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# Pliocene to Quaternary uplift rates quantified by the integration of multiple new and revised terrace age data, Danube River, Hungary, Central Europe

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Different geochronological records provided inconsistent data for the age of the terraces in the Hungarian Danube valley. Such discrepancies between these different chronological datasets have to be solved before evaluating the tectonic and climatic processes that have led to the valley incision and terrace formation. To establish a more robust chronology, new cosmogenic nuclide- ($^{10}$Be depth profiles and $^{26}$Al/$^{10}$Be burial durations) and luminescence-based terrace ages have been acquired and compared to revised paleontological, magnetostratigraphic and published U/Th ages. This revised terrace chronology based on age-elevation data pairs of reference levels allows quantifying the vertical deformation rate of the Gerecse Hills. The new chronology implies time integrated uplift rates of 57-70 m/Ma over the last 3 Ma. While somewhat faster uplift rates could be associated to the mid-Pleistocene terraces (up to ∼100 m/Ma for the last ∼1-0.6 Ma), significantly faster uplift rates could be linked to the youngest horizons (up to ∼200 m/Ma, for the last ∼150 ka). All the applied geo-chronometers have led to similar uplift rates with the exception of the U/Th method applied on terrace covering travertine deposits, which yield significantly higher uplift rates with a considerable scatter. Consequently, U/Th ages in the study area are irrelevant for quantifying uplift rates.

For terraces older than ∼150 ka uplift rates show an increasing trend along the Danube from west to east, in agreement with their distance from the axial zone of the uplifting Transdanubian Range. On the other hand, this trend could not be confirmed for the youngest terraces (from ∼150 ka onwards). We propose that for this time-scale, the climate-induced incision may temporally have overridden the effect of long-term tectonic uplift, leading to a consistently high (and possibly overestimated) apparent increase of uplift rates towards present. From Middle Pleistocene onwards, it is possible to tentatively link the terrace carving to transitional climate phases. The slight acceleration of the uplift during the Middle Pleistocene may be attributed to the eastward horizontal displacement of the western Pannonian Basin. This motion was accommodated between the study area and the Danube Bend and led to the shortening and uplift of the entire northern Transdanubian Range.

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