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Application of surface geophysical methods for delineating sea water intrusion into the coastal aquifers of Israel

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Both the Mediterranean and the Dead Sea (DS) coastal clastic aquifers constitute multi-aquifer systems subdivided by clay and marl beds to sub-aquifers. In order to perform a detailed study of the aquifers, numerous geophysical surveys have been carried out in both areas.

In the Mediterranean coast, the surveys included time domain electromagnetic (TDEM) and shallow seismic reflection measurements. The combined interpretation of the TDEM and seismic data allowed to accurately delineate the geometry of the aquifer and, in some cases, to detect “reversals” of highly resistive bodies (fresh water) below the very low resistivity ones (sea water intrusion).

The Dead Sea (DS) coastal aquifer is represented by the alluvial Quaternary sediments bordered by the faults of the western margin of the DS Rift. The main source of fresh water within the Quaternary aquifer is lateral flow across these faults from the Upper Cretaceous aquifer located to the west of the faults.

A number of TDEM traverses have been carried out across the DS coastal plain between the shore line and the fault scarp. The TDEM measurements allowed to accurately delineate the configuration of water bodies of different salinities and the interface between them. The interface is found to be approximately 10 times shallower than that in the Mediterranean coast and this is in complete agreement with the Ghyben-Herzberg equation using much higher density of the DS brine (1.23g/cc). In some cases the geometry of the interface significantly differs from the expected “conventional” one. These irregularities are related to a multiple aquifer system, as well as to a non-steady state situations and, probably, to the current dissolution of salt layers. A steepening of the interface towards the fault zone, as detected by TDEM, is the result of a significant decrease in the hydraulic conductivity at the fault zone. This observation is supported by the simulation analysis using the US Geological Survey’s SUTRA code.