Palaeogeography, Palaeoclimatology, Palaeoecology 288 (2010) 1–13

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: www.elsevier.com/locate/palaeo

Palaeoecological implications of the Lower Pleistocene phytolith record from the Dmanisi Site (Georgia)

E. Messager [a,b,*], D. Lordkipanidze [b], C. Delhon [c], C.R. Ferring [d]

[a] UMR 7194 CNRS Département de Préhistoire du Muséum national d'Histoire naturelle, 1, rue René Panhard, 75013 Paris, France
[b] Georgian National Museum, 3, Rustaveli Avenue 0105 Tbilisi, Georgia
[c] UMR 6130 CNRS CEPAM, 250 rue Albert Einstein, Sophia Antipolis, F-06650 Valbonne, France
[d] Department of Geography, University of North Texas, Denton, TX, 76203-3078, USA

ARTICLE INFO

Article history:
Received 18 March 2009
Received in revised form 15 January 2010
Accepted 17 January 2010
Available online 25 January 2010

Keywords:
Phytolith analysis
Dmanisi archaeological site
Water stress indices
Palaeoenvironment
Pleistocene
Caucasus

ABSTRACT

Archaeological investigations of the lower Pleistocene deposits at Dmanisi (Lesser Caucasus, Georgia) have yielded an assemblage of hominin and faunal remains within a well-dated context. Although abundant vertebrate fossils have been recovered, paleobotanical studies have been limited. To address this, phytolith analysis has been conducted on two sections in order to reconstruct the distribution and evolution of vegetation throughout the entire sedimentary sequence. Large concentrations of phytoliths were recovered and analysed, permitting the reconstruction of climatic indices. The environmental data obtained from these phytolith assemblages are consistent with other palaeoecological data (i.e. geological, faunal and other archaeobotanical records). When considered together, they indicate an environment in which grasses were well-represented. In addition, the climatically important water stress indices derived from Dmanisi's phytolith assemblages suggest a period of increased aridity in the middle part of the stratigraphic sequence, which is contemporaneous with human occupations of the site.

1. Introduction

Discoveries of Early Pleistocene hominid remains Eurasia provide evidence for an expansion out of Africa earlier than previously assumed. Present evidence suggests that these dispersals occurred several times since the beginning of the Pleistocene. New data are refining the chronological framework in which these first Eurasian occupations took place (Swisher et al., 1994; Oms et al., 2000; Sémah et al., 2000; Voinchet et al., 2004; Falguères, 2003; Carbonell et al., 2008). Although environmental data from vertebrate faunas are available, data from archaeobotanical sources remain scarce. The first dispersals out of Africa appear to have taken place between 1.9 and 1.5 million years ago (Bar-Yosef, 1994; Swisher et al., 1994; Gabunia and Vekua, 1995; Arribas and Palmqvist, 1999; Bar-Yosef and Belfer-Cohen, 2001). At this early stage in hominin evolution, populations probably possessed the biocultural means to adapt their behaviour to new environments (O'Connell et al., 1999; Antón et al., 2002). However, as with most other mammalian taxa, early hominins were likely to have been affected by African terminal Pliocene climatic and environmental changes (Potts, 1998; Zeitoun, 2000; Holmes, 2007; Bonnefille, 1995; DeMenocal and Bloemendal, 1995; Vrba, 1995; Bobe et al., 2002; Bobe and Behrensmeyer, 2004), which also affected Eurasia (Sémah, 1986; Combourieu-Nebout, 1990; Zagwijn, 1992; Combourieu-Nebout, 1993; Suc et al., 1997; Aguirre and Carbonell, 2001).

The site of Dmanisi, situated in present-day Georgia, has yielded abundant fossils of early hominids. It is now well-dated to the very beginning of the Upper Matuyama Chron (1.77 Ma), making the site a very good opportunity to undertake a palaeoenvironmental study.

