Finanziato dall'Unione europea
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PIANO NAZIONALE DI RIPRESA E RESILIENZA
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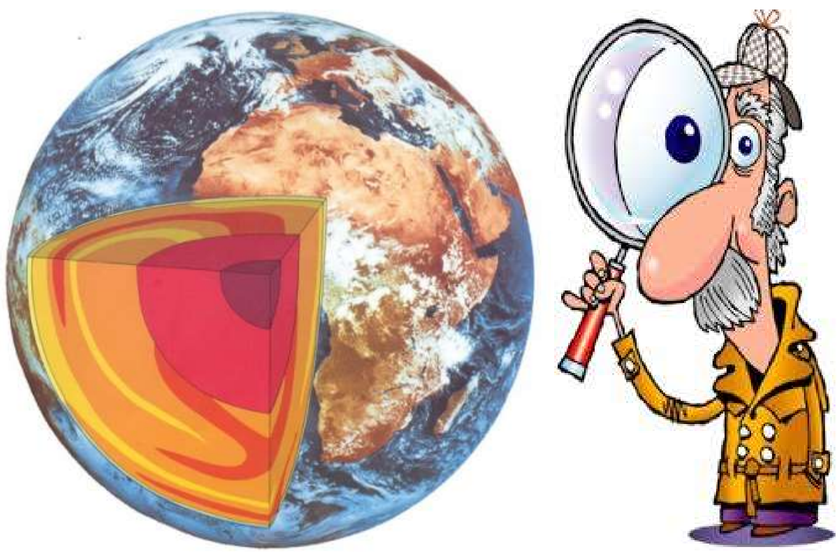
Metodologie geofisiche a supporto dello studio di acquiferi costieri

Lorenzo De Carlo

Geophysical methods

Geophysics is a subject of natural science concerned with the physical processes and physical properties of the Earth and its surrounding space environment

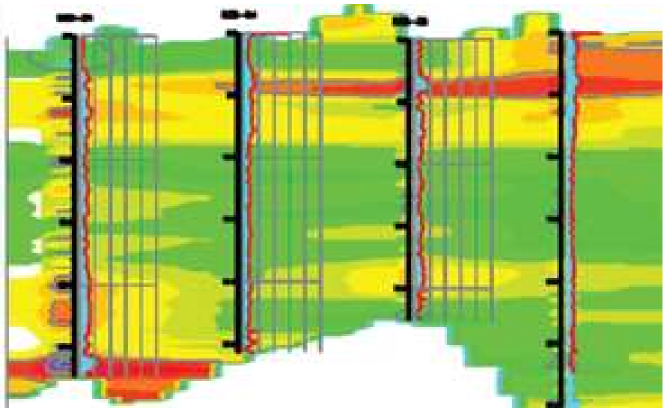


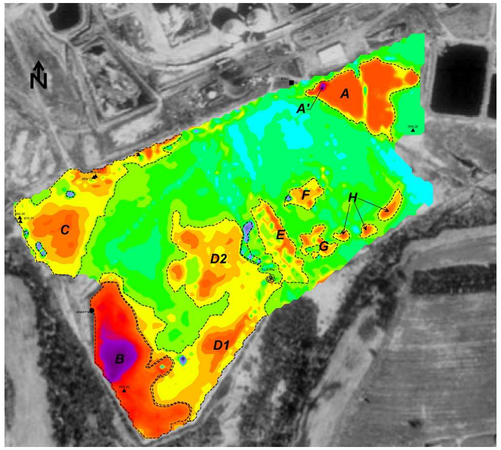
The purpose of the geophysical investigation is to locate or detect the presence of buried geological structures, determine their configuration (i.e. size, shape and depth) and physical properties.

Geophysical data can also be used to identify hydrogeological features, mapping potential subsurface sources of contamination and preferential pathways for contaminant migration.

This information will help develop and refine the conceptual site model

Benefits and limitations of using geophysical prospecting





Benefits

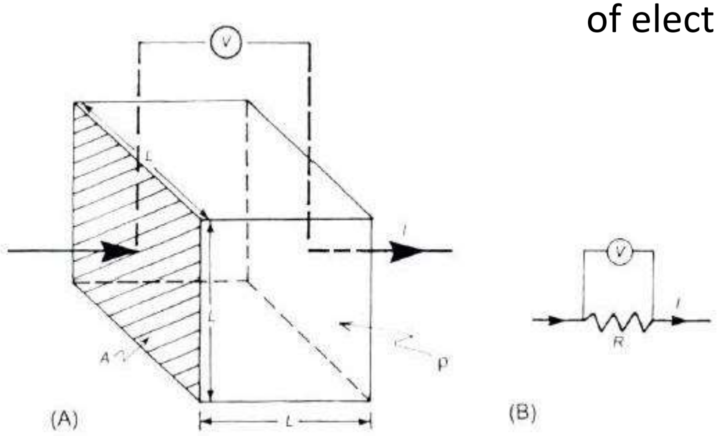
- Minimally invasive or non-invasive techniques;
- High productivity with limited costs;
- High 2D/3D spatial coverage;
- Resolution ranges from cm to km).

