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A 3D approach to understand the taphonomy of the early Hominins from the Plio-Pleistocene cave site of Malapa

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Declaration

I, Aurore Marie Sophie Val, declare that this PhD thesis is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

_____

Signed on the 25th of July 2013, in Johannesburg.

Abstract

The cave deposits at Malapa, on the Malapa Nature Reserve, Cradle of Humankind World Heritage Site, Gauteng Province, South Africa, have yielded the remains of two extremely well-preserved hominins (*Australopithecus sediba*) and associated fauna, dated by U/Pb methods and palaeomagnetism to 1.977-1.8 Ma. The state of preservation of the hominins and some of the non-hominin material, characterised by complete and near complete elements, antimeric sets of bones, specimens in articulation, and well-preserved bone surfaces, is remarkable in the context of Plio-Pleistocene fossil assemblages accumulated in caves, and indicates a unique combination of taphonomic processes, not yet observed in contemporaneous cave deposits in the region. A comprehensive approach, including palaeontological, physical, and spatial analyses of the hominins and associated fauna was undertaken to determine, describe and interpret the taphonomy of the faunal material, with particular reference to the holotype and paratype of *Au. sediba*, Malapa Hominin 1 (MH1) and Malapa Hominin 2 (MH2). An innovative combination of Computed-Tomography (CT), micro-CT scanning and virtual reconstruction techniques was applied to create a 3D model of a selected area of the Malapa cave, with renderings of the two near-complete *Au. sediba* skeletons. The original burial position of the hominins was reconstructed, which necessitated the refitting of *ex situ* fossils into *in situ* deposits. The spatial distribution and orientation of the hominin remains illustrate a very low degree of dispersal of the bones, indicative of very little disruption between death and burial, due to an absence of damage by scavengers and possible natural mummification. The very few carnivore-damaged bones and relative abundance of complete and/or articulated specimens, the presence of antimeric sets of bones in the faunal assemblage, as well as the diversity of the faunal spectrum, and the significant percentage of animals with climbing proclivities (such as carnivores and hominins) indicate that the majority of the faunal material recovered was most likely accumulated via a natural death trap. Their bodies came to rest in a deep area of the cave system with restricted access to

scavengers. Skeletons and bones accumulated in a talus cone below a vertical shaft. There, they decomposed, and became buried without major disruption by biotic or abiotic agents. A new forensic approach, referred to as *palaeoforensic taphonomy*, was followed in each step of the taphonomic analysis of the two hominins in order to reconstruct the processes of decay, disarticulation, burial and preservation. Results show that both individuals did probably not enter the cave system at the same time. They reached skeletonization and were slightly weathered before final burial, indicating several years of exposure before burial. Insects proved to be the primary modifiers of the hominin remains, pre- and post-depositional with hide beetles (*Omorgus squalidus*) providing the closest match for some of the fossil modifications observed. Based on the high number of articulated remains, the absence of preferential orientation for the elongated bones and of significant movement of the hominin remains inside the deposit, the debris flow hypothesis that was previously proposed as the principal agent to explain the burial of the hominins and other well-preserved animals is challenged. Evidence of natural mummification before burial for MH1 and MH2 suggests the possible preservation of soft tissue. The innovative 3D techniques applied in this research to conduct the spatial analysis of the fossils proved useful to address taphonomic questions, and will serve as a guide for future excavations of the Malapa *in situ* deposits, especially for locating the missing skeletal elements of MH1 and MH2.

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