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Vertical movement at the Alpine-Carpathian border (Hainburg Hills) calculated from numerical ages of cave sediments

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The Hainburg Hills form an elevated range at the south of the Male Karpaty mountains and separate the Vienna Basin from the Danube Basin. They consist of Variscian magmatic and metamorphic rocks covered with anchimetamorphic Mesozoic carbonates. The area west of the Hainburg Hills is well-known for its thermal sulfuric spa since Roman times. About 30 karst caves have been mapped in the area that show signs of hydrothermal or sulphuric acid speleogenesis.

Two of these caves vertically separated by 92 m were numerically dated using terrestrial cosmogenic ^{26}Al and ^{10}Be in quartz washed into a cave and ^{230}Th/U of calcite rafts. In addition, aeolian cover sediments were investigated using luminescence age dating.

The upper c. 15 m wide and c. 20 m high cave chamber was completely filled with large, well-rounded quartz cobbles in a red matrix. The matrix contains over 30% clay and consists of quartz, K-feldspar, muscovite, chlorite, hematite, kaolinite, illite, and smectite. The occurrence of smectite in combination with the small grain size indicates soil forming processes in the B-horizon. We conclude that fluvial gravels –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 five quartz cobbles was used to calculate the time of sediment emplacement into the cave. Results indicate a depositional age of c. 4.5 Ma using the isochron technique.

The lower cave was investigated using calcite rafts that form at the surface of cave pools using the ^{230}Th/U dating method. One sample of thin, sharp-edged, and uncoated cave rafts gave the youngest age of c.0.32 Ma. Two other samples were more overgrown and gave older ages between 0.38 and 0.44 Ma. The pristine sample is best suited to reflect the time when the base level was close to the cave.

Rates of vertical displacement vary between 30 and 35 m/Ma for the last 4 Ma and between 150 and 160 m/Ma for the last 0.32 Ma and document an increase of uplift/incision for the region.

These numbers compare well to published rates from the unglaciated surroundings that also range from a maximum of 140 m/Ma to a minimum of 20-25 m/Ma and are generally much lower compared to formerly glaciated areas in the Alps and GPS measured uplift (c. 1000 m/Ma).

The luminescence age of 14.6 ± 0.1 ka recorded in cover sands show that sediments they overly much older gravels. This implies sediments were repeatedly eroded from the top of the karstified bedrock surface. The aeolian sediments are primarily preserved in depressions within the bedrock surface. Therefore, the age may represent the end of a phase of intense aeolian activity when wind velocities decreased sufficiently to cause sand accumulation. This period is the peak in Western and Central Europe periglacial activity and accompanied by formation of aeolian deposits. The ages are comparable to aeolian deposits in the Vienna Basin area and cover sediments from the Transdanubian Range.

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