PT. RAVI SHANKAR SHUKLA UNIVERSITY

Disclaimer:

This presentation is a part of the assignment for MSc III Semester Mineral Exploration theory paper. This is an attempt to enable the students to collect and review the literature, prepare powerpoint presentation and present the work, independently. The data and literature used here has been taken from various sources, and duly acknowledged. This can help as a guideline, and should not be treated as final.

October 2016

EQUIPOTENTIAL METHOD

PRESENTED BY

TULSI YADAV

M. SC 3rd Sem

ELECTRICAL RESISTIVITY SURVEYS for Ground Water Investigation

Introduction:

In Geophysical prospecting different methods are used for tracing Ground water, Oil & Minerals.

The Electrical Resistivity method is widely used in groundwater investigation because of :-

- Relatively direct & simple response to the groundwater conditions.
- Low cost of survey &
- Easy field data interpretation procedures.

ELECTRICAL RESISTIVITY SURVEYS

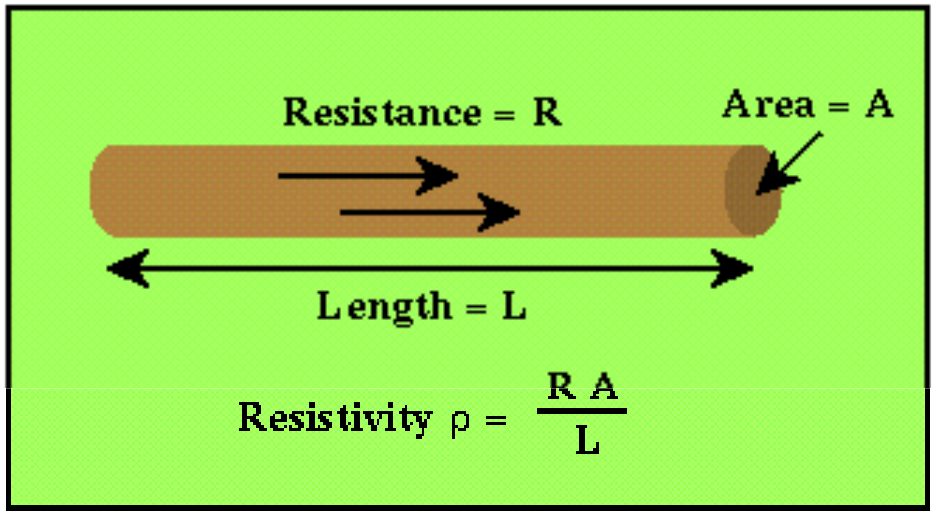
- **Started by American Scientist *SCHLUMBERGER* during year 1912 -1914**
- **It is based on Ohm's Law**
- **Resistivity of a material is defined as the resistance in ohm between opposite faces of a unit cube (l=1 m, A= 1m^2) of the material**
- **If the measurement is made over a semi – infinite space of homogeneous and isotropic material, then it will be a true resistivity**
- **If medium is inhomogeneous or anisotropic then it will be a apparent resistivity**

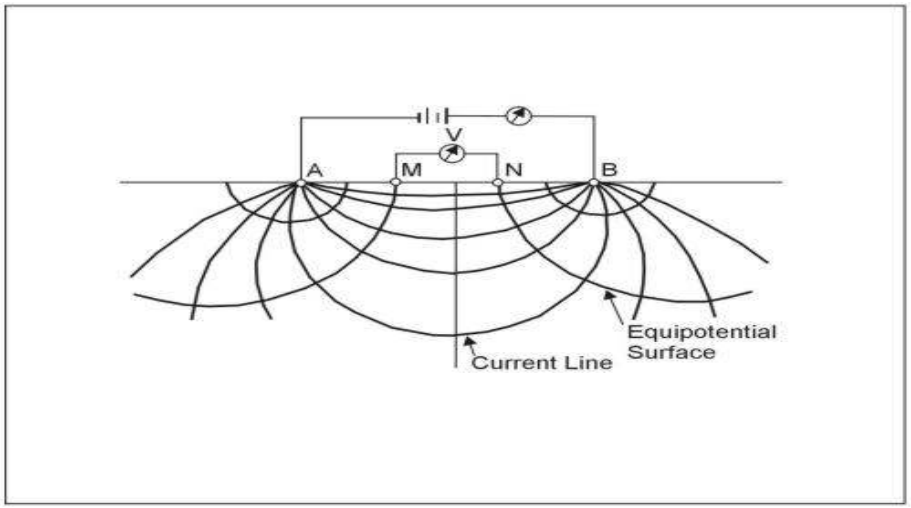
The Electrical Resistivity of a rock depends on:

