Characterization of intermediate depth reservoirs in complex coastal areas with CSEM method

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SUMMARY

The characterization of water resources at intermediate depths (200-1500 m) in coastal peri-urban environments requires the implementation of specific and complementary geophysical techniques to overcome as much as possible the influence of anthropogenic noise and problems related to human infrastructures. Within the frame of the DEM'EAUX THAU project aiming at understanding and ultimately better manage the interactions between meteoritic, marine and deep thermal water in a karstic carbonate reservoir, we undertook to acquire 3D electromagnetic data around Balaruc-les-Bains (Hérault, France) to complete the hydrogeological and geological investigations. 91 controlled-source electromagnetic (CSEM) stations were collected both on-shore (56) and off-shore (35) on the Etang de Thau over ~25 km^2 in the frequency range 0.125 – 8192 Hz using 2 powerful 22kVA transmitters running simultaneously at opposite side of the survey area.

This paper mainly focuses on the analysis of the CSEM data in obvious coastal 3D context. As a first step, apparent resistivity maps show a good agreement with both gravity data and expected geology of the area. Then, 1-D inversion (based on OCCAM1D, Key (2009)) was tried but failed due to the complexity of the area, mainly caused by the highly conductive Etang de Thau lake (~0.16 Ωm) and its rugged geometry. In a third step, 2.5-D inversions along profiles crossing the Etang de Thau have been tried using MARE2DEM (Key and Ovall, 2011) to deal with the shallow highly conductive layer but only partially reconstructed the resistivity distribution at depth due to the too simplistic 2.5D assumption.

Finally 3-D modelling considering the water layer and its complete bathymetry has been performed using the POLYEM3D software (Bretaudeau et al. 2018 – this workshop). The simulations highlight that even though the depth of the water does not exceed 15m, significant charge accumulations all along the coast are visible and depend on the depth and shape of the water layer. These effects are of the order of magnitude of the anomalies sought and can clearly not be neglected during the inversion. Current work consists in performing 3D inversion using the POLYEM3D inversion code by including all the complexity of the water layer.

Keywords: Controlled-Source Electro-Magnetics, On and Off-shore CSEM acquisition, Groundwater management, 3-D EM modelling and inversion