Limitations

- Indirect measurements, imaged targets cannot be directly observed;
- The imaging resolution decreases with depth.
- Data interpretations are non-unique, and their reliability depends on external constraints

Electrical methods

Electrical resistivity (Ohm x m) is a measure of a material's property to oppose the flow of electric current. Its inverse is the electrical conductivity (S/m).



Ohm's law states that the electric current (I) through a conductor between two points is directly proportional to the voltage (V) across the two points. The mathematical equations used to describe this relationship are:

$$V = RI \qquad (1)$$

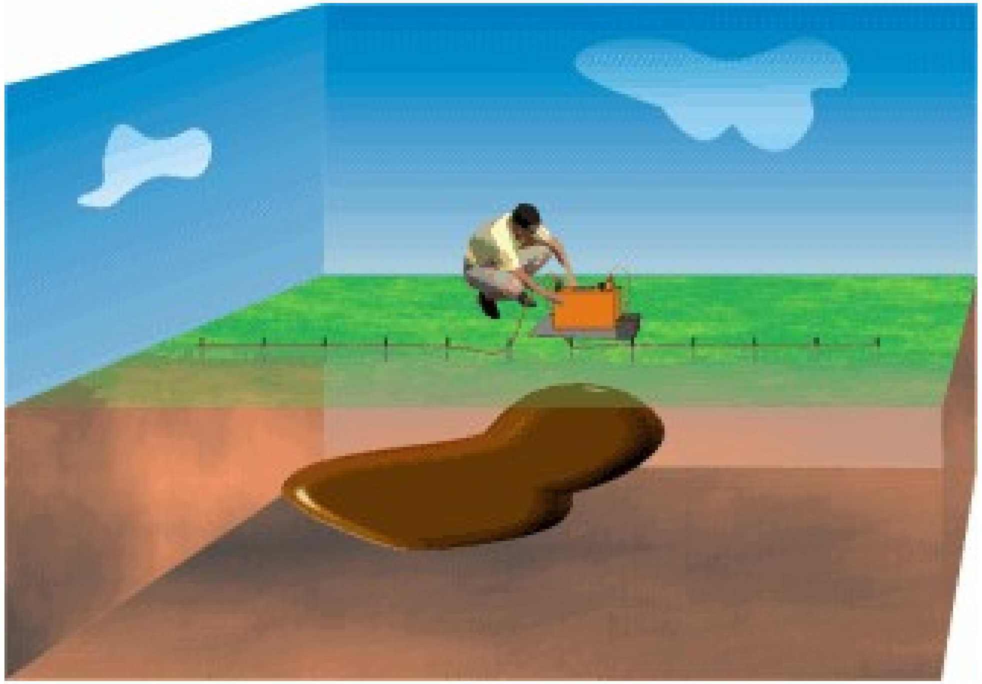
Electrical resistance of a conductor of unit cross-sectional area and unit length.

$$\rho = \frac{Rs}{l} \qquad (2)$$

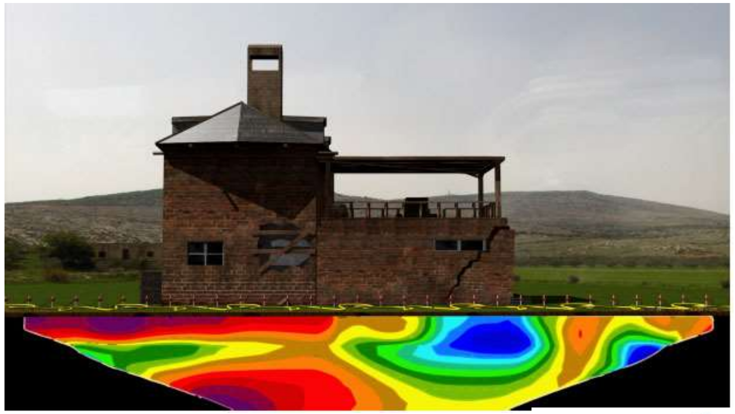
The rock resistivity depends on:

1) degree of fluid saturation; 2) rock porosity and texture; 3) temperature and pressure; 4) clay content; 5) conductivity of the fluid (and its chemical composition)