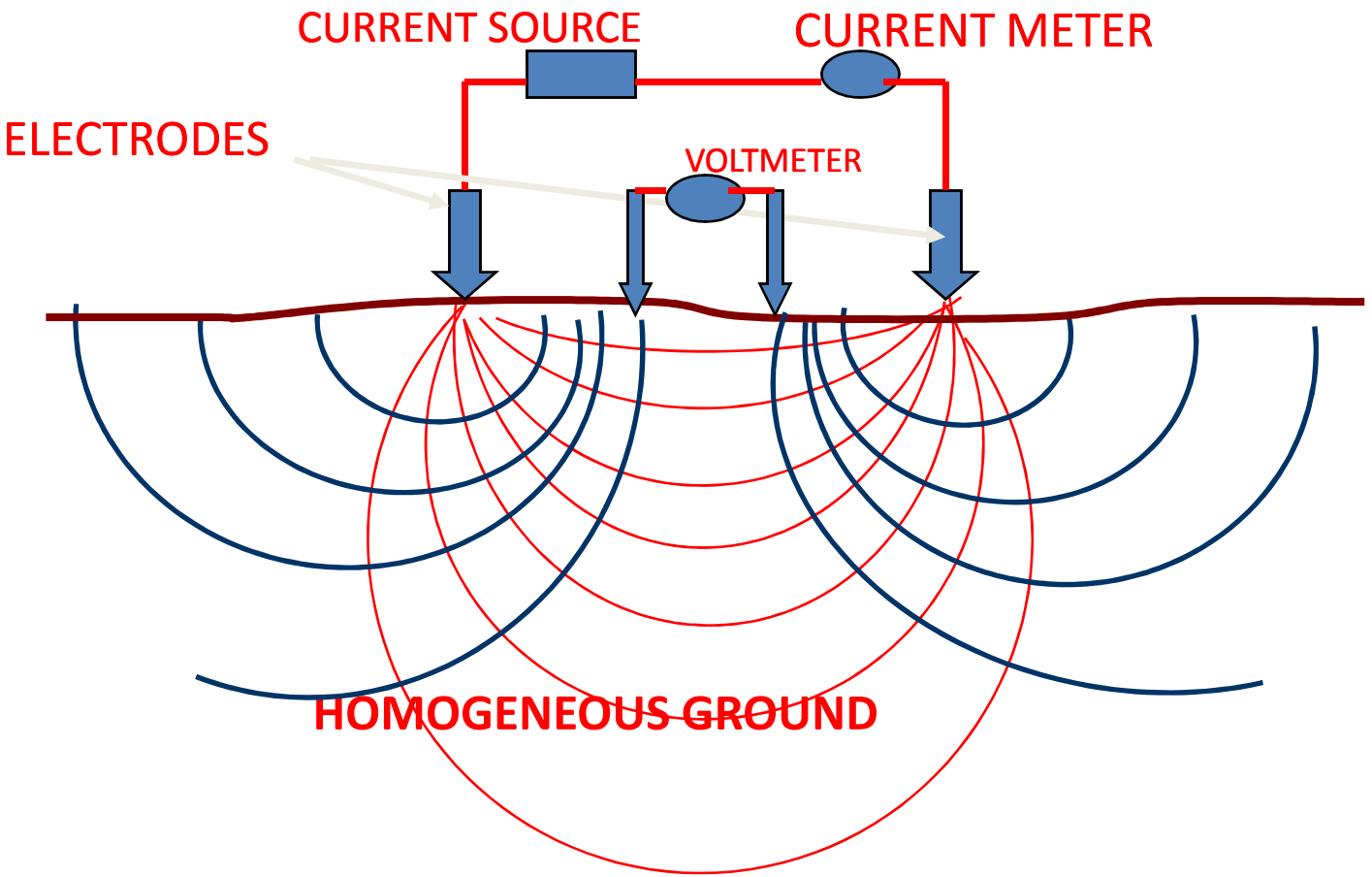
- The nature of the formation.
- Porosity & Permeability.
- Degree of saturation.
- Grain size and compactness.
- Presence of minerals in the rocks.
- Water content and Salinity

