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River terrace formation in response to climate, regional uplift and local normal faulting: The Danube terrace staircase in Vienna

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The formation of impressive Quaternary terrace sequences along many mid to high latitudinal rivers is the consequence of surface uplift and a strong climate related impact on the fluvial system. Glacial and periglacial processes may amplify events of aggradation thereby providing clear stratigraphic markers in the fluvial terrace record. Terrace sequences are essential landforms in many continental basins even though local subsidence may counteract the regional uplift trend. We explore these opposing lithospheric forces, regional uplift vs. local normal faulting along the perialpine section of the Danube River that is supposedly strongly affected by a 100-kyr depositional cyclicity during the Quaternary. Within the city of Vienna, the Danube forms an impressive terrace staircase which is impacted by a continental scale normal fault at the transition Alps – Vienna Basin crossing the city right in its central parts. Hydrocarbon exploration indicate a vertical offset of up to c. 4 km that accumulated during the Miocene, but its recent activity remined so far ambiguous.

Anthropogenic overprint led to the obliteration of terrace morphology and solifluction resulted in thick soil bearing colluvial deposits along slopes. To constrain fault activity, kinematics and stratigraphic information from terrace elevation, we used electrical resistivity tomography and analyzed data from numerous drill logs and outcrops. We applied terrestrial cosmogenic burial and luminescence dating to derive rates of vertical velocities and to support morphostratigraphic age modelling. We show how long-wavelength uplift and concomitant normal faulting controls terrace formation and landscape evolution under periods of aggradation and incision. Our study provides the largest set of cosmogenic derived depositional ages of perialpine fluvial sediments of the Eastern Alps and provides unambiguous evidence of active faulting within the city of Vienna.