SURFACE BASED GROUND WATER EXPLORATION METHOD

The rising demand of groundwater for various purpose such as drinking and other requirements is being increasing constantly. Therefore identification of aquifer over large area are under progress. The prospecting for groundwater is a complicated process. It involves a detailed geological study of the area followed by physical investigation, analysis and interpretation of data obtained from different source.

The geological investigations involves :

Geological Maps

Areal Photographs

Test Drilling.

Surface Geophysical Method:

Geophysical exploration aims at determining the geophysical structure by surface measurement of physical quantities.

Geophysical Prospecting:

This method involves the measurement of different force field used to detect variation in physical properties of rock and some electrical phenomenon related to mineral deposit.

The major geophysical methods are : electrical resistivity, magnetic , gravity etc.

The geophysical method measures the electrical resistivity, velocity of shock waves, gravitational field and magnetic field. The presence of groundwater has largely to be deduced from the indicator geological structure through the resistivity method can give some indication of water containing dissolved salts and seismic wave determination are also influenced method.

Electrical Resistivity Method:

The electrical method is the most suitable for groundwater exploration. It is easy to employs and the equipments is easy to handle from place to place. Information about aquifer, water table, salinities can be obtained from such surveys.

Resistivity is defined as the resistance in ohm between opposite faces of a meter cube of a material and is measured in ohm m^2/m or simply ohm/m.

The resitivity of a material of length L and cross sectional area A having a resistance R is given by:

$$\rho = RA/L$$

Resistivity of consolidated and unconsolidated rocks ranges widely being high for dense impervious rocks, medium for porous rock containing water and low for Clays and saline water.

Resistivity of unconsolidated aquifer depends almost entirely upon the extent and the quality of pore water as follows:

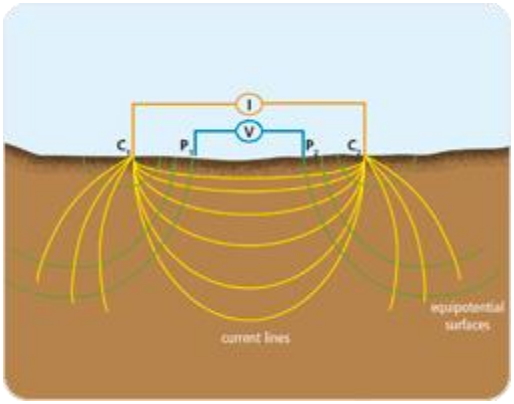
$$\rho / p_w = 3\text{-}n/2n$$

ρ= resistivity of an isotropic aquifer

p_w = resistivity of groundwater

n = porosity of the aquifer

To determine the resistivity of formation, electric current is passed through ground across a pair of electrode C. The potential difference between two intermediate C points in the line of the electrode is measured through electrode P. P consist of Porous cup filled with saturated Copper sulphate solution . A low frequency alternative current or a reversible direct current is used to minimize polarization.



The flow line and equipotential line for flow of current through a homogeneous and isotropic medium are shown in the figure. The apparent resistivity is given by:

$$\rho_a = 2\pi V/I\left(\frac{1}{\frac{1}{l1}-\frac{1}{l2}-\frac{1}{l1}+\frac{1}{l2}}\right)$$

ρ_a = apparent resistivity

v = measured potential difference

I = measured current

$L_1 - L_2 =$ Distance from one of the potential electrode to the respective current Electrode

On increasing the distance between the current electrode the effective depth is increased and a different value of the apparent resistivity is obtained.

Various arrangement for spacing electrode have been standardized. Wenner and Schlumberger arrangements are most common.

In Schlumberger arrangement the potential electrode are placed at third point between the current electrode. If the spacing between adjacent electrode is L;

$$\rho_a = \pi(L^2 - b^2)/4b \ X \ V/I$$

L = spacing of current electrode.