Resistivity Methods

Principle – Ohm's Law





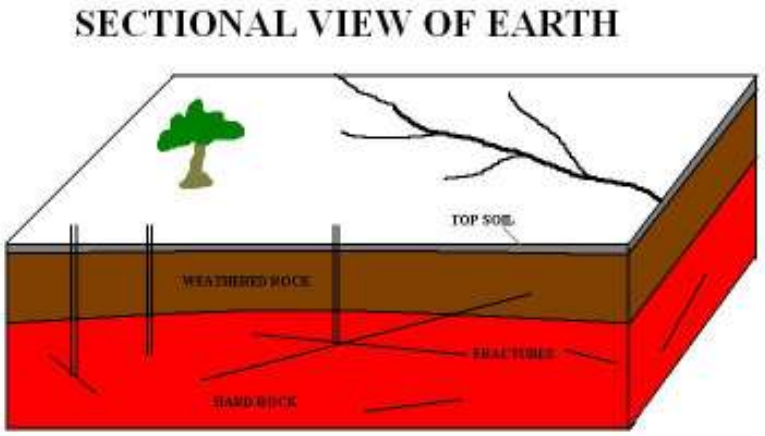

CURRENT SOURCE
CURRENT METER
ELECTRODES
VOLTMETER
HOMOGENEOUS GROUND

ASSUMPTIONS IN RESISTIVITY METHOD

- The subsurface geoelectrical layer, are parallel to the surface of measurement and are laterally extensive. In field it would suffice if the dip is within 15 degrees, and with respect to the station of measurement the layers are radially extensive at least within a circle of radius not less than the maximum separation attained between the end electrodes that in turn obviates lateral inhomogeneties.
- The geoelectrical layers are homogeneous and isotropic, i.e., the electrical resistivity of a layer does not change laterally and vertically, except at the interface above and below.
- The last or bottom layer possesses infinite thickness

The Geophysical Electrical Resistivity method is mainly used for :-

- ✓ To know vertical discontinuities.
- ✓ To know lateral inhomogeneties
- ✓ To know the depth of basement
- ✓ To locate suitable site for Drilling
- ✓ To locate fracture(Hard Rocks)
- ✓ To know overburden thickness
- ✓ To locate Dykes & Faults
- ✓ To delineate the fresh and saltwater interface
- ✓ Study of seawater intrusion in coastal aquifers.



Instrumentation :

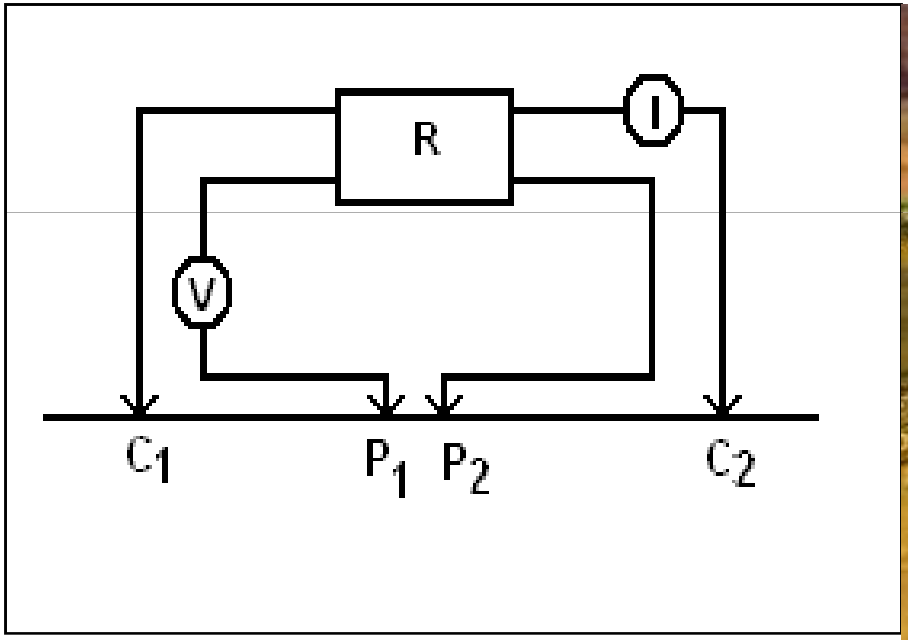
Generally two types of resistivity meters are deployed for the ground water water investigation and following tools are required for the survey:

