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Paleoseismological trenching of the eastern Rhine Graben Boundary Fault: the Ettlingen segment

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Paleoseismic data on the eastern central Rhine Graben Boundary Fault, as part of the Upper Rhine Graben (URG) fault system, revealed Holocene earthquake activity with surface rupturing faults. The URG is one of the most seismically active areas in the stable continental interiors of Central Europe north of the Alps. We opened the first paleoseismic trenches N of Basel and S of Frankfurt along the ca. 300 km long eastern Rhine Graben Boundary Fault (RGBF). After extensive shallow geophysical and morphotectonic investigations and analyses, we discovered that the eastern central RGBF consists of several parallel fault strands that are marked by topographic steps, by varying hydrogeologic conditions, moisture content and by geophysical anomalies in the subsurface (GPR and ERT data). Some of the scarps close to the alluvial plain of the river Rhine have been identified as erosional features. We opened six trenches perpendicular and parallel to the second topographic scarp and strand of the main RGBF in Ettlingen area. Trenching the main RGBF was precluded due to forest cover and the presence of big blocks of rock in the colluvium at the base of the slope (red Triassic sandstones). Trenches were up to 20 m in length and 2 m in width, and up to 3 m in depth. None of the trenches reached the Triassic Buntsandstein “basement”, and all exposed Pleistocene and Holocene strata. Some strata are interpreted as blocky/gravelly colluvium of the Glacial periods, Loess, redeposited gleyey Loess, soli-/gelifluction layers and deposits and organic paleosols. Most of these layers are clearly displaced by faults and downthrown to the west, although some strata appear to warp or fold over faults. Massive liquefaction and periglacial features have been found, the relation to the sedimentary sequences in the trenches need to be elaborated in future. The process is interpreted to be instantaneous, as massive colluvium is placed against clayey/silty Loess deposits, and therefore we attribute these displacements to earthquake-related faulting. Creep along the strand can be ruled out. The displacement on free faces is on the order of 30 – 50 cm per event vertically, and considerable horizontal offset (ca. 2 m), and we found evidence for two of such events. Applying the commonly used empirical relationships, these findings are interpreted as two events with a magnitude M larger than 6. These results show the bias between the seismogenic landforms (scarps, hanging

valleys, triangular facets, etc.) in the eastern UGR margin and seismicity recorded by seismic stations in the area, as currently most of the activity is found in the southern URG near Freiburg. Our findings contribute significantly to the completeness of the earthquake history in the eastern central URG.