Burial dating of cave sediments reveal an uplift/incision at the Carpathian-Alpine border (Hainburg Hills)

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The Hainburg Hills are located in the east of Austria, where they form an elevated range that separates the Vienna Basin from the small Hungarian plain or Danube basin. They are part of the Internal West Carpathians and consist of Variscan magmatic and metamorphic rocks covered by weakly metamorphic Mesozoic sediments – mainly Triassic limestone and dolomite as well as Jurassic in age breccia.

Bad Deutsch Altenburg is a village west of Hainburg Hills, well-known for its thermal sulfuric spa since Roman times. Some 30 karst caves are mapped in the area, most of them were opened during quarrying and show signs of a hydrothermal or sulphuric acid speleogenesis. One, more than 15 m wide and 20 m high, cave chamber was recently excavated in an active quarry. It was completely filled with sediment that contains large well-rounded quartz cobbles in a flashy red matrix. The fine-grained matrix is poorly sorted with more than 30% clay (<2 µm) and consists of quartz, muscovite, and albite. In addition, analysis of the clay fraction identifies kaolinite, illite, and smectite. The occurrence of smectite in combination with the fine grain size most likely indicates soi-forming processes that resulted in an increase in fine material due to formation of new minerals in the B-horizon. Therefore, we concluded that the fluvial gravels, which are similar to modern ones of the Danube River, were transported into the cave together with a matrix, originating from a soil cover.

In-situ produced cosmogenic ^{10}Be and ^{26}Al in quartz can be used to calculate the time of the shielding from cosmic radiation (burial age dating) in an age range between 0.1 and 5 Ma. This method was performed on five quartz cobbles to determine the time when the sediment and matrix were deposited in the cave – most probably when the cave chamber was opened by surface erosion.

We assume that at the time of gravel emplacement, the cave level was at or close to the river level. Today the base of the cavity is 150 m above the Danube, thus the relative incision/uplift at the Hainburg hills may be calculated. In addition, so-called calcite rafts that form only at the surface of cave pools were sampled at a lower cave level and dated using the U/Th disequilibrium method.

Age calculations using the isochron method give an age of 3.8±0.4 Ma of gravel deposition, thus an incision/uplift rate of 36–44 m/Ma.