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# Biotic and abiotic processes affecting the formation of BK Level 4c (Bed II, Olduvai Gorge) and their bearing on hominin behavior at the site

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ABSTRACT

Excavations at BK have provided insights into the behavior of early hominins through the study of several archaeological levels. The present study shows the results for a new archaeological sub-level (BK4c). The main goal is to contribute to the knowledge of the different taphonomic processes that shaped BK4c and to better understand the role played by hominins in its formation. Due to the presence of a fluvial depositional context and a slight channel in BK4c, a spatial analysis has been applied in order to determine the impact caused by water flows. We conclude that water played a role in the rearrangement of the assemblage. However, the spatial properties of the assemblage indicate a limited impact of post-depositional disturbance processes, supporting the autochthonous nature of the site. The taphonomic study of this sub-level indicates that hominins had a primary role in the accumulation, bulk defleshing and demarrowing of carcasses. BK4 assemblages (BK4b and BK4c) indicate a repeated occupation of the site for short time periods. This is interpreted by the overall fast sedimentation recorded in the fluvial system and the paucity of highly-weathered bones showing extensive periods of sub-aerial exposure in between sedimentary episodes. The site functionality is potentially different from that inferred for earlier Oldowan periods, where sites were smaller and showed less marked spatial clustering of lithics and stone tools caused by hominin behavior.



## 1. Introduction

A central issue in taphonomy is the problem of site integrity and resolution. Several faunal assemblages excavated in Bed I of Olduvai Gorge (Tanzania) were initially interpreted as the result of hominin butchering activities (Bunn, 1982, 1986; Bunn and Kroll, 1986; Leakey, 1971; Potts, 1982, 1988). A more recent reevaluation of those sites has shown that hominids contributed marginally or nothing to their formation (Domínguez-Rodrigo et al., 2007a,b; Egeland, 2007), except for FLK Zinj (Domínguez-Rodrigo and Barba, 2006; Domínguez-Rodrigo et al., 2007a, 2010, 2014a). In Bed II, several sites have also been interpreted as palimpsests produced by the action of different processes and agents, with hominins and carnivores acting independently over time (Domínguez-Rodrigo et al., 2014b; Egeland and Domínguez-Rodrigo, 2008; Yravedra et al., 2015).

The first excavations in Bell's Korongo (BK) were conducted in the 1950s, with the intensive excavation at the BK site by the Leakey's, (1971). Research at the site was resumed in 2006. The Olduvai Paleoanthropology and Paleoecology Project (TOPPP) exposed a large area (>45 $m^2$) containing a large amount of fossils and stone tools. This allowed the reconstruction of the behavior of early hominins for several archaeological levels (from 1 to 5) at the site (Domínguez-Rodrigo et al., 2009a, 2014c; Organista et al., 2015). The site also yielded a new date for the underlying Tuff IID of 1.35 Ma (Domínguez-Rodrigo et al., 2013). In this paper, we present the results obtained from the analysis of a new archaeological level at BK: the 4c level. This sub-level is differentiated solely on a lithological basis from the overlying levels 4a and 4b mostly encased within a clay matrix (Domínguez-Rodrigo et al., 2009a, 2014c). Level 4c is found in a more detritic sedimentary matrix than BK4b, including a well-defined channel. The main objective of this work is to

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contribute to the knowledge of the different formation processes of BK4c and understand its relationship to BK4b.

Throughout the sequence (Levels 1–5), the BK materials are preserved in low-energy fluvial deposits within a wide channel that has eroded the upper part of Bed II, including Tuff IID. The ancient river flowed from south to north and its former course is currently only visible on the paleochannel's right margin. The overbank shows a minimum depth of 4 m and a width of 50 m, although it appears to be both wider and deeper to the west. The fluvial infill is composed of four sedimentary units that thin upwards and overlap towards the right margin (Fig. 1). The two lowermost units (Units 1 and 2) are gently undulated, tilt to the west, and increase in thickness towards the left margin of the paleochannel. These units show a lateral accretion to the west. The overlying units (Units 3 and 4) completely fill the channel basin and spread over the bank.

Sub-level 4c is the lowest within the archaeological Level 4, composed also of sub-levels 4a and 4b (Fig. 1). All of them correspond to the facies association of the B sedimentary unit (see Domínguez-Rodrigo et al., 2014c). Each level is variable in thickness and consists of massive silts, very fine sands, and clay. Some of them are floored by channel-lags of coarse sands and low density aggregates, composed of clay, silt, and edaphic carbonate (pelletoids). BK4c occupies a smaller area than 4b, with a maximum extension in the excavated trench of 22 $m^2$ and an average depth of 5–10 cm outside the area occupied by a small channel. The bottom of the level is irregular, but in the central part it contains an elongated depression, which slightly define a channel of 1 m of width and 20 cm of maximum depth.

