The use of water marks mapping to understand flood overflow events inside karst cavities: Cueva Fría and Cueva Rosa (Asturias - NW Spain)

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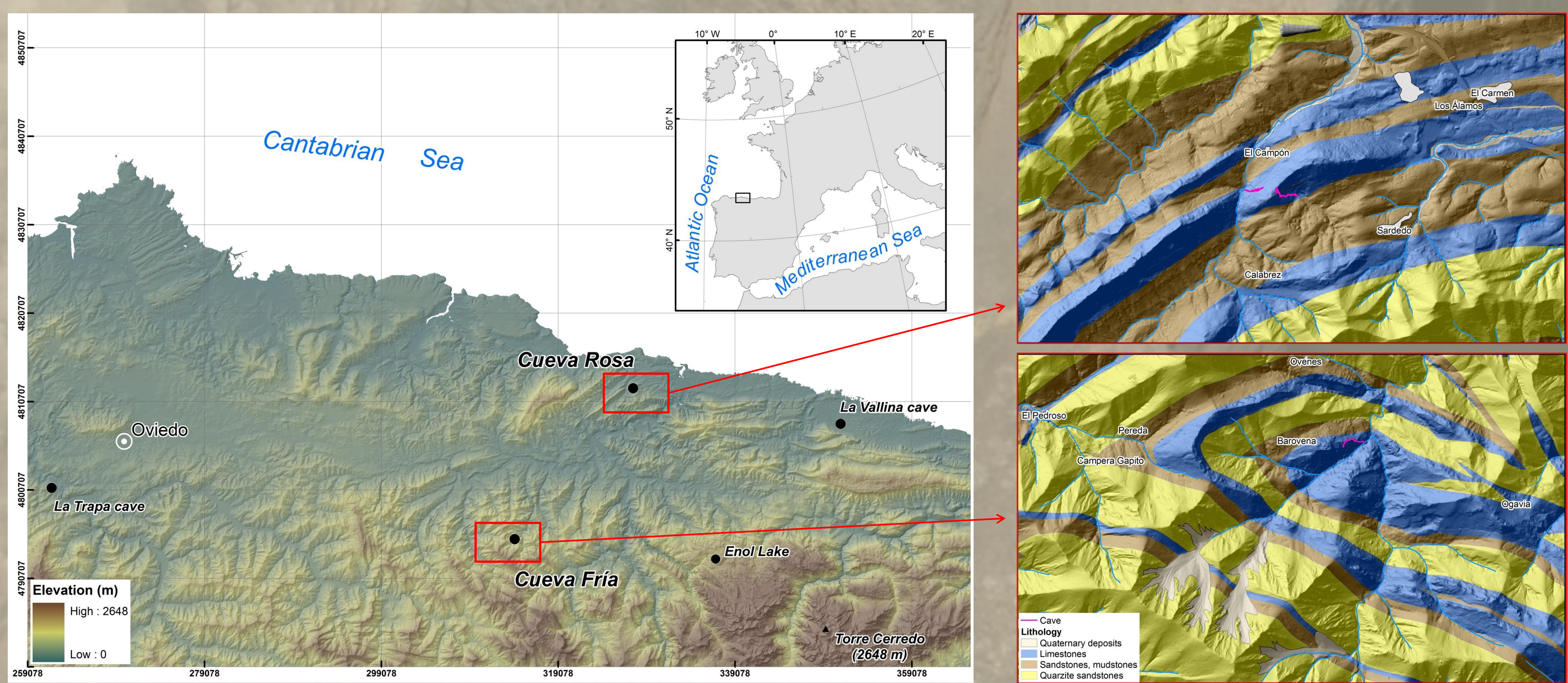
Background of Research

Several karst systems in Asturias (NW Spain) present evidence of fluvial deposits cemented in speleothems that may provide good chronology of past flood events inside caves. The ***aim of this work*** is to study flooding evidence preserved in Cueva Fría and Cueva Rosa caves, which have in common the presence of a perennial stream inside the cave and a low gradient of the cave passage.



