Clastic cave sediments and speleogenesis of the Buraca Escura archaeological site (western-central Portugal)

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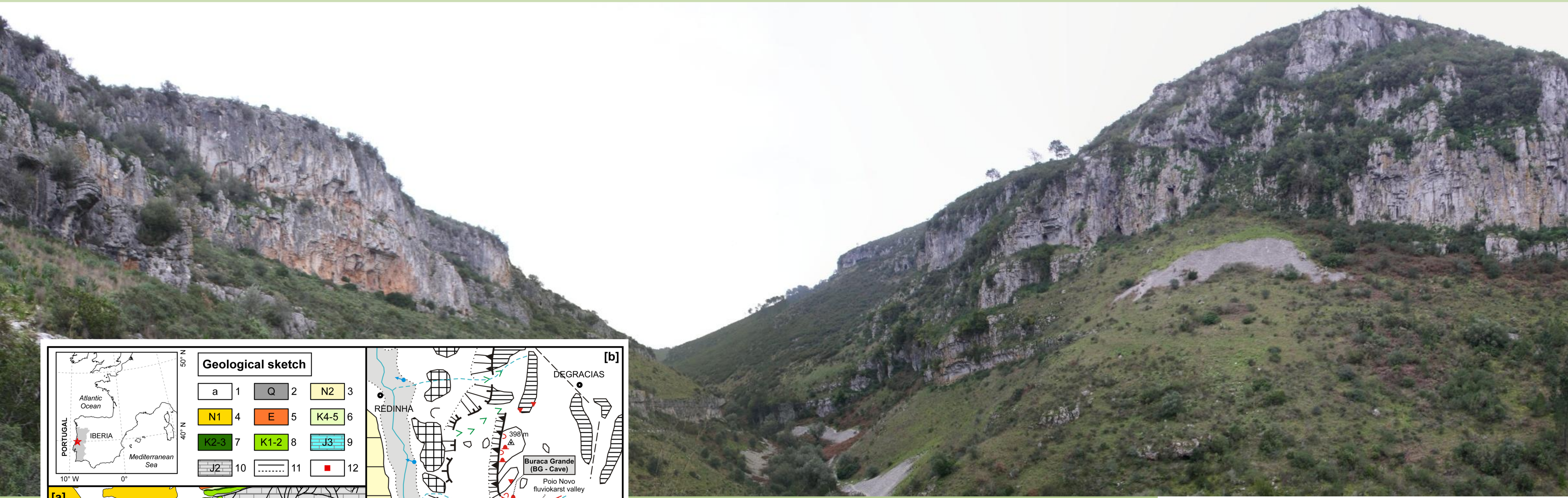
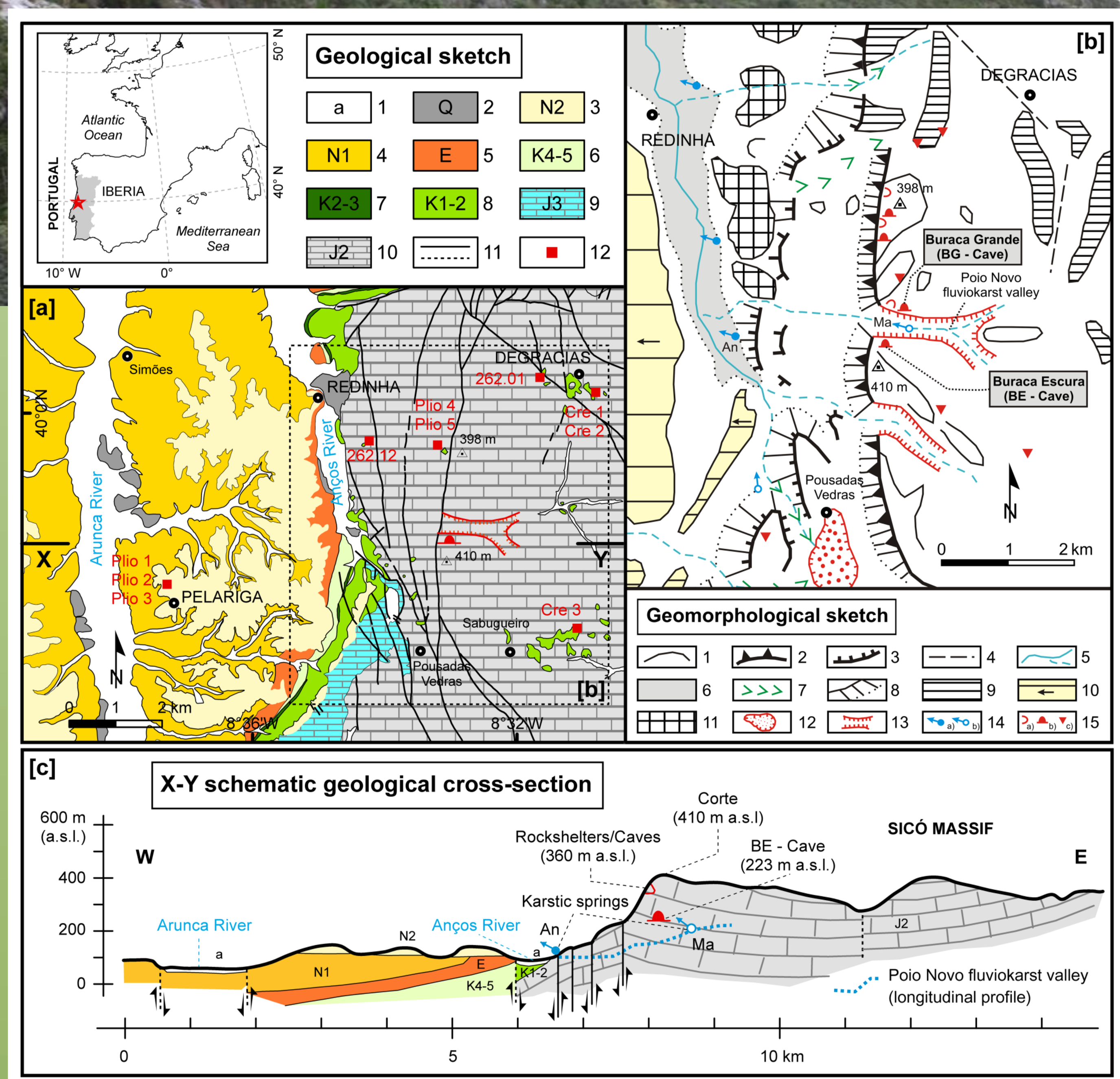
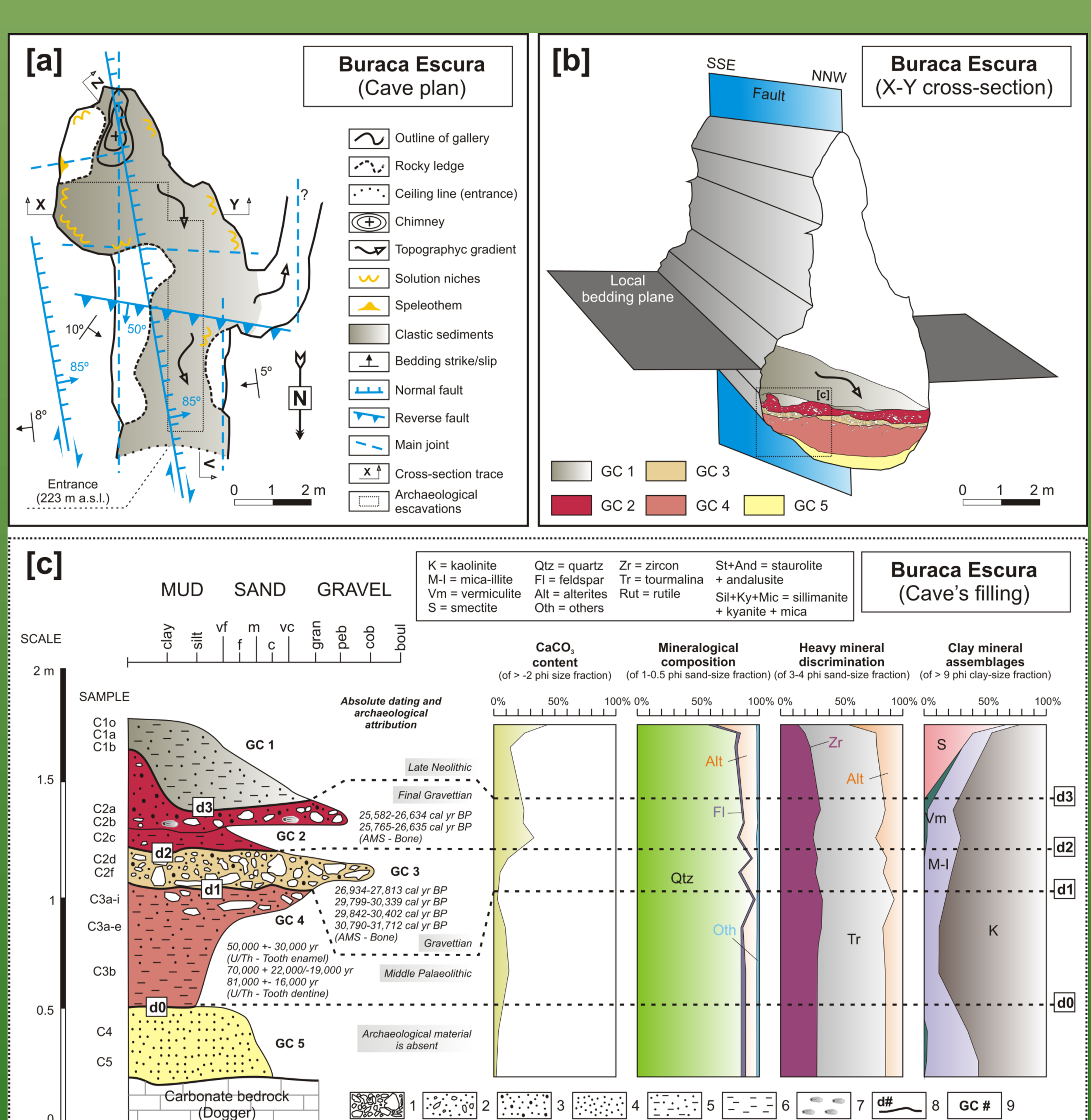




