

Delineating the fresh/ saline groundwater interface in a subsea aquifer using Ex-Bz marine time domain electromagnetic system

Eldad Levi^{1,2}, Mark Goldman, Gideon Tibor^{2,3} and Barak Herut^{2,3}

¹Geoelectric Department, Geophysical Institute of Israel, Lod, ISRAEL

²Department of Marine Geosciences, University of Haifa, Haifa, ISRAEL

³Israel Oceanographic and Limnological Research, Haifa, ISRAEL

ABSTRACT

To delineate the offshore extent of the fresh water bodies occupying the lower sub-aquifers of the Mediterranean coast of Israel, a marine time domain electromagnetic (TDEM) system was developed using an AB floating transmitter (Tx) line and a short offset Bz coil receiver (Rx) located at the sea floor. Using this array with a proper offset, significantly increases the relative response from a resistive target (fresh water, hydrocarbons). It was found that under the specific Israeli near shore geoelectric conditions, a short offset receiver coil located at the land-side of the transmitter line represents an optimal array.

The study included four offshore campaigns, during which a total of 35 marine TDEM measurements were carried out at 20 different Tx locations. The measurements were performed along four offshore traverses, which ran both parallel (south-north) and perpendicular (east-west) to the coastal line. The perpendicular traverses extend to approximately 3000 m offshore. The roughly 15 km long S-N traverse was run at a distance of several hundred meters offshore the metropolis of Tel Aviv, where onshore measurements were impossible due to EM noise problems.

The results clearly show the existence of a relatively resistive structure in the lower portion of the sub-seafloor aquifer within approximately the same depth range as it was detected onshore. This structure is consistent with the expected relatively fresh groundwater within sub-seafloor sediments.

The geoelectric measurements managed to delineate this offshore fresh water body within the lower sub-aquifers at a depth range between 100 to 250 m BSL, with sea bathymetry exceeding 30 m at the westward edge of the perpendicular traverse. In the S-N direction, the fresh water body extends along an approximately 30 km strip between the city of Ashdod in the south to north Tel Aviv in the north, while in the E-W direction it extends to about 3 km offshore. The edge of the target in the west represents a sharp contrast between high and low resistivity, indicating that the sub-aquifer is apparently blocked to the sea and is controlled by facies changes from sands to clays.