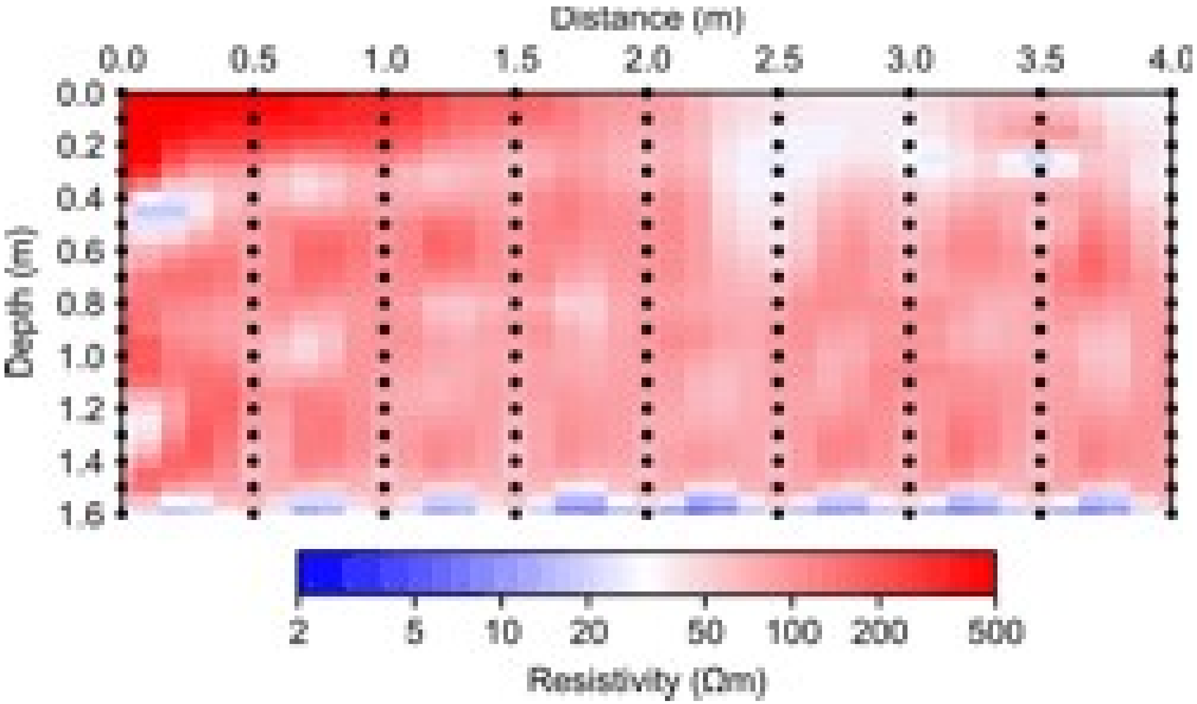
Electrical measurements – Electrical Resistivity Tomography (ERT)

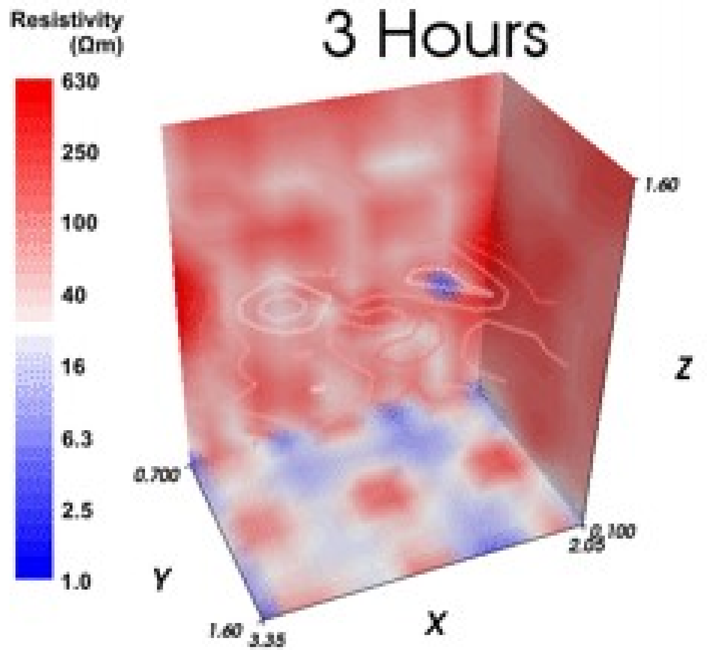


The method of measuring subsurface resistivity involves placing four electrodes in the ground in a line at equal spacing, applying a measured AC current to the outer two electrodes, and measuring the AC voltage between the inner two electrodes. A measured resistance is calculated by dividing the measured voltage by the measured current. This resistance is then multiplied by a geometric factor that includes the spacing between each electrode to determine the apparent resistivity.