In the months of June–July of 2012, three trenches (1.3 × 5.5 m each) were excavated. A large amount of fossils and associated stone tools were discovered (Fig. 2, Supplementary Fig. S1). At the northern end of the third trench we documented a higher density of fossil remains within the channel, so it was decided to identify the specimens as belonging to Cluster 1 (the "channel" cluster). Subsequently, other clusters were observed in the assemblage. As revealed in Fig. 3, the surface of BK4c shows three clusters with high density of materials. The application of a Chi-square test on the sample confirms that the distribution is inhomogeneous with $p$ value <0.05 ($\chi^2 = 723.47$, df = 14; $p$-value ≤ 0.05) (Baddeley and Turner, 2005). Furthermore, the use of allstats function representing the K, F, G, and J tests, indicates an agglomerative pattern at BK4c (Fig. 4) (Baddeley and Turner 2005). For this reason, and because of the fluvial depositional environment, we focused on the study of the role of hydraulic flows in the assemblage.

For years, several actualistic works have been made aimed at detecting possible alterations caused by water on any given assemblage (e.g., Badgley, 1986a,b; Badgley and Behrensmeyer, 1980; Behrensmeyer, 1975, 1982; Boaz, 1982; Boaz and Behrensmeyer 1976; Coard, 1999; Coard and Dennell, 1995; Dodson, 1973; Frison and Todd 1986; Frostick and Reid 1983; Gifford, 1977; Gifford and Behrensmeyer, 1977; Hanson, 1980; Isaac, 1967; Korth, 1979; Petraglia and Nash

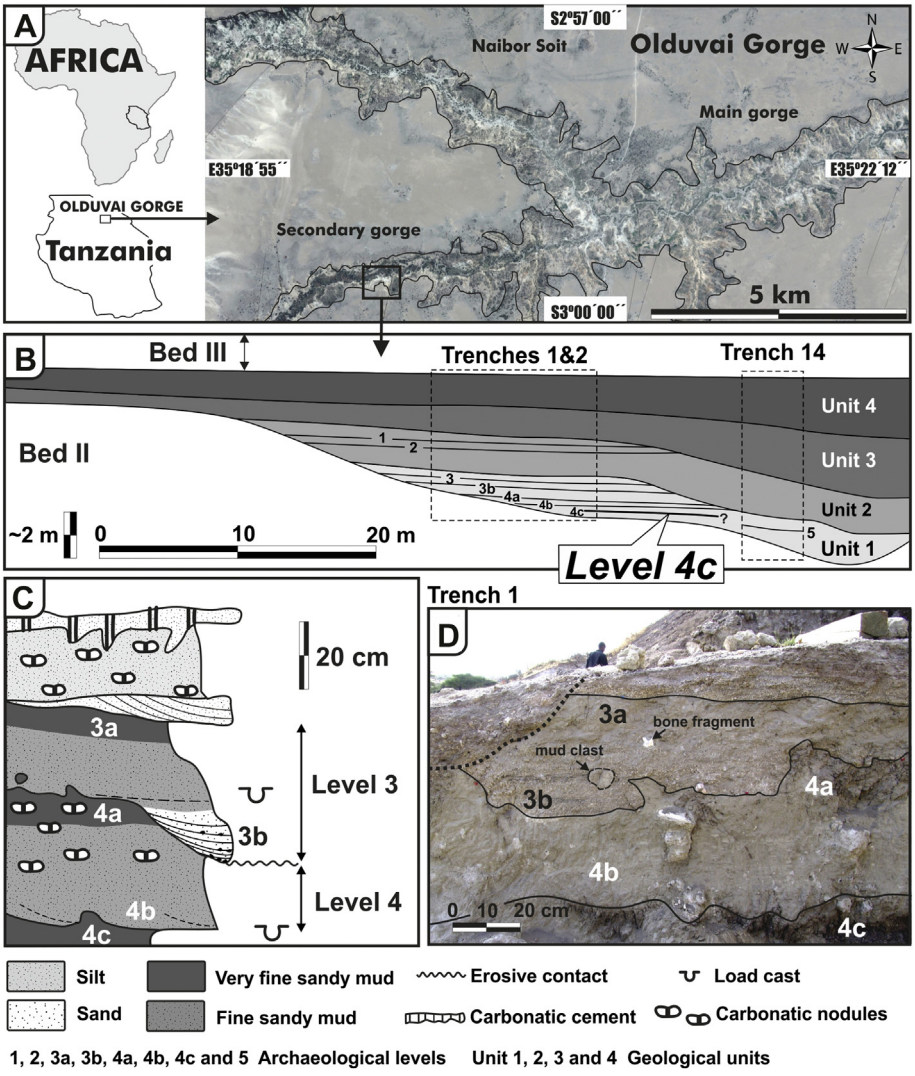


**Fig. 1.** A: Location of BK in the Olduvai Gorge. B: Detailed stratigraphic section of the four geological units with the different archaeological levels identified at BK. C: Detailed stratigraphic section of levels 3 and 4. D: contact shape between the strata 3 and 4.

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