

# 3D RECONSTRUCTION OF THE CARNIVORAN-DOMINATED ASSEMBLAGE OF BATALLONES-3 (LATE MIOCENE, MADRID BASIN, SPAIN)

David Martín-Perea<sup>a,b\*</sup>, Jorge Aldama<sup>c</sup>, M. Soledad Domingo<sup>a,d</sup>, Alberto Valenciano<sup>a</sup>, Juan Abella<sup>e, f</sup>, Jorge Morales<sup>b</sup>



<sup>a</sup> Paleontology Department, School of Geological Sciences, Complutense University of Madrid (Madrid, Spain)

<sup>b</sup> Paleobiology Department, National Museum of Natural Sciences-CSIC (Madrid, Spain)

<sup>c</sup> Technical School of Architecture of Barcelona ETSAB (Barcelona, Spain)

<sup>d</sup> Department of Evolutionary Ecology, Doñana Biological Station (Seville, Spain)

<sup>e</sup> Institut Català de Paleontologia ICP Miquel Crusafont (Barcelona, Spain)

<sup>f</sup> Santa Elena Península State University (Santa Elena, Ecuador)

\*Corresponding author: davidmam@ucm.es



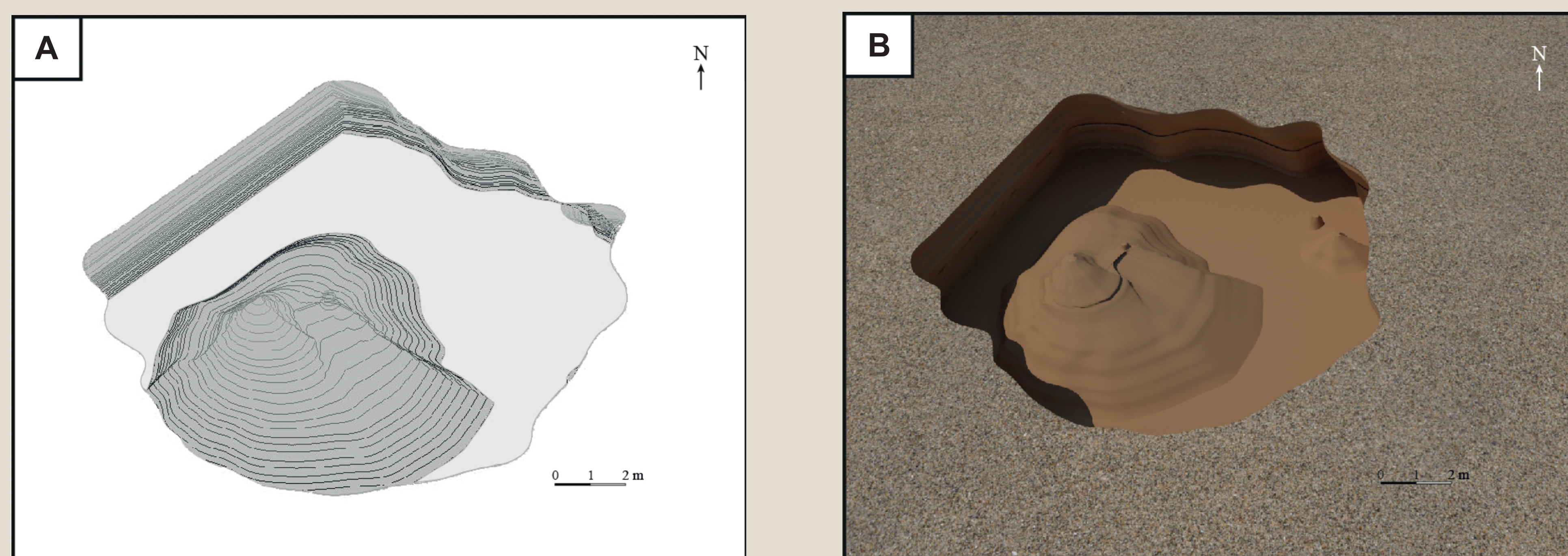
## Introduction

Batallones-3 is one of the nine late Miocene mammalian sites found in the Batallones butte (Madrid basin, central Spain, Calvo *et al.*, 2013). Alongside Batallones-1, Batallones-3 contains an unusually large concentration of carnivoran remains: Batallones-1 hosting 98.39% of carnivoran remains whereas Batallones-3 99.58%. Carnivore-rich fossil sites are highly uncommon in the fossil record so their taphonomic study can provide valuable insights about the causes of formation of such concentrations and about the paleoecology of these species (Domingo *et al.*, 2013). Remains are found in marl deposited inside a domically-shaped pseudokarstic cave, with an inferred upper opening in the center.

Paleontological sites in the Batallones area have a great repertoire of paleoartistic reconstructions. However, Batallones-3 did not have one until recently, when Mauricio Antón created a fine piece where *Machairodus aphanistus* and *Indarctos arctoides* are seen inside de cave (Pozo *et al.*, 2018). Although cave morphology in the piece is quite accurate, a quantitative 3D reconstruction would be invaluable for future paleoartistic works.

## Creating the 3D reconstruction

Remains are found as part of a dense fossiliferous breccia in marl (Calvo *et al.*, 2013). As a result of this geology, with such density of remains, the spatial distribution of the remains can be used to delimitate the geomorphology of the cave. The spatial distribution of the remains was vertically divided into separate slices every 10 cm, creating a total of 20 spatial distribution diagrams on the horizontal (X-Y) plane, created using GIS software. An outline was accordingly traced around the assemblage's limits using Adobe Illustrator, acting as contour lines for a given height (Figure A). Using these contour lines, a three-dimensional reconstruction of the Batallones-3 cave has been produced: Rhinoceros 5.0 was used to create the general volume using the "transition" tool, which was later exported to 3DS MAX 2016 with V-Ray 3.20, which rendered the final 3D model (Figure B).



## Creating the 3D reconstruction

This reconstruction only represents the lowermost section of the cave, since the rest was removed due to slope erosion. Cave height (5 m) was inferred from the depth of other similar pseudokarstic caves found at the butte, such as Batallones-1 (Domingo *et al.*, 2013), and the cave opening was inferred to be above the debris cone. With all these criteria in mind, a complete reconstruction of the cave was created:



## References

- Calvo, J.P.; Pozo, M.; Silva, P.G.; Morales, J. (2013) Pattern of sedimentary infilling of fossil mammal traps formed in pseudokarst at Cerro de los Batallones. *Sedimentology*, 60: 1681-1708.
- Domingo, M.S.; Alberdi, M.T.; Azanza, B.; Silva, P.G.; Morales, J. (2013) Origin of an Assemblage Massively Dominated by Carnivorans from the Miocene of Spain. *PLoS One*, 8, e63046.
- Pozo, M., Calvo, J.P., Silva, P.G. & Morales, J. (2017). La estructura geológica del Cerro de los Batallones: litofacies y mineralogía. In: *La colina de los Tigres Dientes de sable. Los yacimientos miocenos del Cerro de los Batallones* (Torrejón de Velasco, Comunidad de Madrid (ed. Jorge Morales), 86-87.