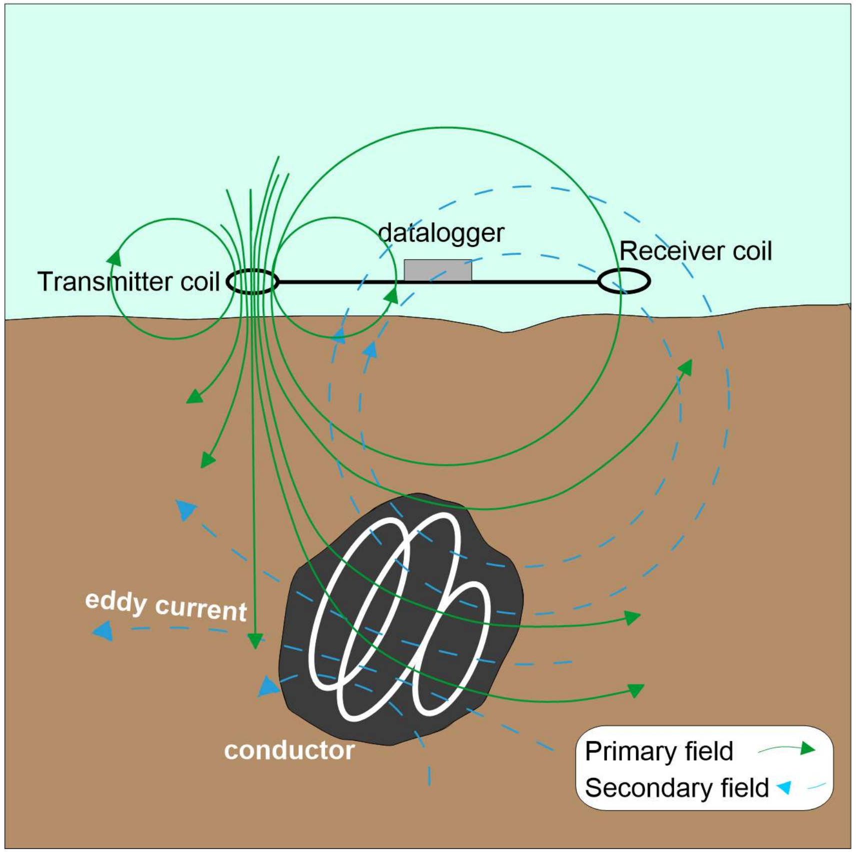


Monitoring spatio-temporal dynamics via time-lapse ERT survey





Electromagnetic Induction (EMI) technique



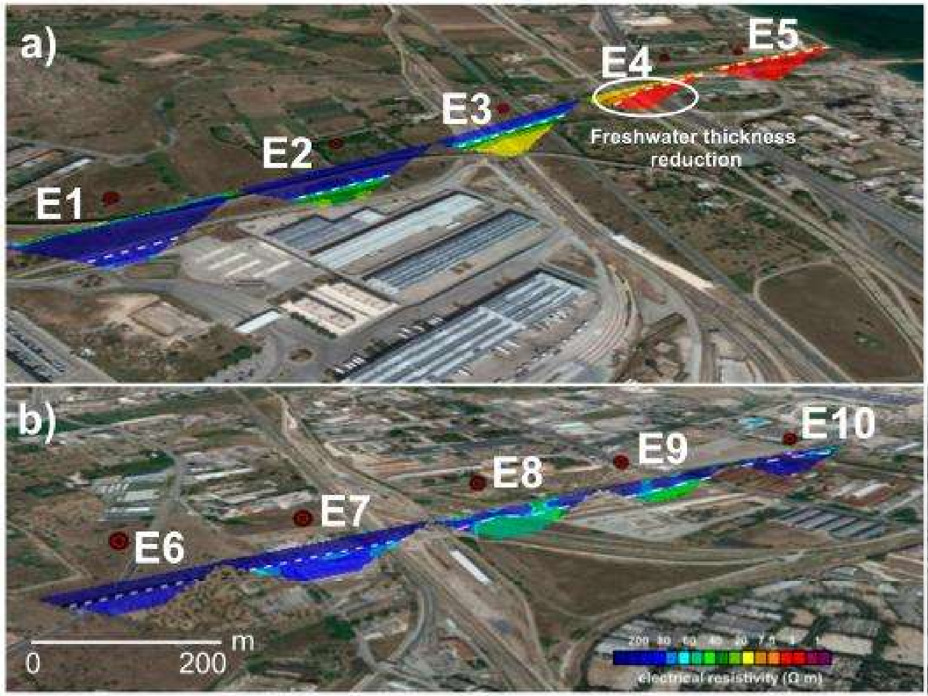
Electromagnetic induction (EMI) is based on the mutual induction among three coils.