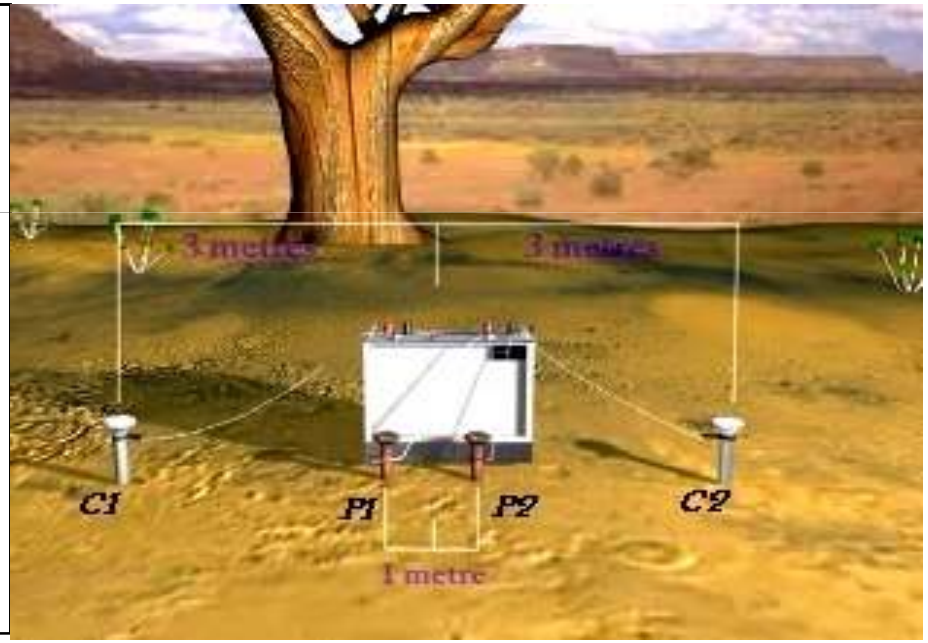
- D.C. Resistivity meter/ Low frequency A.C. Resistivity meter.
- Current Electrode-2 no & Potential Electrodes 2 nos.
- Two hammers (4-5 kg Each).
- Two steel/ aluminum frame winches/reels each with 500 – 600 m of thick PVC insulated, multi – strand thin cable of low resistance(for current).
- Two steel/ aluminum frame winches/reels each with 200 m of thick PVC insulated, multi – strand thin cable of low resistance (for potential).

- Measuring tape- 2 nos (100m).
- Crocodile clips, banana pin connectors & insulation tapes.
- Power pack (in case of D.C.instrument).
- Porous pots and copper sulphate solutions.

- Survey umbrellas& Chair.
- Prismatic compass /Brunton Compass.
- Buckets and mug.
- GPS

➢The Electrical Resistivity survey is based on measurement of potential difference (V) between one pair of potential electrodes (P1& P2) by sending a known amount of current(I) through another pair of current electrodes (C1& C2). The ratio of V/I multiplied by a constant (Configuration factor) enables to measure Electrical Resistivity of the formation.





➢The Resistivity value so obtained is termed as Apparent Resistivity which is the characteristic of the subsurface formation under investigation.

Mode of Surveys

- PROFILING
  - To study lateral homogeneity like lineaments, fault, dyke, etc
  - Four electrode moves at a time
  - Interpretation is simple
  - Measurement made across the structure
- SOUNDING
  - To study vertical homogeneity at a point
  - Two electrode move at a point
  - Interpretation is little lengthy

