Palaeogeography, Palaeoclimatology, Palaeoecology xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

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

The FLK Zinj paleolandscape: Reconstruction of a 1.84 Ma wooded habitat in the FLK Zinj-AMK-PTK-DS archaeological complex, Middle Bed I (Olduvai Gorge, Tanzania)

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ARTICLE INFO

Article history:
Received 5 March 2017
Received in revised form 7 April 2017
Accepted 12 April 2017
Available online xxxx

Keywords:
Hominins
Paranthropus
Paleovegetation
Paleoenvironment
Phytoliths
Spring

ABSTRACT

We have analyzed the phytolith content of 37 samples from the paleosol capped by Tuff IC dated 1.84 Ma within Middle Bed I at Olduvai Gorge, Tanzania. Samples were obtained from different trenches sampling an area of about 25 ha to document the paleovegetation associated with the abundant faunal remains and hominin artifacts in FLK, AMK, PTK and DS sites. The analysis reveals the abundance of globular granulate and forest indicator phytoliths (from 3% to 86% relative to the total number of phytoliths in the assemblages) attributed to woody plants, and of short cell grass phytoliths (up to 22%). The presence of palm phytoliths (up to 57%) attests for meso-haline soils in the area in agreement with the presence of the saline/alkaline Olduvai paleolake and one (or more) groundwater discharge areas (freshwater springs and/or wetland). Phytoliths provide botanical evidence for a mixed paleovegetation dominated by forest and woodland with patches of open-spaces occupied by grasses, prior to the deposition of Tuff IC. The presence of fern phytoliths in some assemblages suggest shaded and humid habitat, which supports the presence of freshwater (watercourses or springs) that might have attracted hominins and other animals. Yet, we have found that our phytolith extractions (residues) also include micrometric zeolites (chabazite, clinoptilolite, phillipsite), which attest that the phytolith signal in the Zinj paleosols is certainly affected by dissolution. This study completes the spatial analysis of the area and reveals that the wooded area extends north, south, and west of FLK Zinj, with palm trees preferentially located in the periphery, like the Zinj, AMK, and DS sites. The phytolith-inferred distribution of plants does not support the hypothesis that topography was influential in the location of these sites, particularly given that trees and/or shrubs were dominant all over. Rather, it is the presence of freshwater ponds that seem to have been the attractive factor for hominins at this particular place and time.

1. Introduction

The East African Rift Valley is one of the most important areas to understand hominin evolution. A large number of hominin fossils have been discovered from south to north of the rift. At Olduvai Gorge (Tanzania) (Fig. 1), the holotype (OH5) of *Paranthropus* (*Zinjanthropus*) *boisei* was discovered in Level 22 (Zinj layer) of the FLK (Frida Leakey Korongo) site (Leakey, 1959). The hominin remains recovered during the excavations also included three more individuals of *Homo habilis* and *P. boisei* (OH6, OH35, OH44) (Day, 1976; Leakey et al., 1964; Tobias, 1991). When discovered, the site was considered as one of the first sites in which the co-occurrence of lithics and bone remains appeared functionally linked (Leakey, 1971). It was, and still is, the largest excavation of an anthropogenic site belonging to the Early Pleistocene. FLK Zinj is important for understanding early hominin behavior, the interpretation of which is still a matter of debate since Leakey (1971) suggested that the site was a "living floor". The abundance of skull and limb bones has been interpreted, so far, in two different ways (Domínguez-Rodrigo et al., 2007): a) hominins carried selected parts from fleshed carcasses to the site, and hence were most likely hunters (Bunn and Kroll, 1986; Domínguez-Rodrigo, 2002; Domínguez-Rodrigo and Pickering, 2003; Domínguez-Rodrigo, 1997; Oliver, 1994; Rose and Marshall, 1996); b) hominins transported selected skeletal parts from partially defleshed carcasses (Blumenschine, 1995; Capaldo, 1997), or completely defleshed carcasses, which implied the scavenging of brain

