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Fault related cracking of pebbles in unconsolidated sediments (SE Vienna Basin, Austria)

Christoph Tuitz (1), Ulrike Exner (1), Bernhard Grasemann (1), and Alexander Preh (2)

(1) University of Vienna, Geodynamics and Sedimentology, Vienna, Austria (christoph.tuitz@univie.ac.at), (2) Institute for Engineering Geology, Vienna University of Technology, Austria

Cracked pebbles from unconsolidated sediments were investigated in a gravel pit south of St. Margarethen (Burgenland, Austria). Extensional tectonics in these sediments resulted in the generation of conjugate sets of predominately WNW- and subordinate ESE-dipping normal faults. These faults were primarily localizing in meter-thick gravel layers and, with increasing displacement, eventually crosscut other lithologies. The gravel layers contain a significant number of cracked pebbles. Detailed structural mapping of the distribution of cracked pebbles revealed their preferential occurrence in the vicinity of the normal faults and, in these, within zones of roughly uniform-sized pebbles. The findings indicated a strong relation to the mechanics of faulting within the sediment. To find the controlling factors for the localization of pebble fracturing, the grain-size distribution and shape and the number of point contacts of the pebbles were statistically measured. Furthermore, on the basis of point load tests, failure statistics and finite element analysis a breakage criterion was defined which characterizes the breakage behavior of the pebbles.

The results were then used as input parameters for discrete element simulations (DEM). This method was applied to simulate the effect of overburden on a certain volume of particles (i.e. the pebbles). Results from these simulations indicate that a maximum estimated overburden of a few tens of meters would not have been able to generate contact forces high enough to crack the significant number of pebbles that were observed in some parts of the outcrop. Additionally the comparison of different sub-domains of the gravel layers clearly confirmed that the predominance of cracked pebbles in the domains which are in the vicinity of faults cannot be attributed to the effect of overburden alone. The DEM simulations show that other domains containing less cracked pebbles at the outcrop should in fact contain more cracked pebbles according to the model, than the domains in the vicinity of the faults. We therefore conclude that cracking was related to faulting by force jamming due to pebble reorganization and/or by contact force concentrations due to boundary effects of layering.