Most organic bio-proxies (i.e. spores, pollen grains, fruits and seeds) deposited in dry sedimentary environments and subjected to weathering are not usually well-preserved. As a result, the identification of climatic changes in these types of terrestrial sequences is often very difficult, if not impossible. On the other hand, the resistant composition of phytoliths (hydrated silicon dioxide opal) has been shown to be less affected by weathering processes. Phytoliths can be recovered in large concentrations and have been used in reconstruction of palaeoclimate and palaeoenvironments for a variety of sediments, which include loess (Tungsheng et al., 1996; Blinnikov et al., 2002; Lu et al., 2007), lacustrine sediments (Thorn, 2004), sand dunes (Horrocks et al., 2000), archaeological sediments (Albert et al., 1999; Piperno et al., 2000), palaeosols (Fredlund and Tieszen, 1997a; Delhon et al., 2003) and marine sediments (Abrantes, 2003). Their characteristic morphology can be used as a diagnostic tool to identify the plants that produced them. For instance, plants of the family Poaceae are known to contain large quantities of phytoliths in their tissues (Hodson et al., 2005), and these exhibit significant morphological variability among the several Poaceae subfamilies. Therefore,

* Corresponding author. UMR 7194 CNRS Département de Préhistoire du Muséum national d'Histoire naturelle, 1, rue René Panhard, 75013 Paris, France.
E-mail address: erwan.m@mnhn.fr (E. Messager).

0031-0182/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.palaeo.2010.01.020

this proxy is particularly useful for grassland studies (Fredlund and Tieszen, 1997a,b; Blinnikov et al., 2002; Strömberg, 2002, 2004). Other plant groups which tend to yield large concentrations of phytoliths include the Cyperaceae (Le Cohu, 1973) and Arecaceae (Runge, 1999) families from the Monocotyledonous group as well as plants of Dicotyledonous taxa, such as certain tropical trees (Piperno, 1988; Hodson et al., 2005). As a result, the analysis of phytoliths is frequently applied to reconstruct the histories of tropical ecosystems (Alexandre et al., 1997; Barboni et al., 1999; Runge, 1999). In tropical regions, this type of analysis provides a good tree cover proxy for the reconstruction of paleoenvironments. Phytolith analysis has also been successfully applied to reconstructing palaeoenvironments in temperate climatic contexts (Verdin et al., 2001; Delhon et al., 2003; Strömberg et al., 2007).

In this study, we used phytolith assemblages to reconstruct the environmental and climatic conditions which prevailed during the deposition of the Dmanisi archaeological deposits. We propose that the study of phytoliths should be used in combination with water stress indices for palaeoenvironmental reconstructions, in addition to other archaeobotanical data.

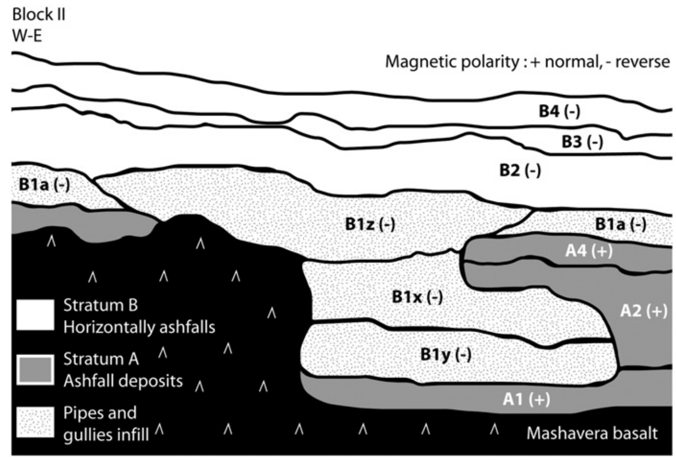

Fig. 2. Schematic stratigraphic section of Block 2. × vertical exaggeration. Modified from Lordkipanidze et al., 2007.

2. Study area and present environmental conditions

Dmanisi (44° 21′E, 41° 19′N) is located at an elevation of 1015 m in the Masavera River valley (South East Georgia), in the Lesser Caucasus, 85 km southwest of Tbilisi (Fig. 1). The Dmanisi region receives less precipitation than the Colchis region of western Georgia where the proximity of the Black Sea supports the present-day subtropical forests (Nakhutsrishvili, 1999; Denk et al., 2001; Volodicheva, 2002). In contrast to the Colchis lowlands, the Dmanisi region does not constitute a favorable refuge for relict floras as a result of its cooler and drier continental climate, which is accentuated by the orographic effect of nearby mountain chains (Volodicheva, 2002). The elevation of the site favors oak (*Quercus iberica*), and oak-hornbeam forests (*Q. iberica*, *Carpinus caucasica* and *Carpinus orientalis*). In humid contexts, however, *Fagus orientalis* (Beech) can sometimes appear on hilltop forests. Human activities in the vicinity of the site have significantly altered the vegetation of the surrounding area.