An alternating sinusoidal current in the transmitter produces a primary magnetic field H_P, which induces small eddy currents in the subsurface.

These currents produce, in turn, a secondary magnetic field H_S, which is sensed by the receiver.

The ratio H_S/H_P of the secondary to the primary magnetic fields is measured by the device, providing information about the amplitude and the phase of the signal.

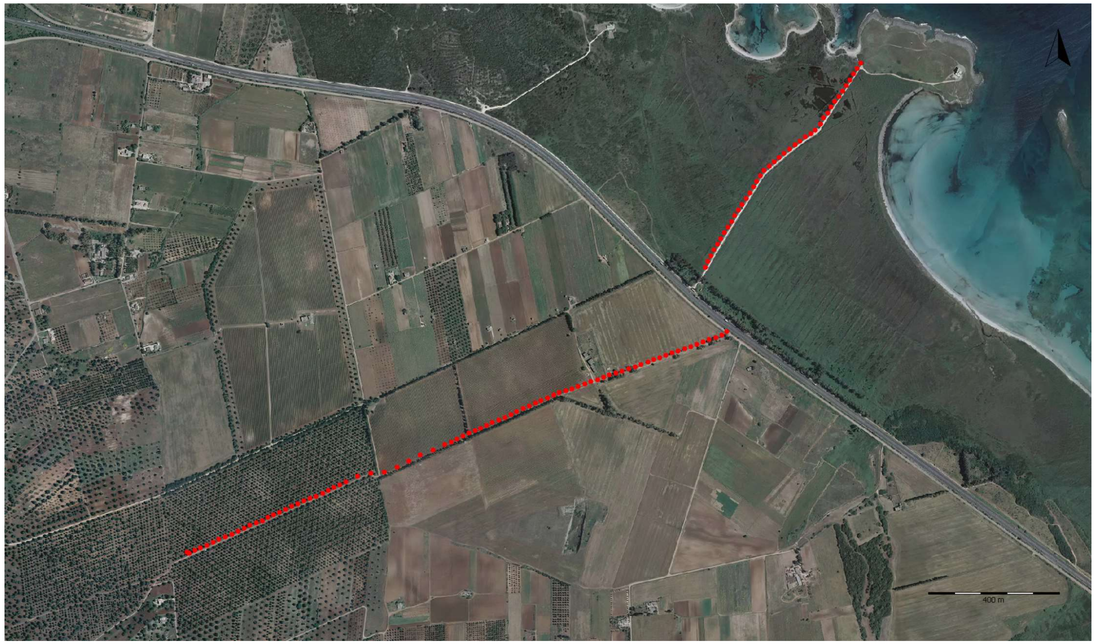
Case study 1 – ERT survey for identifying saltwater intrusion in the Bari fractured aquifer



High conductivity ⟶ saltwater intrusion

Masciopinto, C.; Liso, I.S.; Caputo, M.C.; De Carlo, L. An Integrated Approach Based on Numerical Modelling and Geophysical Survey to Map Groundwater Salinity in Fractured Coastal Aquifers. *Water* **2017**, *9*, 875. https://doi.org/10.3390/w9110875

