Geophysical Research Abstracts
Vol. 15, EGU2013-10472, 2013
EGU General Assembly 2013

Geophysical analysis of the recent sinkhole trend at Ghor-Haditha (Dead Sea, Jordan)

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For essentially the last 30 year the water level of the Dead Sea has highly dropped. One of the major associated facts is sinkhole occurrences along the shoreline both in Jordan and Israel. As the principal invoked mechanism, many studies have concluded that sinkhole formation results from the dissolution of a previously immersed salt layer, progressively in contact with fresh to brackish water. In Jordan, the triggering of this phenomenon could also be the result of particular tectonic settings, associated with the Jordan-Dead Sea transform fault system. At Ghor Haditha (south–est Jordan), the consequences have been dramatic for farmers with the shrinking of temporary available lands and industry with the closing of at least one factory. The shallow material in this area is heterogeneous and composed of intercalated sand and clay layers of alluvial-colluvial origin, over a salty substratum, whose precise depth and thickness are yet partially hypothesized.
Between 2005 and 2008, a multi-method high-resolution geophysical survey was performed, approximately over a 1 km2 area at Ghor Haditha, associating mainly electromagnetic soundings, magnetic resonance soundings (MRS), and seismic profiling, ground-penetrating radar and electrical resistivity tomography. At the same time, this specific area was the location of a dramatic evolution of sinkhole occurences, regularly followed by geodetic measurements.
Over the 3 years period, about 120 TEM (Transient ElectroMagnetic) soundings allow to map precisely the depth of the conductive layers below the resistive overburden. Two conductive layer are then revealed, the latter showing the lowest resistivity below 1 Ohm.m corresponding to the saline substratum. Several MRS (3 in 2005, repeated in 2007 and 12 additional soundings) show an east-west hydraulic gradient towards the Dead. However, the main sinkhole trend coincides with both:
- a clear low transmissivity axis determined from MRS measurements;
- the western side of a depression into the top of the most conductive layer.
This shows so clearly a correlation between the recent sinkhole phenomenon and the current water circulations, but paleo-topography below the Pleistocene deposits mays equally be a clue in the sinkhole hazard.