Geothermal

TEM and MT Methods

Resistivity surveys, as carried out by Iceland GeoSurvey yield important information on physical properties of geothermal systems. The TEM survey delineates the uppermost one km of the reservoir and the MT survey may detect heat flow zones at greater depths, up to tens of km.

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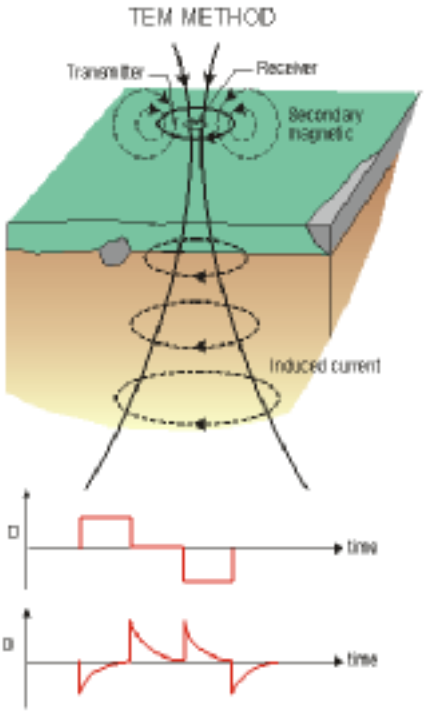
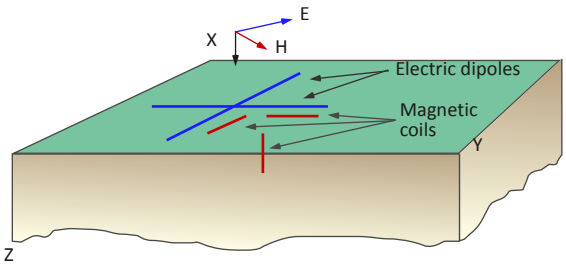
TEM (Transient Electro Magnetic)



In the TEM soundings electrical current is transmitted into a big loop of wire (300x300 m) laid on the ground. This current produces a magnetic field. The current is abruptly turned off and the decaying magnetic field causes induction currents in the ground. The strength of the induced currents is dependent on the resistivity structure below the survey site. The ground response is measured by a small coil in the center of the big transmitting loop. The time decaying signal is generally measured from 88 µs to 70 ms from the time of turning of the current.

The TEM soundings can survey the ground resistivity down to about ½ - 1 km, depending on the resistivity. For low subsurface resistivity the depth of penetration can be as low as a few hundred meters, but in higher resistivity surroundings it is possible to explore the resistivity down to about 1 km in favorable conditions.

MT (Magneto Telluric)



In the MT method, the natural fluctuations of the earth's magnetic field are used as signal source. Those fluctuations induce currents in the ground and are measured on the surface with two horizontal and orthogonal electrical dipoles (Ex and Ey) and the magnetic field is measured in three orthogonal directions (Hx, Hy and Hz). It is customary to set the x direction to the magnetic north direction. For simple earth (i.e. homogenous or layered) the electrical field is coherent with its orthogonal source magnetic field (i.e. Ex correlates with Hy, and Ey with Hx) and this relation depends on the earth's resistivity structure.

$$\mathbf{E} = \begin{bmatrix} E_x \\ E_y \end{bmatrix} = \begin{bmatrix} Z_{xx} & Z_{xy} \\ Z_{yx} & Z_{yy} \end{bmatrix} \begin{bmatrix} H_x \\ H_y \end{bmatrix} = \mathbf{Z}\mathbf{H}$$

The MT sites are deployed each day and picked up the following morning. How many depends on the number of instruments. This gives about 20 hours of continuous time series, and MT data in the range from 320 Hz (0.003 sec) to about 1000 seconds. The short-period MT data (high frequency) is mainly dependent on the shallow structures due to their short depth of penetration, whereas the long period data are mainly dependent on the deeper structures. The MT method has the greatest exploration depth of all resistivity methods (some tens up to hundreds of kilometers) and is practically the only method for studying deep resistivity structures. The exploration depth of the MT soundings varies, depending on data quality and the resistivity structure at the measuring site.

The TEM and MT methods are measured at the same site and the TEM results are used for static shift correction of the MT data. This effect is caused by local resistivity inhomogeneities and is commonly seen in MT data, especially in volcanic areas and causes shift in the apparent resistivity curve. The correction is done by a joint interpretation (inversion) of the TEM and the MT data where the MT shift parameter is one of the solved parameters.

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