Exploration of deep aquifer in North Jordan using TEM and MT

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SUMMARY

Deep aquifers at depths of 300 m to 1000 m have rarely been the focus of groundwater research. However, their importance for groundwater supply, especially in arid regions, is increasing, not least since the unmistakable climate change.
In order to quantify the location, extent and size of such deep aquifer systems, to understand them and thus to be able to use them sustainably, we used a combined transient electromagnetics (TEM) and magnetotellurics (MT) approach to investigate the distribution of electrical conductivity in relation to hydrogeological structures in a field study in northern Jordan.
42 TEM and 24 MT soundings were conducted in 2018 and 2019, mostly along profiles.
The TEM and MT data are complementary. MT resolves structures below 600 m, which is below the depth of investigation (DOI) of TEM. This allows deeper aquifer systems and their bases to be explored. In addition, lateral variations in conductivity can be detected with MT. Since the MT-data seem to indicate a one-dimensional (1D) background in the period range between 10^{-4} and 10^{1}s, the TEM-data could be used to correct the observed static shift in the MT data. Subsequently, both separate inversions of TEM and MT and joint inversions of TEM and MT were performed.
Another added value of the combined use of two methods is the strengthening of the robustness of the results by the joint inversion.
The joint 1D inversion confirms and complements the results of the separate inversion of the TEM- and for static-shifted corrected MT-data. The conductivity models, which provide a two-dimensional image of the conductivity in the subsurface, confirm hydrogeologic structures that are already known or suspected at a few points from well data, but also reveal new structures and new insights that are very valuable for understanding the aquifer system.

Keywords: Magnetotellurics, Transient electromagnetics, deep aquifers, joint inversion