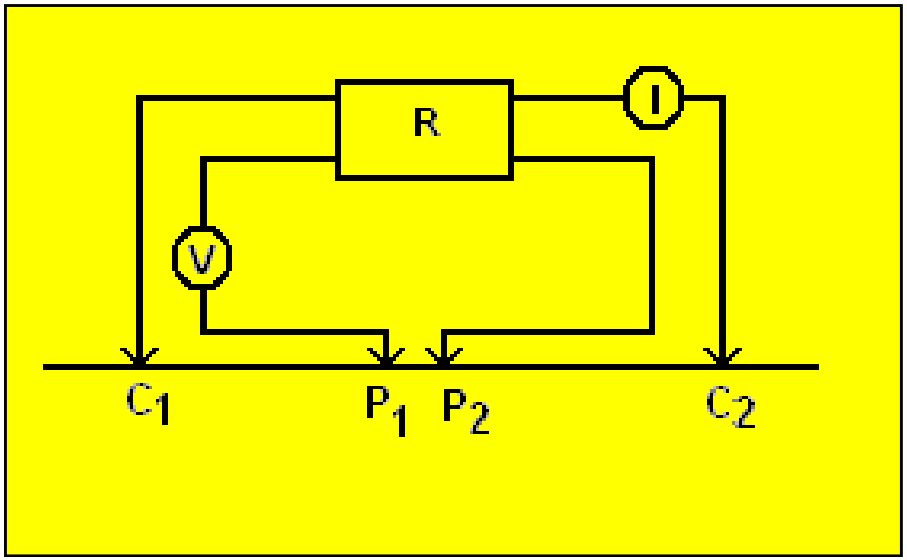
Types of Survey:

Depending on electrode configuration the following methods are used for ground water exploration :

- **Wenner configuration**
- **Schlumberger configuration**
- **Pole-di-pole method**

Out of the above all methods Wenner and Schlumberger methods are widely used for profiling and vertical electrical sounding.

2.Schlumberger Configuration:



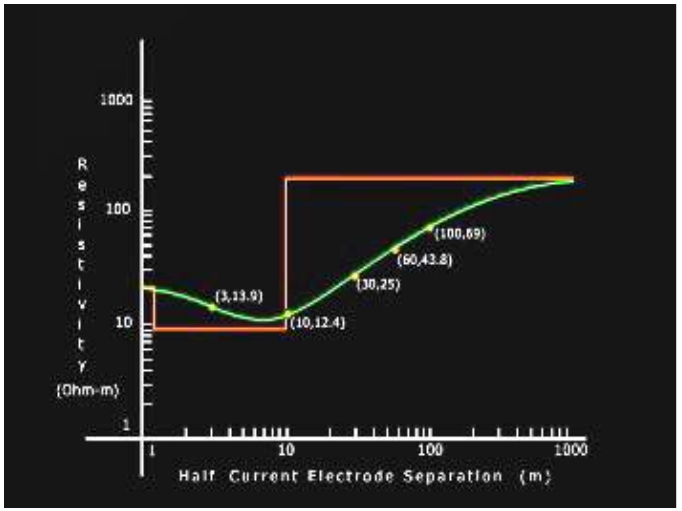
The formula for measuring the electrical resistivity (apparent) is

$$\rho_a = \pi R \frac{[(AB/2)^2 - (MN/2)^2/]}{MN}$$

Where AB/2 = Half current electrode separation

MN/2 = Half potential electrode separation

R = V/ I (V= Voltage) (I= Current)



Equipotential method

- According to Parasnis (1973), the equipotential method was one of the
- first electrical methods and was used as far back as 1912 by
- Schlumberger. As explained elsewhere in this volume, when electric
- energy is applied to two points at the ground surface, an electric current
- will flow between them because of their difference in electrical potential.

If the medium between the two electrodes is homogeneous, the current and potential distribution is regular and may be calculated. When good or poor conductors are imbedded in this homogeneous medium, a distortion of the electrical field occurs. Good conductors have a tendency to attract the current lines toward them, whereas poor conductors force current flow away. Theoretically, it should be possible to detect bodies of different
conductivity by measuring the geometric pattern of these current lines. In
practice, this cannot be done with sufficient accuracy; it is necessary to
determine the direction in which no current flows by locating points that
have no potential difference (Heiland, 1940). The lines of identical electrical potential, called equipotential lines, are at right angles to the
current lines. The equipotentials are circles in the immediate vicinity of the electrodes.

In the past, equipotentials were traced individually in the field by using a
null galvanometer, but such a procedure was tedious and time-consuming.
The modern practice is to measure the electric voltage at each observation
point with respect to a fixed point, plot the results, and draw contours. The
equipotential method was used extensively in the early days of geophysics,
but has been almost completely replaced by modern resistivity and electromagnetic methods. When the method is used, it is usually in are connaissance mode, and quantitative interpretation of equipotential surveys is rarely attempted.

Thankyou