Case study 2 – Mapping saltwater intrusion in the Torre Guaceto aquifer



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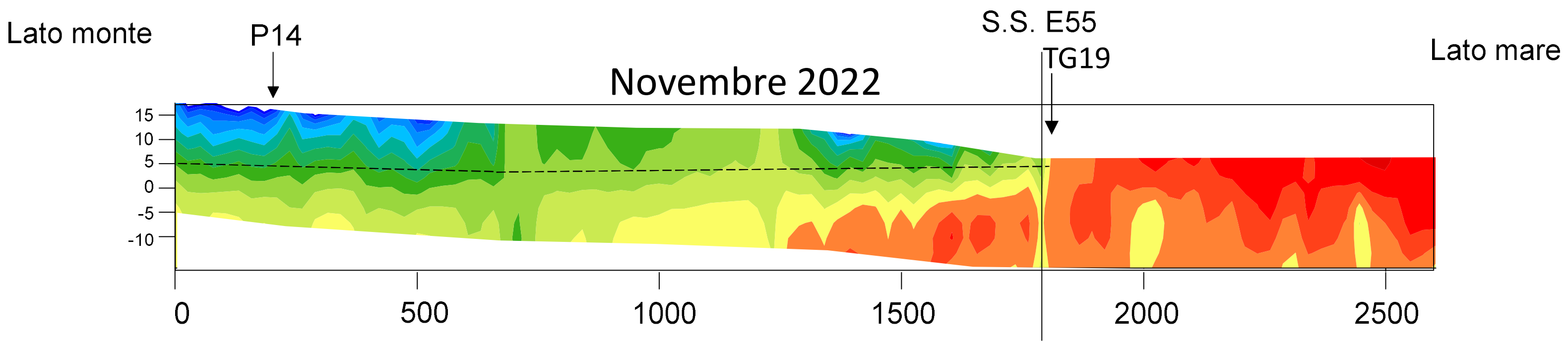
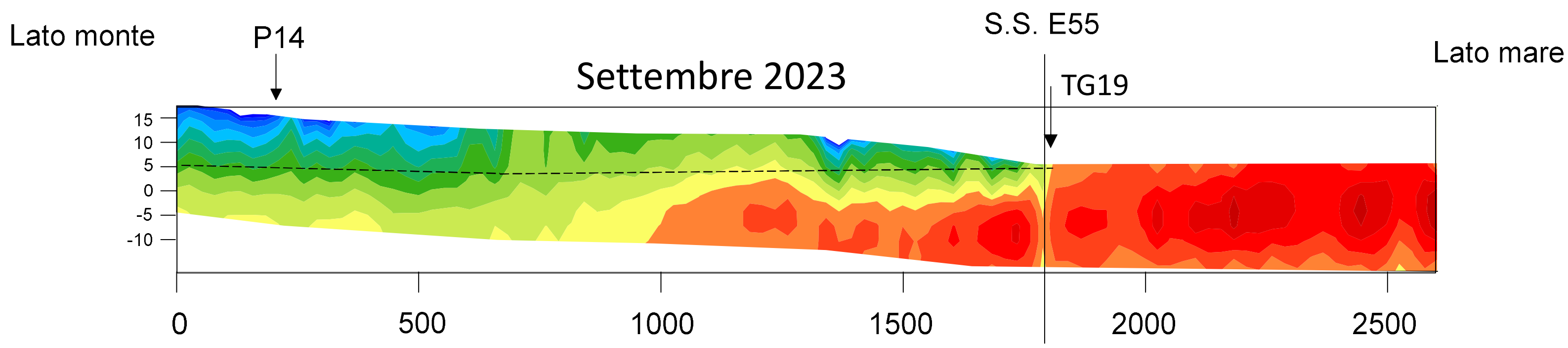
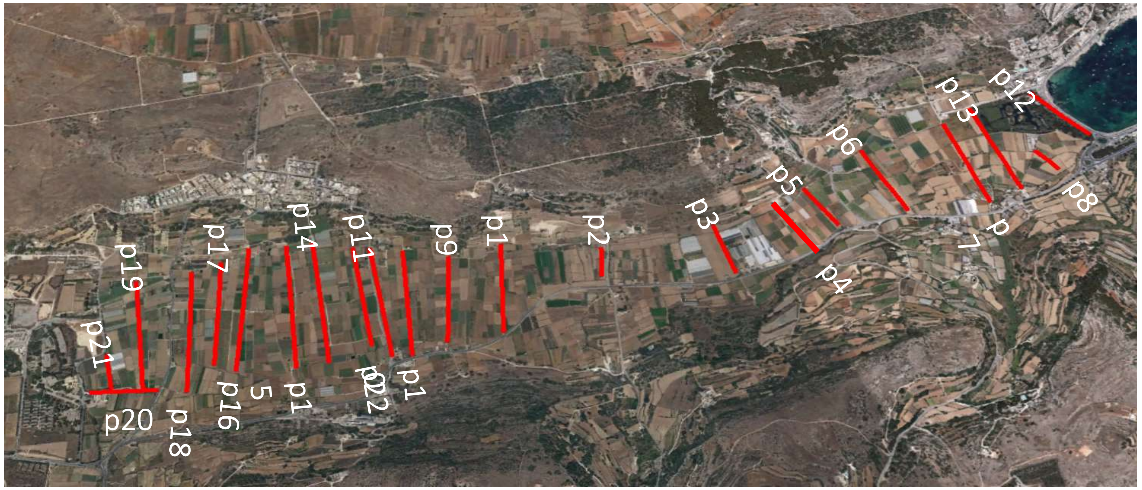




Case study 3 – Mapping saltwater intrusion via EMI technique in Maltese Island



De Carlo L., Turturro A C., Caputo M C ., Sapiano M., Mamo J, Balzan O, Galea G, Schembri M . Mapping saltwater intrusion via Electromagnetic Induction (EMI) for planning a Managed Aquifer Recharge (MAR) facility in Maltese Island submitted to Acque Sotterranee - Italian Journal of Groundwater