Flooding evidence: sediment transport and watermarks

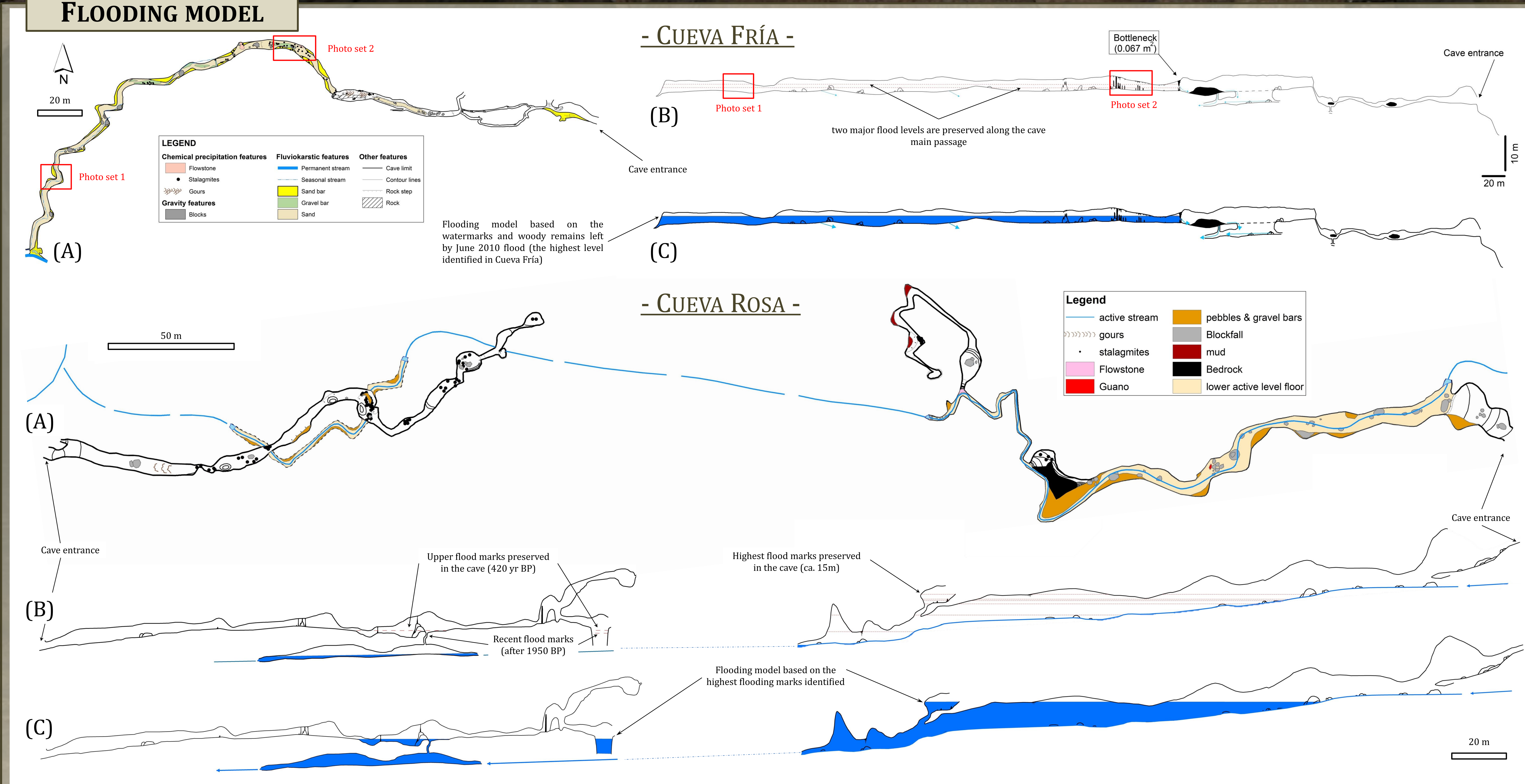
Photo set 1

Photo set 2

Sequence of photographs taken in Cueva Fría between 2009 and 2012, which illustrate differences in the distribution of sandy sediment fills in the gallery (locations are indicated in the geomorphological map of Cueva Fría). A flooding episode occurred in June 2010 filled up a pool area up to 1 m depth (photo set 1) and partially buried stalagmites (photo set 2). Subsequent minor flooding episodes eroded this sediments.

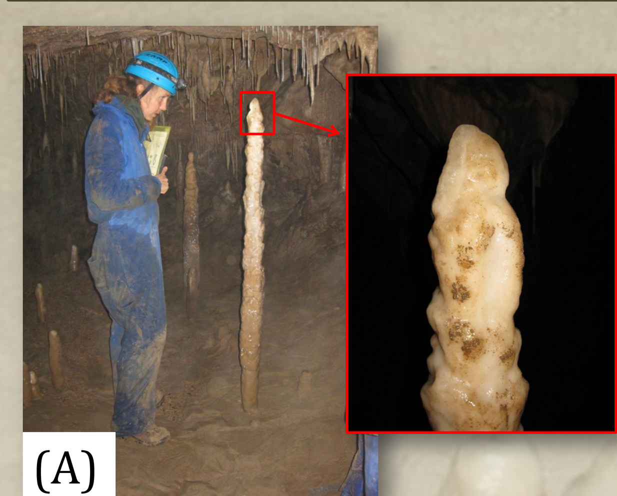
Several watermarks levels can be correlated along the cave passage evidencing flooding episodes of different entity