Studied area: *Geological and geomorphological sketches, geological cross section and location of siliciclastic covers sampled. (a): 1 - alluvium; 2 - Quaternary fluvial terraces; 3 - Plio-Pleistocene (sandy and gravelly siliciclastics); 4 - Miocene; 5 - Paleogene; 6 - Upper Cretaceous; 7 - Cenomanian; 8 - Lower Cretaceous (sand and conglomerate siliciclastics); 9 - Upper Jurassic carbonates; 10 - Middle Jurassic carbonates; 11 - main fault (certain and probable); 12 - sample of siliciclastic cover. (b): 1 - top of scarp; 2 - fault scarp (> 100 m high); 3 - fault scarp (< 100 m); 4 - fracture with morphological expression; 5 - stream (permanent and temporary); 6 - alluvial plain; 7 – dry valley; 8 - slope top and base; 9 - planation surface above 300 m; 10 - Pliocene littoral platform (arrow indicate tilt); 11 - planation surface at 100 m; 12 - karstic close depression (flat bottom covered by polygenic siliciclastics); 13 - fluviokarst canyon; 14a - permanent karstic spring; 14b - temporary karstic spring; 15a - rockshelter; 15b – predominantly horizontal karstic cave; 15c – predominantly vertical karstic cave; Ma - Malhadouro temporary karstic spring; An - Anços permanent karstic spring.*



Results: *Buraca Escura Cave - morpho-structural plan (a), transverse cross-section (b) and clastic cave sediments synthetic log with laboratorial data (c). 1 - clast supported conglomerate bearing limestone fragments with low sphericity, angular to sub angular; 2 - matrix supported conglomerate; 3 - polymodal sand bearing sub-rounded to sub-angular quartz and quartzite clasts; 4 - unimodal sand; 5 – silt; 6 – clay; 7 - carbonate concretions; 8 - erosive unconformity; 9 - geoarchaeological complex (see more details in AUBRY et al., 2011). GC3 complex includes new, unpublished, ^{14}C-AMS dating.*

