What is ERT?

Understanding ERT

Electrical Resistivity Tomography

Electrical Resistivity Tomography (ERT) is a geophysical suvery, and therefore, it energizes the earth in order to get some information about it. The main product of ERT is the visualization of the subsurface structure by looking at its resistivity distribution, and this is achieved this by injecting a known amount of direct current (DC) at strategic points throughout an entire surface and measuring the resulting voltage on each of them, thus being able to calculate its resistivity (actually an apparent resistivity). Finally, as in every tomography method, we solve the inverse problem for our data, obtaining a visual representation of who caused the resistivity that we measured.

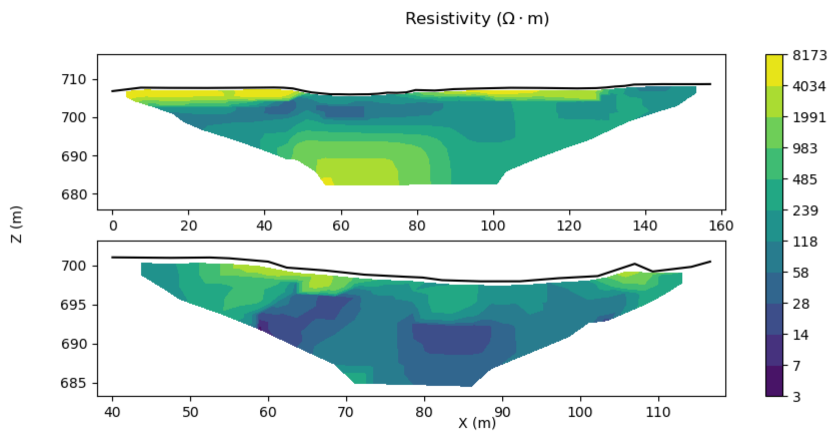

Figure 1: ERT plot from `.xlsx` data from lhalloran/ERTplot.

ERT is applied as a non-invasive technique for geological or hydrological subsurface structure detection, to finding pollution leakages, and since the 1940s it is being used for mineral exploration[1].

This method demands simple equipment and provides good spatial resolution. The following document will discuss about some whys about ERT and its mathematical and physics principles.

Why resistivity?

Electrical resistivity ρ $(\Omega \cdot m)$ is a bulk property of materials that characterizes how much they oppose the flow of electrical current. Materials with low resistivity are called conductors, while those with high resistivity are called insulators. Resistivity is the reciprocal of electrical conductivity σ $(\frac{\text{siemens}}{m})$, which is the ability of a material to conduct electric current.

[1] In the 1940s, Andrey Nikolayevich worked on solving the inverse problem for the not yet formalized ERT technique, managing to discover large deposits of copper without any help from computers.

Both resistivity and conductivity are *intensive properties*[2], which mans that they do not depend on the amount of material. This means that, by visualizing the subsurface resistivity distribution, we are also viewing at the material distribution, and we can easily distinguish between conductive and insulating materials (e.g. minerals and rocks).

The figure below shows the resistivity range of some common subsurface materials.

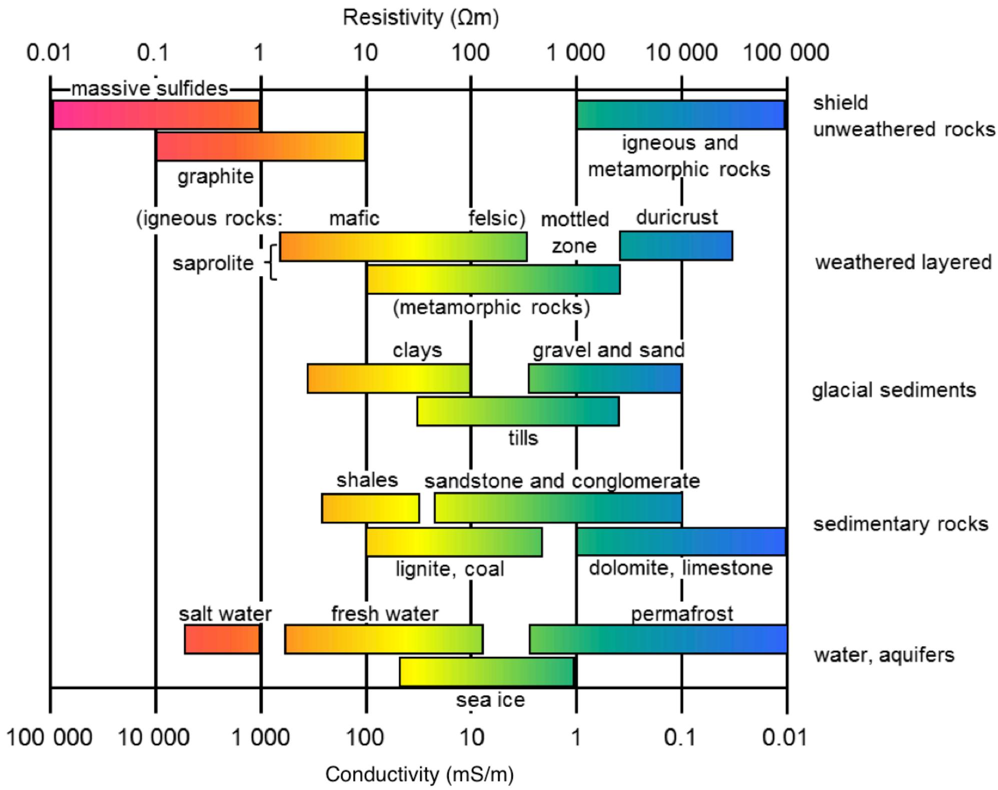

Figure 2: Electrical conductivity and resistivity of common rocks.

Note that there is no absolute value for resistivity, in our measures, resistivity will depend on many factors like:

- Porosity of material (how much empty space it has), which increases resistivity.
- Moisture content, which may increase or decrease resistivity depending on the material.
- Temperature[3], hydraulic permeability, etc.

[2]Not to be confused with their *extensive* versions: resistance and conductance.

[3]For better precision, some resistivity tables add an additional column with the *Temperature coefficient* (K^{-1}) of the material.