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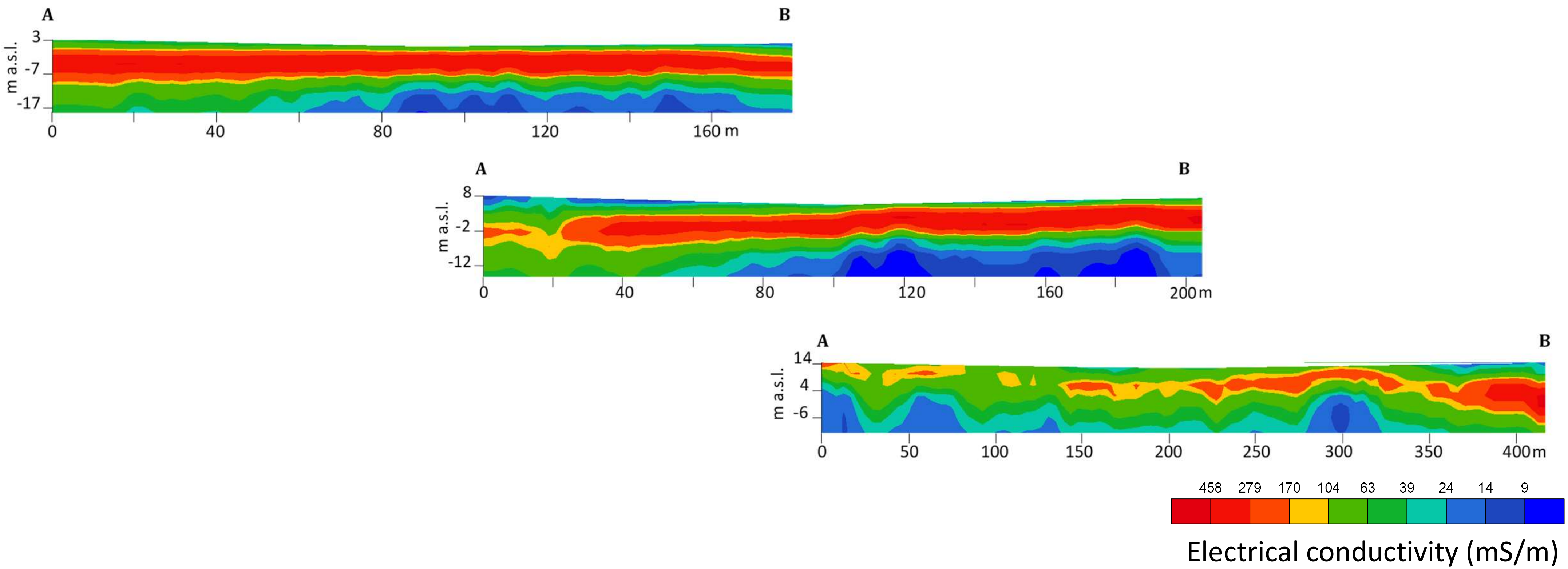

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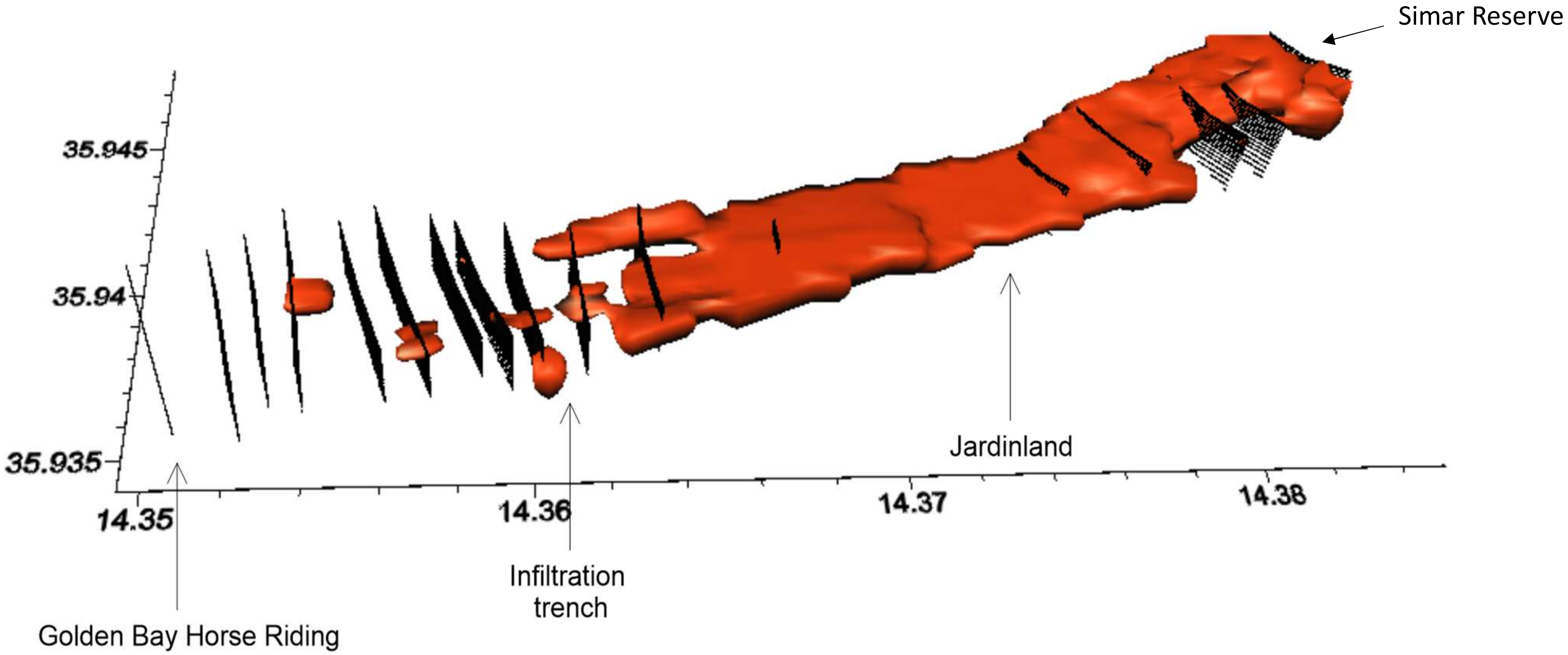

