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New process model for the Dead Sea sinkholes at Ghor Al Haditha, Jordan, derived from shear-wave reflection seismics

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In October 2013 a shear wave reflection seismic pilot study was carried out at the most destructive sinkhole site in Jordan, close to the village of Ghor Al Haditha at the South-East end of the Dead Sea. The investigation is part of the DEad SEa Research Venue (DESERVE), a virtual institute of the Helmholtz Association, designed as a cross-disciplinary and cooperative international project of the Helmholtz Centers KIT, GFZ, and UFZ, and their partners.
Since nearly 30 years - apparently contemporaneous to the rapid decrease of the Dead Sea level - ongoing unknown sinkhole processes in the subsurface continuously compromise farming areas, housings, industrial sites, and infrastructure at the investigation site, resulting in massive destructions. Similar processes are observed also at the western border of the Dead Sea. Although many geophysical studies have been carried out at the site since more than 20 years, the subsurface structure and the process itself is quite unknown until yet. In recent years, a massive salt layer at 40 m depth or more was proposed below alluvial fan deposits, which was the target of this reflection seismic pilot study.
We spent 10 days in the field and acquired four shear-wave reflection seismic profiles of 1.8 km total length to yield a high-resolution structural image of the subsurface. The lines cover in NW-SE and NE-SW direction the sinkhole-affected area as close as possible to recent collapse structures. There is no evidence for the hypothesized shallow salt layer, at least not down to 100 m probably up to 200 m depth. Instead, the detected subsurface structures show a complex interlock of alluvial fan deposits and marine sedimentation layers of the Dead Sea between 0-200 m depth. Therefore, we propose a new hypothesis for the sinkhole processes in the region: salt-rich marine clay layers are present in the fresh water contact zones inside the alluvial fan, which are destabilized and mobilized by dissolution of the salt contained. This suggestion is well supported by surface observations at the current border of the Dead Sea. Similar leaching effects are well known from the quick-clay problem in e.g. Scandinavia. Time-lapse profiling at the investigation site in the upcoming years should lead to a better knowledge of the subsurface processes.