Mapping sea-water intrusion along coastal aquifers

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Airborne electromagnetics (AEM) can greatly improve the data quality and coverage in tidal and coastal areas, lagoons, estuaries, and river deltas while significantly cutting the acquisition costs and time. The application of AEM for groundwater monitoring and modeling has been steadily rising in the past decade, due to parallel developments of better AEM systems together with processing and inversion methodologies.

Regarding the mapping of sea-water intrusion, thanks to the high conductive response, it represents an optimal target, so that it is possible to resolve salt, from brackish and fresh water.

The first example is a SkyTEM prospection carried out in the Venice Lagoon, Italy. This part of the Venice territory, located in the South side, which is devoted to agricultural activity, seriously suffers from land degradation due to salt water intrusion in connection with relative sea level rise, i.e. eustacy and land subsidence.

Figure 1 presents the results of the inversion of AEM data as horizontal average resistivity maps at different depth intervals (from the multi-layered models results) at 0–5, 10–20, 30–40, 60–80, and 100–120 m depth intervals. In the lagoon sector the resistivity values increase from less than 1 ohm-m in the shallower layer to about 4 ohm-m down to 100 m depth. An interesting feature in the near surface of the lagoon is the more conductive zone (0.5 ohm-m) in correspondence with tidal marshes. The 0.5 km wide coastland just south of the lagoon margin is characterized by the highest variability. The resistivity reaches its minimum values (1–2 ohm-m) within the 10–20 m depth layer and increases to 8 ohm-m both upward at the ground surface and downward to about 100 m depth. Below this depth, the resistivity significantly differs (from 5 to 30 ohm-m) in the lagoon and the inland sides. In the inland area two distinct layers with relatively low resistivity (about 5 ohm-m) are detected from the ground surface down to 20 m depth (Figures 1b and 1c) and within the 60–80 m depth interval (Figure 1e). Their landward intrusion is highly variable to a maximum of about 2 km from the lagoon margin. In the other portions of the farmland subsoil, the resistivity has a large increase, up to 70 ohm-m.

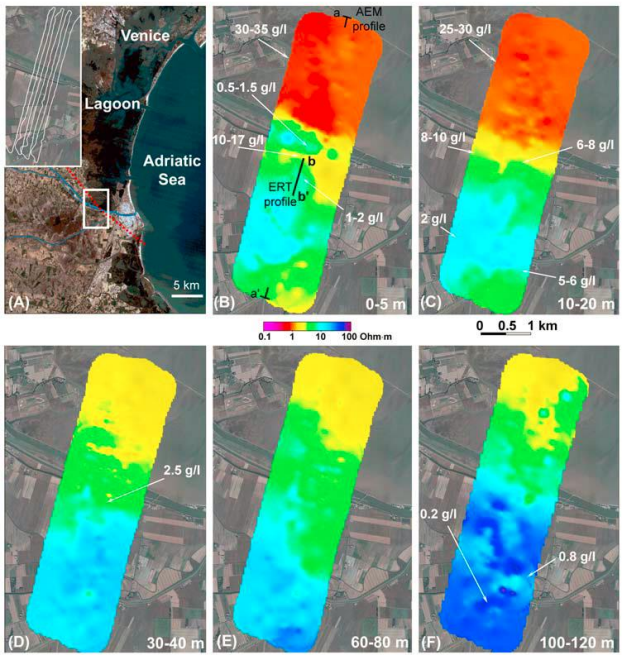

Figure 1

The second example is drawn from a SkyTEM survey carried out in the Galapagos islands. In this case the use of AEM is really advantageous, due to complex internal structure and challenging access. Figure 2 shows a vertical resistivity profile along a south-north direction, with the corresponding hydrogeological interpretation (bottom panel). Beside the low resistive perched aquifer, made up by fresh water-saturated volcanics, it is clear the seawater intrusion on both sides of the Santa Cruz Island, entering the island fro many Km and characterised by very low resistivity (< 10 ohm-m).

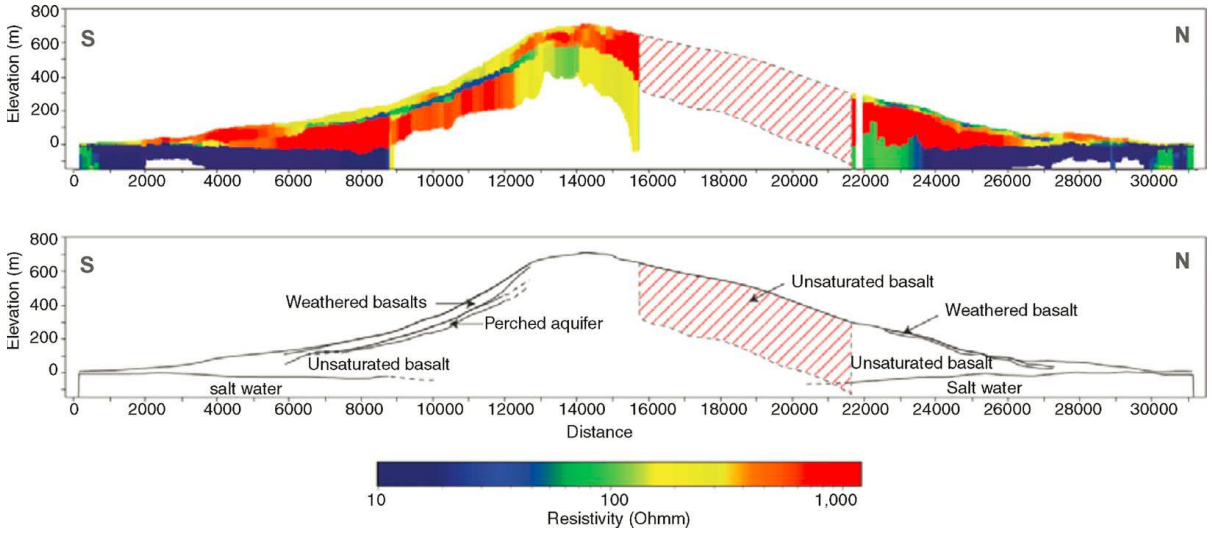

Figure 2