framework of this program, we performed a systematic study of the geological sources which included a full identification of outcrops (types of sources and sub-sources and geomorphological contexts, associated with systematic

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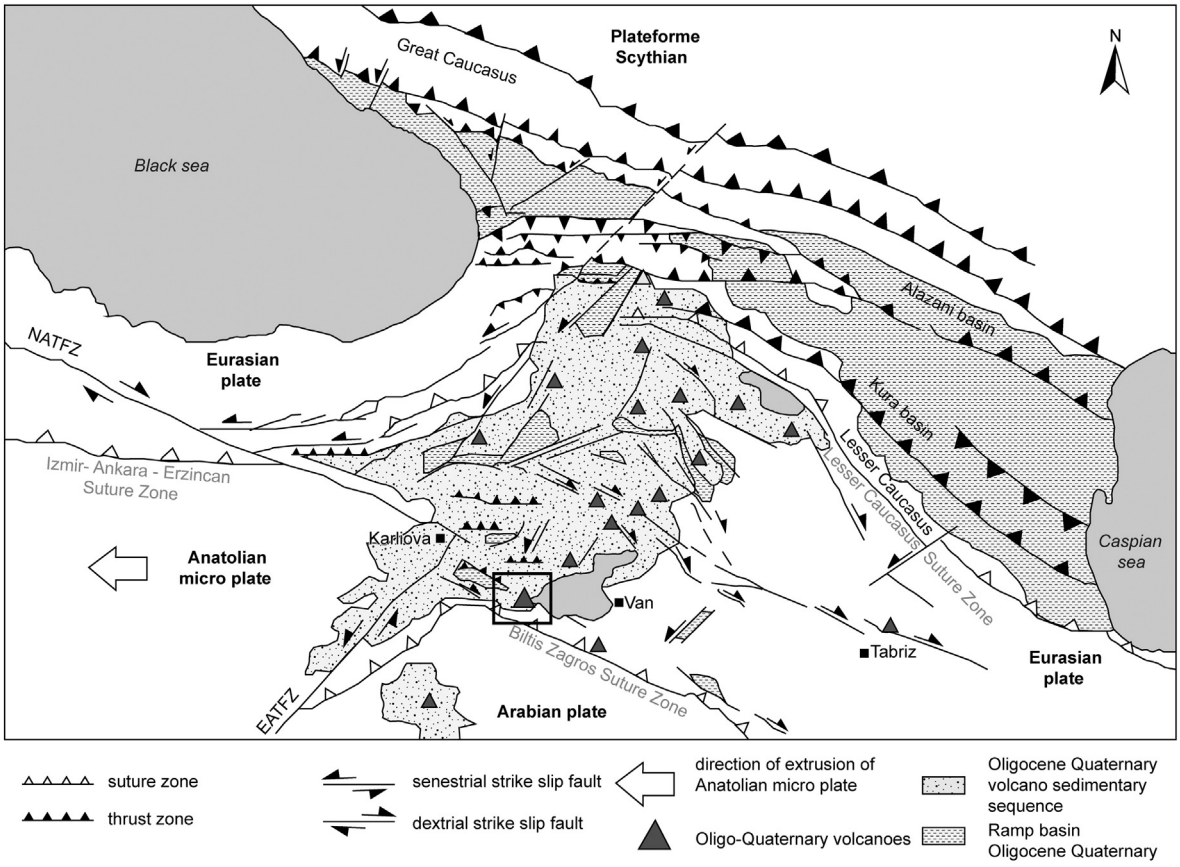

Fig. 1. Nemrut location map (square) within the north-eastern Anatolian and Caucasus structural context. [Modified from Koçyiğit et al. (2001).]

sampling, flow dating, and geochemical/lithological characterization). We also analyzed selected archaeological artefacts (techno-typological aspects, geochemical composition, stratigraphic position within sites, types of usage etc.) from various sites in the Arabian Gulf, northern Syria, and Iraq. These samples were analyzed in the field (X-ray fluorescence (XRF), in museums (XRF) and in the laboratory (Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)).

Among the sources from eastern Anatolia, the Nemrut obsidian sources have been largely enigmatic. A recent study published by Frahm (2012) highlights the geochemical affinity between several Near-Eastern artefacts recovered from archaeological sites and obsidian sources from Nemrut. However, this study also points out that known obsidian outcrops from this volcano that were used for comparison (Bigazzi et al., 1997) are all of very poor quality for knapping. Using our own set of samples collected from the Nemrut volcano in 2014 and 2015, as well as new field observations we propose a solution to this inconsistency.

2. State of the art

2.1. Previous archaeological research

The most common method used to source obsidian (geological and archaeological) is based on geochemical analyses of whole glass (Gratuze, 2013). Such analyses have allowed us to match archaeological artefacts recovered from archaeological sites to specific obsidian sources (Cauvin et al., 1998). Using this approach, many archaeological artefacts are attributed to eastern Anatolian obsidian sources (Chataigner, 1994; Cauvin et al., 1998). Nemrut material has long been recognized as an important source for obsidian artefacts (Cauvin and Chataigner, 1998). According to recent publications, such artefacts, spanning the Epi-Paleolithic to the Bronze Age (Frahm, 2010), have been found in Iraq (eg. Campbell and Healey, 2013); western Iran (eg. Darabi and Glascock, 2013), Turkey (eg. Carter et al., 2013), Syria (eg. Orange et al., 2013) and Lebanon (eg. Khalidi et al., 2014) (Table 1).

At the Halaf site of Arpachiyah (Iraq), archaeological artefacts made of peralkaline obsidian represent 74% of the lithic assemblage. According to Campbell and Healey (2013) three eastern Anatolian sources, namely Nemrut, Bingöl and Meydan, have been identified in the assemblage of obsidian artefacts recovered at this site. All archaeological artefacts recovered from the Neolithic site of East Chia Sabz (W Iran), were analyzed by Darabi and Glascock (2013) using XRF and NAA (Neutron Activation Analysis), and are attributed to the Nemrut volcano. The attributed Nemrut sub-source appears in Frahm (2012) as "sub-source 2", which the author localizes on the southern slope of the volcano. Using EDXRF (Energy Dispersive X-Ray Fluorescence) Carter et al. (2013) identified four obsidian sources at the Epi-Paleolithic/PPNA (Pre-Pottery Neolithic A) site of Körtik Tepe, including Nemrut, Muş, Bingöl B (Alatepe area) and, Bingöl A (Solhan area) (see Cauvin et al., 1986). At this site, 12.5% of the total obsidian lithic assemblage is

Table 1
Some archaeological sites where obsidian artefacts have been attributed to Nemrut outcrops.

Country	Site	Reference	Cultural phase
Iraq	Arpachiyah	Campbell and Healey (2013)	Halaf (Neolithic)
Iran W	East Chia Sabz	Darabi and Glascock (2013)	Neolithic
Turkey	Körtik Tepe	Carter et al. (2013)	Epi-Pal./PPNA
Lebanon	Tell Labwe South	Khalidi et al. (2014)	PPNB, PN
Syria	Tell Aswad	Orange et al. (2013)	PPNB