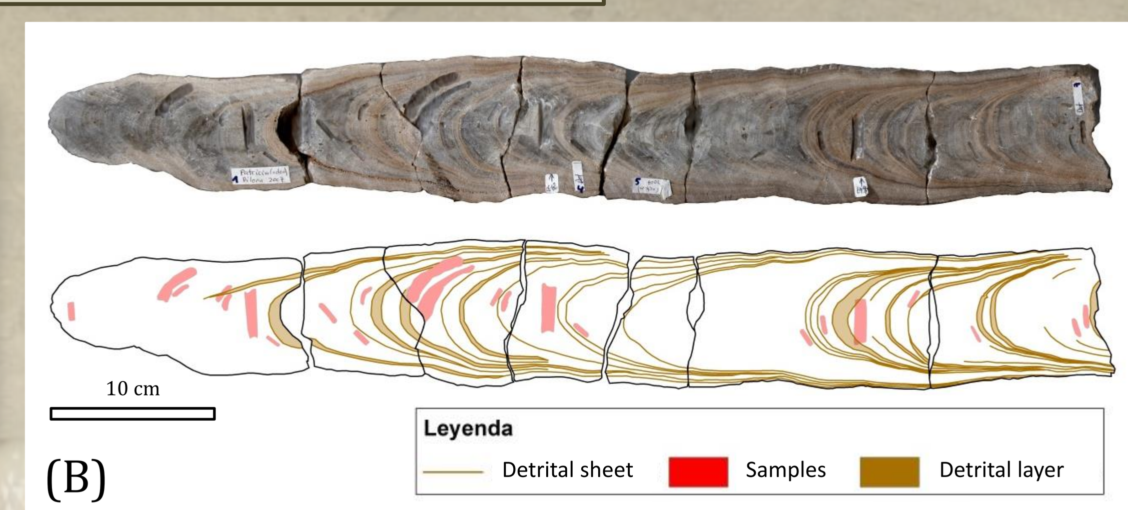
Flooding model

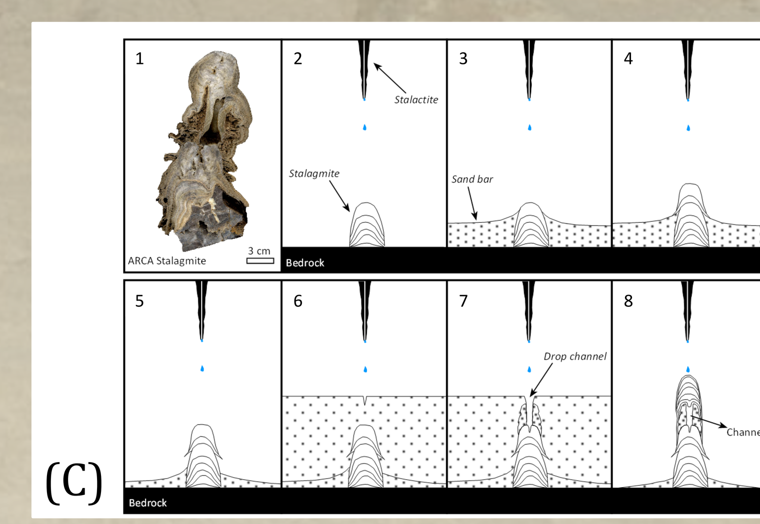


Geomorphological maps of fluviokarstic evidence inside the studied caves (A); profiles along the cave main passage showing the watermark correlations and the identified water evacuation routes during flooding conditions (blue arrows) (B); cave flooding models (C).

Past floods recorded inside stalagmites







(1) Arca stalagmite (Cueva Fría) formed with alternating intervals of burial and exposure (2-8). Stalagmite growth by drip water under vadose conditions (2). If the stalagmite is partially buried by fluvial sediments (3), drip water partially cements fluvial sediments (4) and forms a projection on the stalagmite after subsequent erosion of detrital sediments (5). Alternatively, complete burial of a growing stalagmite (6) results in cementation of the drip channel (7) which may be preserved within subsequent stalagmite growth upon erosion of the fluvial sediments (8).

Detrital minerals can attain content of 2-3% weight SiO_2 inside stalagmites in the form of fine sand to clay sized particles that represent weathering products from adjacent sedimentary rocks. They remain stuck on the stalagmite surface after a flood event and might be fossilized, so they incorporated as inclusions or layer among the stalagmite layers by subsequent carbonate dripping (A). Thus, each detrital layer potentially represents a flooding episode that can be identified through layer counting (B). Partial or total burial can also occur forming complex layering (C).

Conclusions

- During periods of high rainfall, the movement of the sand-bars inside the cave can cover partially or completely active stalagmites, facilitating the cementation process and trapping abundant detrital material inside the stalagmite carbonate.
- ^{14}C and U/Th dating of the stalagmites can provide a chronology, so that the abundance of fluvial material in the stalagmites can reveal periods of enhanced vs. reduced flooding in the cave over the past several thousand years (Holocene).

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