# ERT surveys

Understanding ERT

# ERT survey

In the context of geophysics, surveying is the process of collecting geophysical data in form of signals to indirecly determine the subsurface properties and its spacial structure.

> Geophysical surveys are essentially source-response geological studies; source being the natural fields of the earth (passive methods) or by artificially energizing the earth (active methods) and the responses are interpreted as due to the geological variations. (Gupta and Ramamurty 2022)

Geophysical survey methods are separated by the type of energy source used to excite the subsurface[1]. ERT falls into the category of electrical methods.

## Injecting DC current into the ground

So, ERT energizes the earth by injecting current into the ground. Here we need to moved beyond the image of current flowing linearly through a wire. In any 3D shaped body, electrical current is not constrained to follow a single path.

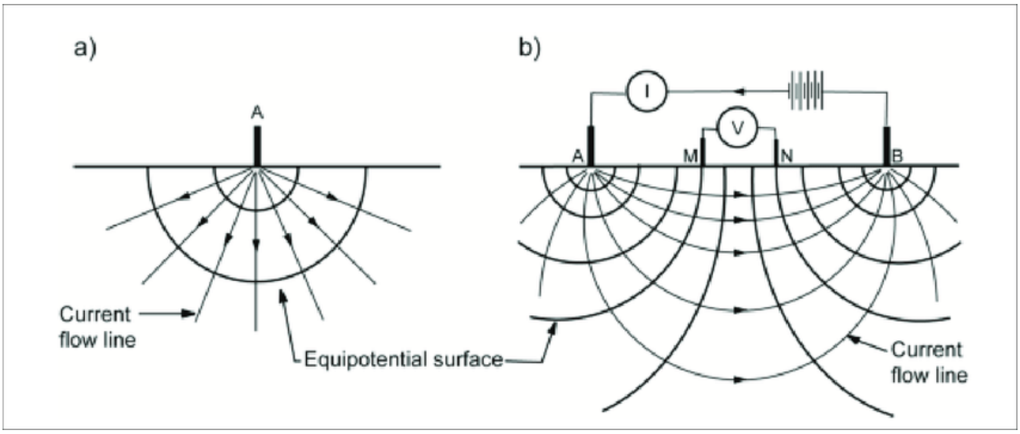


Figure 1: Simplified current flow lines and equipotential surfaces arising from (a) a single current source and from (b) a set of current electrodes (a source and sink).

In the Figure 1 above, a) shows how current flows when injected into the ground through a single electrode. In ERT, two electrodes (A and B) are used to inject current into the ground, as shown in b)[2]. The current flows from the positive electrode into

[1]In general, we distinguish from magnetic, electromagnetic, seismic, and electrical methods.

[2]Here, you are looking at 2D current flow lines. However, is worth to mention that current actually flows trough the 3D space. a) is radially symmetric, while b) *seems* ellipsoidal. Try to think of how the current flow lines would look like in the subsurface 3D space.

the ground and back to the negative one. Electrodes M are N are used to measure the potential difference between them. Later, we will see why this is important.

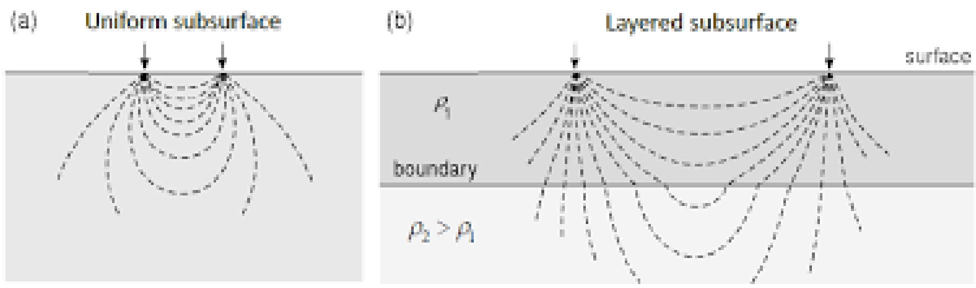


Figure 2: Current flow lines in uniform and non-uniform earth models.

Back into reality, since Earth is not uniform, current flow lines are distorted by the presence of resistivity heterogeneities. Current density ($J$), the amount of electric current flowing per unit cross-sectional area of a material, increases in areas of low resistivity and decreases in areas of high resistivity. This current propagation is described by Ohm's law[3]:

$$J = \sigma E \tag{1}$$

Where:

- $J$ is the current density (SI unit: $\frac{A}{m^2}$);
- $\sigma$ is the conductivity (SI unit: $\frac{S}{m}$ or $\frac{1}{\Omega m}$);
- $E$ is the electric field (SI unit: $\frac{V}{m}$ or $\frac{N}{C}$).

You can think of this as "The amount of current passing through a cross sectional area $J$ is proportional to the existing electric field $E$, where the conductivity $\sigma$ is the constant of proportionality: current density increases within conductive regions, and decreases within resistive regions".

## Measuring potential difference

Potential difference ($V$) is measured between two points, in this case, between electrodes M and N.

[3]Physicists use the term Ohm's law to refer to the many forms on which the relation ($V = IR$) can be represented. You can think on this form as a 3D version of this relation, since it involves the flow of current through a material.

# Bibliography

Gupta, D., & Ramamurty, V. (2022). *National geophysical mapping in geological survey of india—an impetus to mineral exploration.*