3. Geology

The archaeological site is situated on a promontory at the confluence of the Masavera and Pinezauri rivers, whose valleys were eroded into the local Cretaceous volcaniclastic and marine rocks, which form the hills surrounding the site. Latest Pliocene basaltic eruptions west of Dmanisi resulted in a flood of lavas down the Masavera Valley, which filled the valley, covered the lower part of the promontory, and spilled for a short distance up the Pinezauri Valley, creating a dam of that stream. The lavas cooled to form the Masavera Basalt, dated by $^{40}Ar/^{39}Ar$ to 1.85±0.01 Ma (Gabunia et al., 2000a,b); this basalt is conformably overlain by the hominin and artifact-bearing Plio-Pleistocene volcaniclastic and colluvial deposits at the site (Fig. 2).

Dmanisi's sediments have been divided into two main stratigraphic units; Stratum A directly overlies the Masavera Basalt, and has been subdivided into four major substrata (A1–A4). A minor erosional

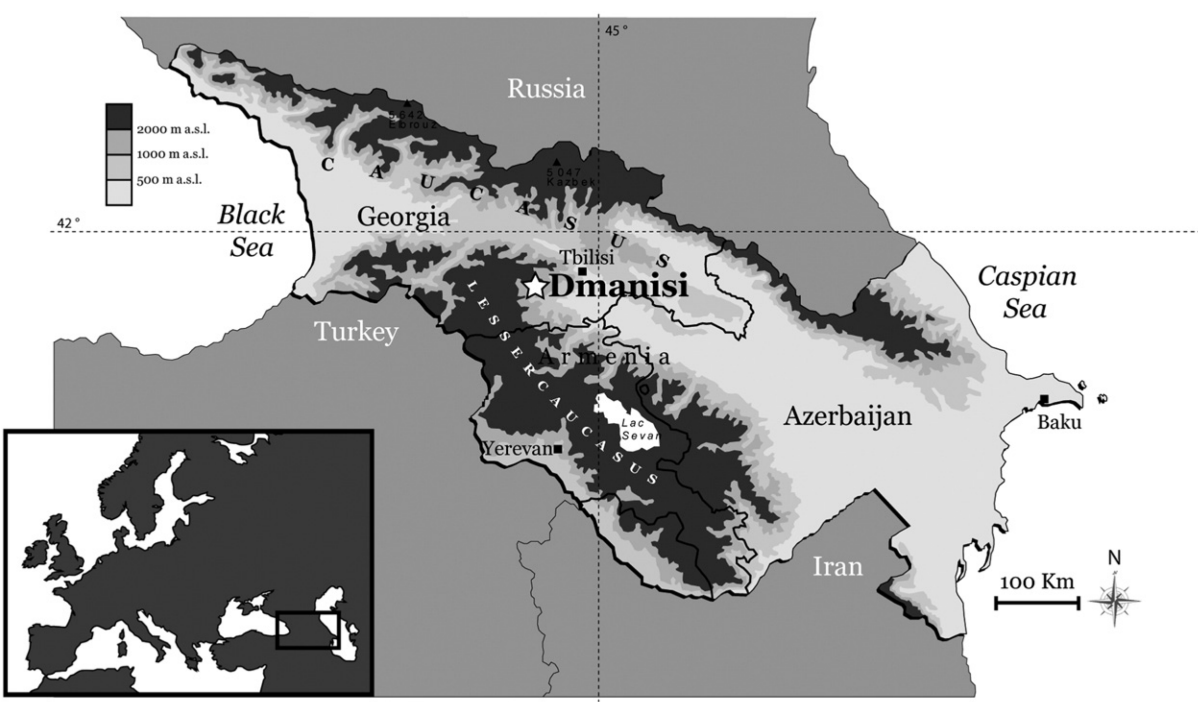

Fig. 1. Location of the Dmanisi site in Georgia.