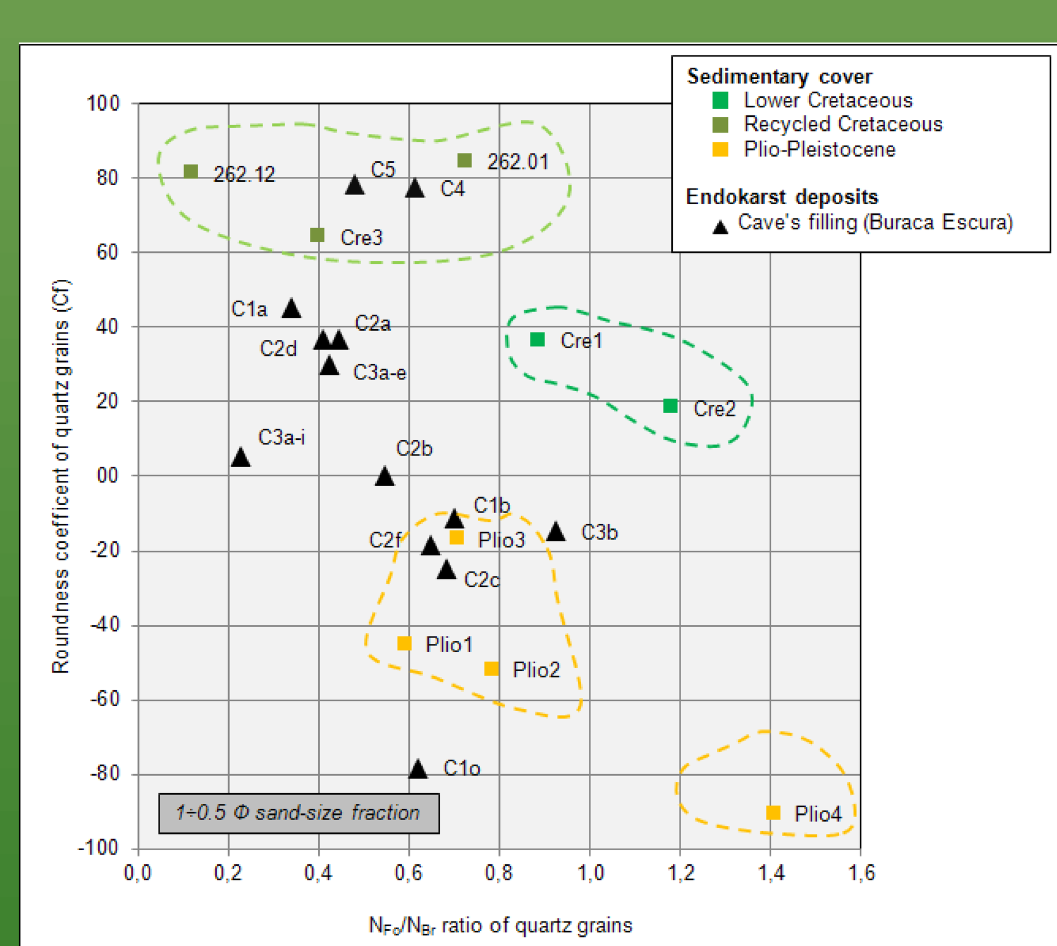
INTRODUCTION

There is now an increasing awareness of the potential of continental stratigraphic archives for providing high-resolution records of palaeoenvironmental changes at regional scale, namely climatic. Caves are *loci* prone to the preservation of different sediments: (a) autochthonous (e.g. collapsed blocks and insoluble bedrock remains); (b) allochthonous materials with water and gravity-driven transport; and (c) chemical deposits (e.g. secondary cave minerals, as speleothems). The first and second categories are clastic cave sediments (CCS).

The complex polyphasic speleogenesis attested in the main carbonate massifs of the western-central Portugal includes Mesozoic episodes, but the main one is due to Cenozoic tectonic activity and palaeoclimate (CUNHA, 1990). This study of Buraca Escura Cave (BE) includes new geomorphological and structural data, sedimentological/stratigraphic analysis of CCS and local post-Jurassic siliciclastic covers, related with previous geoarchaeological works (AUBRY *et al.*, 2011). It aims to enlighten the regional geological/geomorphological Cenozoic evolution, including depositional, tectonic and palaeoclimatic events, as well as Neanderthal and Anatomically Modern Human occupation of the cave and surrounding territory.

