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Paleoseismic evidence for seismogenic faulting in the epicentrical area of the 1755/56 Düren earthquake series, Lower Rhine Embayment, NW Germany

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The Lower Rhine Embayment (LRE), the NW branch of the western European Cenozoic rift system, is currently one of the most tectonically active regions in central Europe. This intraplate fault-system is generally characterized by long recurrence intervals of $M \geq 6$ events. Historical records for the LRE document the occurrence of at least 21 $M > 5$ events, the largest of which appears to have been the 1755/56 earthquake series in the area of Düren city (ML 5.8 – 6.1). The space-time-distribution of earthquake and fault-rupture patterns in the LRE is still poorly understood but is important to understand the mechanical behaviour of faulting in this tectonically active region.
Historic damage related to the 1755/56 events implies that any of four recently active faults in the epicentrical area may have ruptured. Possible seismogenic faults are the Feldbiss-, Rurrand-, Sandgewand-, and Schafberg faults. We carried out trench investigations along the Schafberg fault, a 6 km long E-dipping normal fault approximately 10 km SSW of Düren. Previous studies estimated a total offset in the range of 5-10 m on the fault since early Pleistocene times. At the trench location in the Rur River valley, SW of Untermaubach, the Schafberg fault is covered by late Pleistocene fluvial gravel, Holocene gravel and sand deposits, and late Holocene flood deposits. The suspected surface rupture is expressed in a NNW-trending topographic scarp of 0.5-1m. We excavated the fault along a 5 m deep and 85 m long trench approximately 200 m W of the recent Rur river course. Seasonal variations of the groundwater level in this part of the valley lead to intensive alteration of the unconsolidated sediments. Within the sedimentary layers, earthquake-related deformation is mostly focused in the late Pleistocene gravel units exhibiting many (>200) fractured and rotated clasts along vertical deformation zones. Furthermore, we mapped several types of soft-sediment deformation in the Holocene sandy and clayey deposits including sand and clay intrusions as well as asymmetric folding of cm- to dm-scale related to liquefaction processes. The overlaying fine-grained flood deposits do not show clear signs of seismogenic deformation.
The overall surface-displacement across the fault appears to range between 0.8 and 1.2 m based on an observed offset of a suspected Holocene-Pleistocene marker horizon within the gravel deposits. This corresponds to estimates derived from borehole data, geophysical prospecting and morphometric analysis. The fractured and rotated clasts are the strongest indicator for seismogenic faulting along this portion of the fault as these features cannot be produced by aseismic creep. Deformation analyses also suggest at least one, possibly two, ground-rupturing events since late Pleistocene times because one well-defined and one less well-defined event horizon could be traced within the late Pleistocene gravels. Geochronological analyses of samples from around 20 horizons across the trench are in progress, and will help to better time and classify single ground-rupturing events.