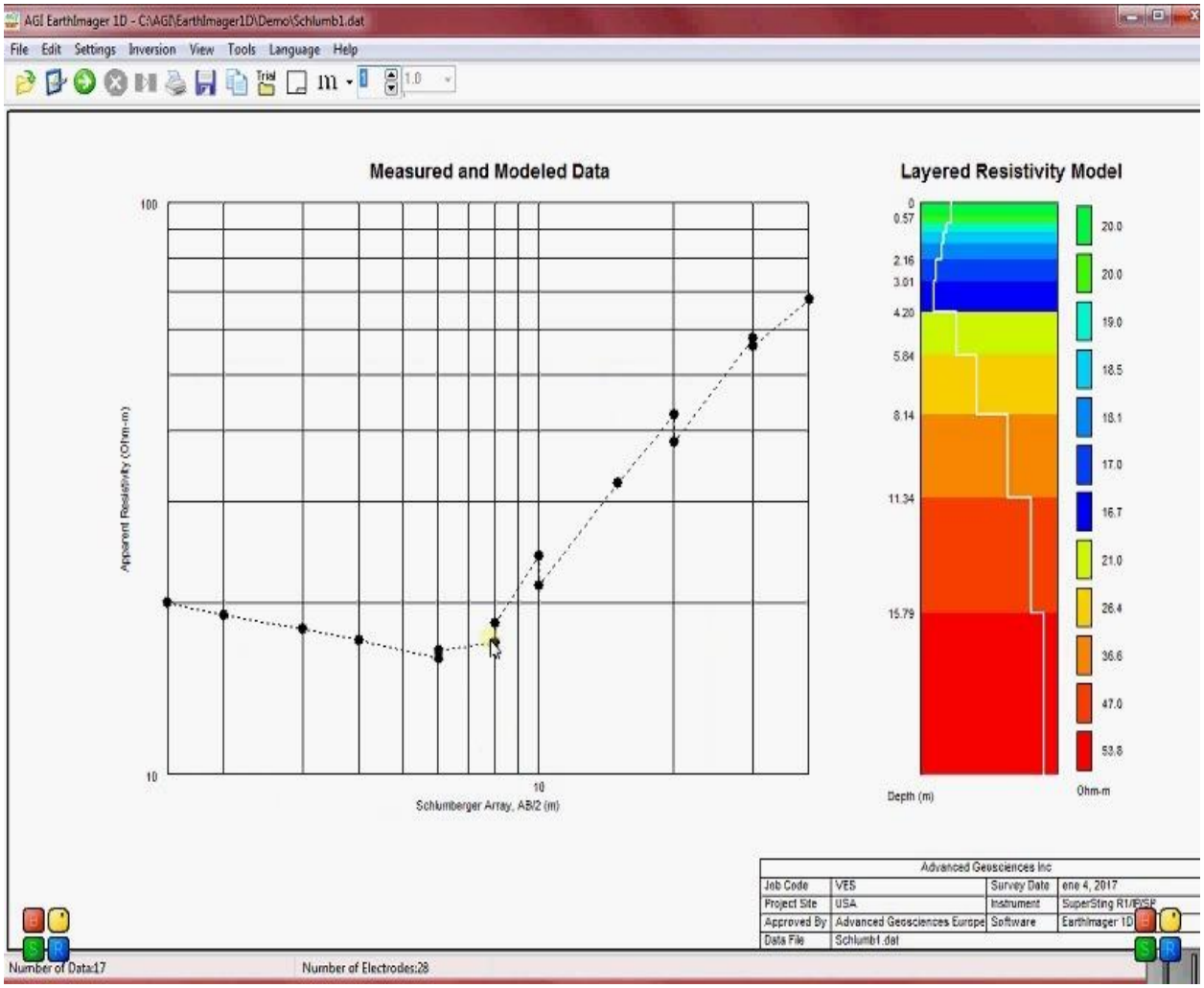
b = spacing of potential electrode.

In the Wenner arrangement the potential electrode are kept much closer together. The apparent resistivity is given by:

$$\rho_a = 2\pi LV/I$$

L has to be much larger than b and good result are obtained if L >>>b.

The most common technique for obtaining a vertical electrical sounding graph consists of determining the apparent resisitivity for various spacing of the electrode. By plotting the calculated resistivity value against the electrode spacing on a double log paper, vertical electrical sounding is obtained. The graph depict the apparent resistivity of a certain depth be the average of all resistivity from the surface to the depth of exploration. The graph can be analytically decomposed so as to yield the depth and calculated resistivity to each layer by using curve matching technique.



