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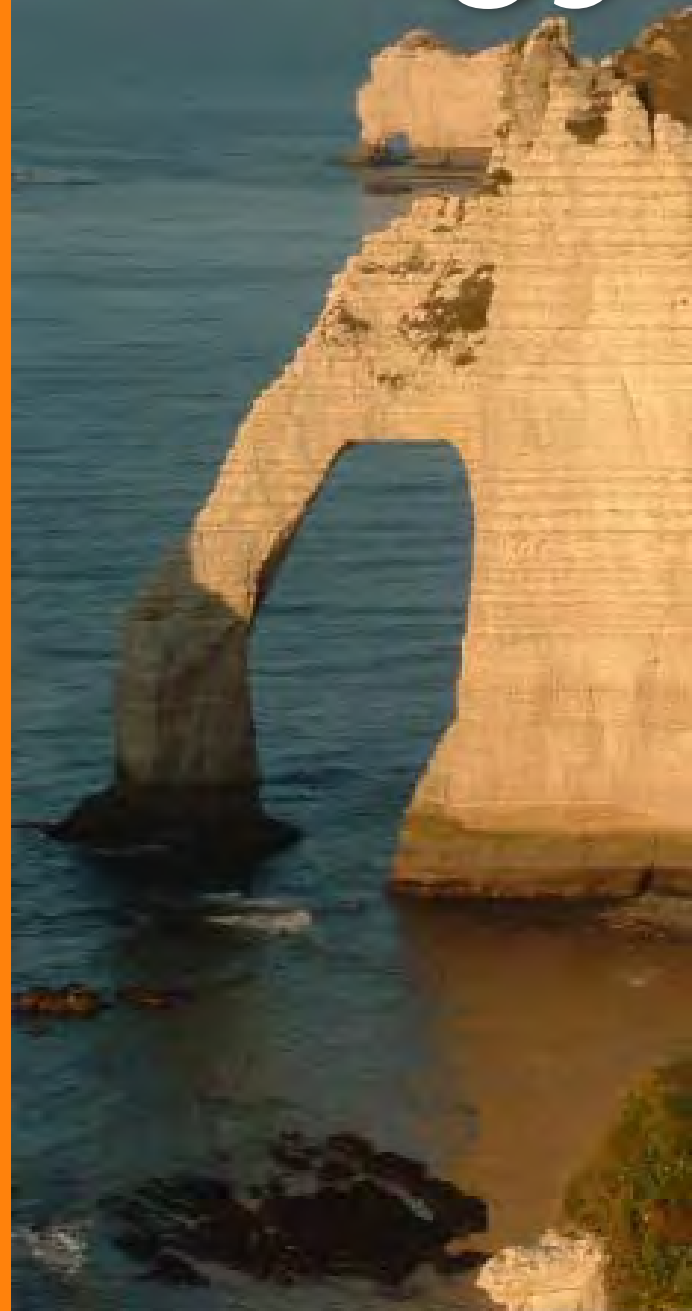
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### **Morphogenesis reconstitution on Kelb valley, Lebanon: contribution of Jeita cave speleogenesis and karst landforms study**

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A geomorphological study has recently been conducted in Lebanon and aims at reconstituting the palaeogeographical stages of valleys related with the downcutting of the Mediterranean hydrographic network. This study focuses on the reconstitution stages of Kelb valley incision. Whereas geomorphic indicators are rare on the surface, we used sub-surface geomorphologic indicators revealed from the speleogenesis study of Jeita cave.

The study area is located downstream of the valley and close to the Mediterranean Sea. It is characterized by: i) a geological structure controlling the phreatic zone (dammed karst), ii) a cave network with 10 km of galleries located between 60 and 250m altitude, and iii) few relict landforms (marine terraces, relict valleys). A crossover analysis between speleogenesis stages, the geology of the sector and the relict landforms suggest three stages of Kelb valley evolution from Pliocene to quaternary period. The study highlights on: i) the paragenesis process in Jeita upper galleries along with Kelb river aggradation in response to Pliocene transgression, ii) the incision of Jeita canyon due to the reorganization of the drainage (fluvial and karstic) system during Quaternary, iii) implications of the Mount Lebanon tectonic uplift and the transgression/regression of the Mediterranean sea during these episodes. The reconstitution of Kelb valley downcutting is extended to the adjacent Antelias valley, where some identified paragenetic caves are located at an altitude close to Jeita upper galleries. Finally, this study can suggest a new chronostratigraphy to marine terraces identified along the western flank of Mount-Lebanon. These terraces up to 300 m. altitude were thought to be quaternary in age while altitudinal correlation between Jeita upper galleries and marine terraces (160 to 250m) of Kelb valley suggest another chronology: Lebanon high marine terraces could be of Pliocene age, while lower terraces were formed during quaternary period.

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### **Thermal Carbonic and Sulfuric Acid Speleogenesis in Cave Provalata, Republic of Macedonia**

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Cave Provalata (Republic of Macedonia) is a rare case of a successive carbonic and sulfuric acid speleogenesis, separated by complete infilling of cave passages with clays. It is a small but remarkable hypogenic cave with abundant gypsum deposits, mostly covering thick corroded calcite crust, with cupolas, ceiling and wall channels, feeders and replacement pockets as some of the most characteristic morphological features. Morphological and mineralogical analyses suggest hypogenic origin in two phases: the first by thermal CO<sub>2</sub> rich waters, the second by sulfuric acid dissolution, which were separated by complete infilling of cave passages with clays. In the first phase cave passages were formed by dissolution along fractures due to cooling of rising carbonated thermal waters. They were later covered with thick calcite crust, deposited after shifting to shallower environment. The cave was completely filled with clays in Early Pleistocene, due to deposition of pyroclastic rocks and travertine deposits in lacustrine environment in Mariovo Basin. After draining of Mariovo Lake and establishing fluvial drainage, Buturica River incised first in the lacustrine deposits, then in Cambrian marbles, creating its superimposed valley, which lowered the water table and allowed washing of the clay deposits. The second phase started after introduction of H<sub>2</sub>S in the thermal waters, which produced sulfuric acid at or near water table, rapidly dissolving the calcite crust and marble host rock. Most of the dissolution happened above water table due to condensation corrosion which produced abundant gypsum deposits as replacement gypsum crust, that later detached and piled as gypsum blocks. At the contact of sulfuric acid with the clay deposits, alunite, jarosite and natroalunite were formed. <sup>40</sup>Ar/<sup>39</sup>Ar dating gave maximum age of 1.6 Ma (alunite) and 1.46 Ma (jarosite). The cave continued to evolve downwards due to lowering of the water table as Buturica River incised its valley.