C8 Overview of electrical and electromagnetic methods

- DC resistivity exploration uses signals at **zero frequency**. The electric current is constant and there is no associated magnetic field.

- Electromagnetic (EM) methods use a **time varying** electromagnetic field to image the electrical resistivity of the ground. There are many different techniques but all are based on the principal of **EM induction**

- EM methods can be classified in several ways

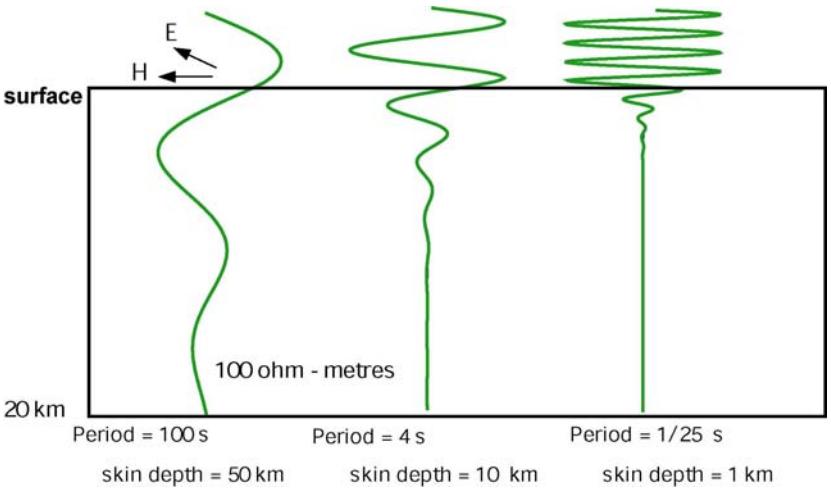
Natural source	*Artificial source (controlled source)*
Time-domain	*Frequency domain*
Ground-based	*Airborne*

Magnetotellurics (MT)

- A natural source method that uses aurora and distant lightening as sources of EM waves

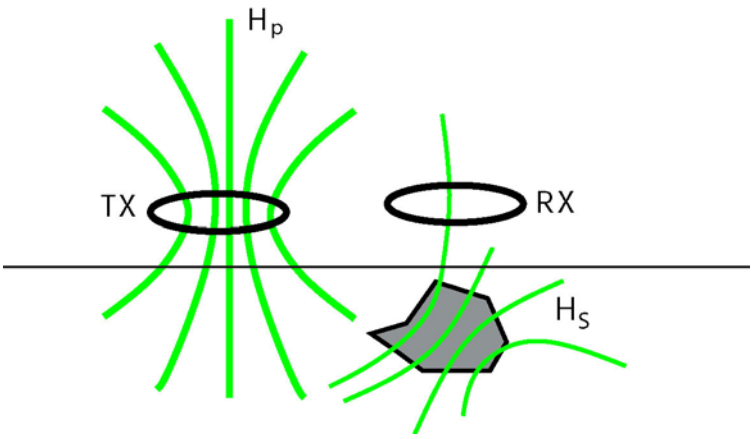
- Works through the skin-depth phenomena (lower frequency penetrates deeper into Earth)

- Resistivity of the earth is proportional to $(E/H)^2$ at each frequency



- MT is commonly applied in many areas *e.g.* geothermal exploration, mineral exploration, hydrogeology, tectonic studies and also hydrocarbon exploration.

Loop-loop electromagnetic methods



- AC flows in transmitter (TX) loop and generates a dipolar primary magnetic field (H_P)
- If conductive bodies are present in the earth, secondary electric currents are induced. These are exactly the same as eddy currents in transformers.
- Secondary currents generate a secondary magnetic field (H_s)
- Total magnetic field ($H_T = H_P + H_s$) induces a voltage in the receiver (RX) loop. It can be shown that this voltage depends on the conductivity of the Earth.
- Measurements are made at many locations and variations in conductivity can be mapped. This effectively measures the mutual induction between the two loops and the instrument is essentially a sophisticated metal detector.
- Common applications include: water table studies, soil salinity measurements, mineral exploration (both airborne and ground based).
- A major advantage is that no exposed, high voltage electrodes are used. Electric current is made to flow in the Earth through induction.

MJU November 2005