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Pleistocene reactivation of a major Miocene fault system within the city of Vienna: Evidence from offset Danube terraces

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The Vienna Basin is located at the transition between the Alps and the Carpathians, with a total length of c. 200 km and a maximum width of c. 55 km. Vienna city is situated at its western edge and is transversed by a set of major Miocene faults, part of the Leopoldsdorf Fault System (LFS). Here, alpine units are vertically offset by up to 5 km. The Vienna Basin lacks evidence for Pliocene faulting but activity resumed not later than the Middle Pleistocene, resulting in the formation of several small sub-basins. These young sub-basins are associated with the activity of the Vienna Basin Transfer Fault at the eastern part of the basin inducing a suggested maximum seismicity of Mmax= 7 (Hintersberger et al., 2018). In contrast, recent activity of major sidewall fault systems delimiting the complete Miocene Vienna Basin remained unclear and not reliably constrained.
Here we present evidence for Quaternary activity of such a major sidewall fault system, the LFS. Potential fault trace positions could be constrained due to numerous seismic sections and abundant borehole data derived from hydrocarbon exploration surveys. We focused on Pleistocene Danube Terraces crossing the LFS, generating a strong resistivity contrast to the underlying fine-grained marine sediments of the Miocene and the overlying Quaternary loess deposits, respectively. Regional uplift affecting the region since at least the Pliocene provides the basis for terrace preservation. First evidence by dating re-deposited quartz gravel using cosmogenically produced 26Al and 10Be indicate a preliminary depositional age of Danube gravels at 1.8 +/- 0.3 Ma. These sediments are today located at 80 m above the recent level.
We used electrical resistivity tomography and data derived from driller's lithologic logs, as well as high resolution digital elevation models to constrain vertical offset of terraces. We found a 30 m vertically offset gravel body, coinciding exactly with the westernmost and most prominent footwall cutoff of the LFS. The fault is buried below thick, redeposited loess-like sediments, which presumably filled the developing fault throw. Preliminary luminescence ages of loess-like deposits close by provide a minimum depositional age of at least >200 ka. Uphill, the loess-like cover sediments thin out and Neogene fines or fluvial gravels appear partly uncovered or eroded. Even though the area is agriculturally used and overprinted, the detected normal fault seems to also have a surface expression as suggested by an up to 1 m high scarp preserved at some locations. Our results suggest that major sidewall displacement might be much more active at recent times than previously thought.

References:
Hintersberger, E., Decker, K., Lomax, J., Lüthgens, C. 2018: Implications from palaeoseismological investigations at the Markgrafneusiedl Fault (Vienna Basin, Austria) for seismic hazard assessment. Nat. Hazards Earth Syst. Sci., 18, 531–553, 2018