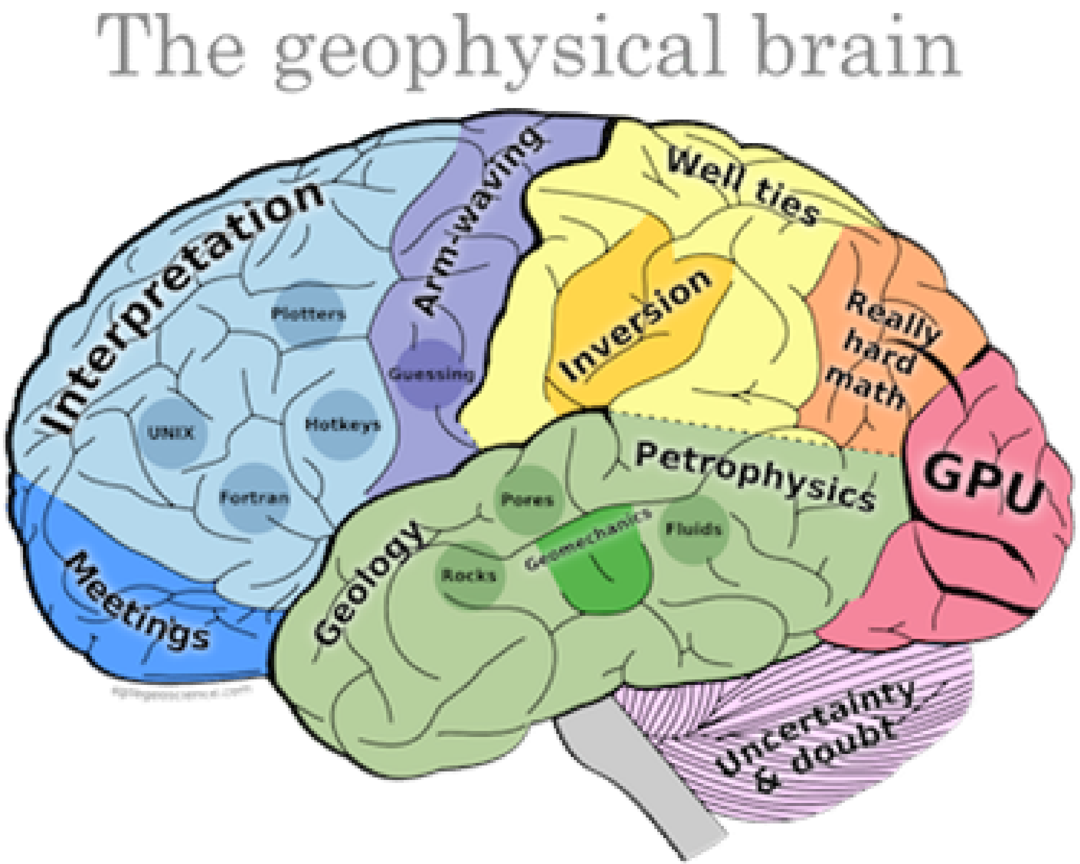

Thank you for your attention!