MATERIALS AND METHODS

CCS (just siliciclastic fraction) and Lower Cretaceous (*in situ* and recycled) and Pliocene samples were studied. Under a binocular microscope, it was evaluated the composition of ca. 100 (1.0-0.5 phi fraction) grains per sample, the surface aspect (frosted or bright) and roundness of quartz grains, as well as heavy mineral discrimination in 3-4 phi fraction (also estimated by X-ray diffraction). Grain-size data was obtained by ½ phi sieving coupled with laser particle sizer. Clay mineral assemblage of > 9 phi fraction was estimated by X-ray diffraction. $CaCO_3$ content of > -2 phi fraction was obtained with a Bernard calcimeter.



Results: *Quartz grains were classed according to their roundness into the six graded classifying system of Powers (1953) (i.e. very angular - VAg; angular - Ag; sub-angular - SAg; sub-rounded - SRo; rounded - Ro; well rounded - WRo). Roundness coefficent (Cf) was calculated for each samples using the followed expression:* $Cf = (N_{VAg} * 3 + N_{Ag} * 2 + N_{SAg} * 1) - (N_{SRo} * 1 + N_{Ro} * 2 + N_{WRo} * 3)$ *where* N_{VAg} *is the quantity of grains belonging to the class very angular,* N_{Ag} *is the quantity of grains belonging to the class angular, and so on. Quartz grains surface was classed according to their aspect in two class (i.e. frosted - Fo; bright - Br), and the ratio between the quantity of these was calculated* (N_{Fo}/N_{Br}) *for each samples.*

INTERPRETATIONS

General affinities indicate that CCS are remobilized Lower Cretaceous and Pliocene deposits, occasionally with some admixture. The Cretaceous-like CCS seem to have suffered an intra and/or extra-endokarstic transport, unlike the levels with Pliocene-like, apparently reworked from quite close sources or even directly deposited in the cave.

According the stratigraphy and texture, GC5 complex is probably pre-Pliocene. Thus, a Late Cretaceous to Miocene speleogenetic inception can be deduced, following fractures created by NE Pyrenean transpression, later opened by Betic N-S compressive stress (with paroxysm during the Late Miocene).

The early cave speleogenesis as a phreatic/epiphreatic tube, along the intersection line between a guiding bedding-plane and the local vertical fractures, was probably developed at (or very near) the hydrographic base-level. Phreatic sedimentation promote contemporaneous upward erosion (paragenesis *sensu* FARRANT & SMART, 2011), developing a narrow slot. Subsequent, vadose conditions allowed phases of alluviation and flushing as the cave rose above base-level and the valley incised. Inflowing sediments fills the cave and promote lateral corrosion, also at the contact between the sediments and the rock walls. The latest morphological modifications are given by freeze-thaw and condensation corrosion actions, leading to overprinting of existing (paragenetic-type and sub-alluvial) morphologies.

Older CCS (GC5 complex) had an exclusive Cretaceous provenance, till the Pliocene marine transgression most likely flooded a pre Poio Novo valley. Some of these nearshore sediments remained in the endokarstic system, partially *in situ* or reworked and mixed with the Cretaceous. During the Pleistocene the cave records episodic deposition and flushing, as well as sporadic human occupation, as above referred. Autochthonous calcareous angular fragments (GC3 and GC2 complexes) are interpreted as linked with cold humid phases, in accordance with absolute dates, namely Heinrich Events 3 and 2. Finally, the topmost GC1 complex shows pedogenetic features and composition both compatibles with the relatively warm Holocene climate.

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PTDC/CTE-GIX/117608/2010
CAVE Project – Karstic caves of Central Portugal as palaeoenvironmental archives: speleogenesis and present-day dynamics

This study was financed by the European Fund for Economic and Regional Development (FEDER) through the Program Operational Factors of Competitiveness (COMPETE) and National Funds through the Portuguese Foundation of Science and Technology (PTDC/CTE-GIX/117608/2010, FCOMP-01-0124-FEDER-022634)

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