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http://dx.doi.org/10.1016/j.palaeo.2017.04.025
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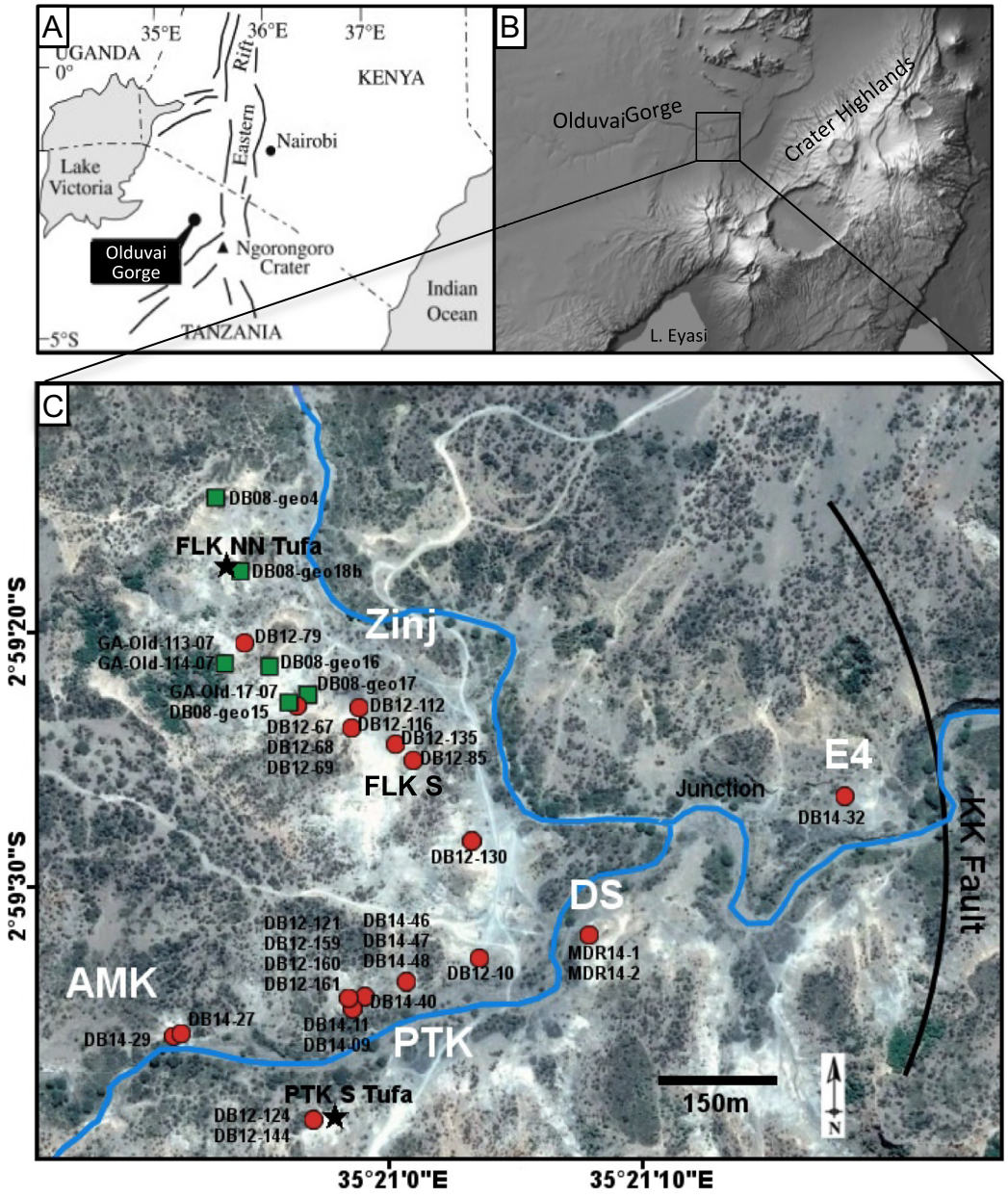

Fig. 1. Location of Olduvai Gorge, Tanzania. (A) Position of Olduvai Gorge in East Africa. (B) Close-up on the Crater Highlands region (map from NASA's Earth Observatory website). (C) Position of the paleosol samples from Zinj complex in the junction area (map from Google Earth). Red circles: samples analyzed in this study, green squares: Ashley et al. (2010a), stars: tufa position. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

and marrow-bearing long limb bones from prey found at felid kills (Blumenschine, 1995, Blumenschine, 1991). The former interpretation is currently widely supported by taphonomic research (e.g. Domínguez-Rodrigo et al., 2014). These interpretations grant different functionality to sites: a redundant transport of food surplus to the same location would promote food-sharing and central-place provisioning behaviors. The repeated transport of defleshed scavenged remains to the same spot would only be feasible if such location acted as a refuge (e.g., Blumenschine, 1991). Earlier interpretations of the ecological context of FLK Zinj placed it in the middle of a barren lacustrine floodplain (Blumenschine and Masao, 1991). This was incompatible with the site having been a central-place spot or a refuge.

Earliest paleovegetation inferences, using pollen and stable carbon isotope studies, placed Olduvai Gorge Pleistocene sites in a grass-dominated landscape (Bonnefille, 1984, Cerling and Hay, 1986). Bovid ecomorphology later showed a significant proportion of intermediate and closed habitats (Kappelman et al., 1997; Plummer and Bishop, 1994). Phytolith analyses of samples from FLK Zinj level 22 and contemporaneous paleosols in surrounding areas (~2 ha) reconstructed a densely wooded environment near a freshwater spring (Ashley et al., 2010a). $\delta^{13}C$ values for sedimentary leaf lipids and total organic carbon also indicated recurrent ecosystem variations, where open C_4 grasslands abruptly transitioned to closed C_3 forests within several hundreds to thousands of years (Magill et al., 2013a) in response to varying precipitation (Magill et al., 2013b). More recently, plant biomarkers from the Zinj level confirmed the presence of a dense forest patch with sedges and shade-loving ferns near the freshwater source at FLK NN and more open vegetation with C_4 grasses at FLK S (Magill et al., 2016).

Subsequent research south of FLK Zinj suggested the presence of a river channel and a wetland 50 to 200 m southeast of FLK Zinj site (Blumenschine et al., 2012). Geo-archaeological and geometrically corrected reconstruction of the 1.84 Ma FLK Zinj paleolandscape provides a different interpretation with water supplies coming from the south as low-energy watercourses (Uribelarrea et al., 2014). Further

Please cite this article as: Arráiz, H., et al., The FLK Zinj paleolandscape: Reconstruction of a 1.84Ma wooded habitat in the FLK Zinj-AMK-PTK-DS archaeological complex, Middle B..., Palaeogeogr. Palaeoclimatol. Palaeoecol. (2017), http://dx.doi.org/10.1016/j.palaeo.2017.04.025