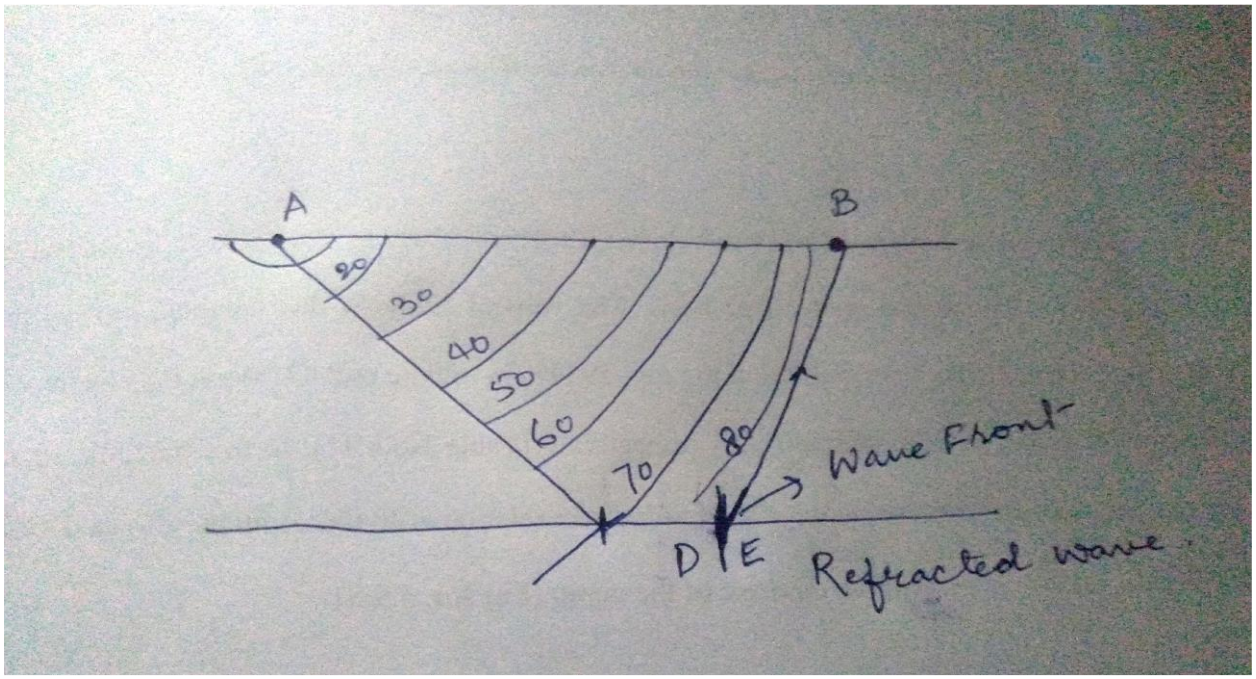
SEISMIC REFRACTION METHOD :

The velocity of seismic or elastic waves depends upon the elasticity of the carrier medium. The velocity increased with an increase in water content or decrease in porosity . In consolidated rocks and clay the wave travel at velocities higher than 2000m/sec. In unconsolidated unsaturated aquifer the velocity ranges from 500 to 1000m/sec. While saturation increases then 1000 – 2000 m/sec.

The seismic wave follow the same law of reflection and refraction as light rays are reflected by hard surface and refracted at an interface between two material with different elasticities.

Seismic refraction methods on the other hand be used within 100 m depth through in some cases these have been used for much larger depths.

In seismic refraction method the velocity of travel of a shock wave through the earth material is observed. The shock wave is generally heated by exploding dynamite seismometer also known as geophones pick ups or detector are placed on the ground in a line radiating the shock point at every 3 to 15m. These transmit electrical signal to a central amplifier and recording oscillograph which record the instant of shock and the arrivals of shock waves at various seismometer. Consider a homogeneous , unconsolidated material with water Table at elevation CD or two layer separated by a horizontal plane CD the lower layer being denser so that the velocity of seismic wave in the Lower layer than that in the Upper layer is larger than that in the upper layer. If a shock is created at a point A, energy travels out from it in hemisphere wave front. A detecting instrument placed at B would receive first the wave AB moving horizontally through the upper medium if the distance AB is small. If the distance is large , the wave moving at faster speed through the lower medium would overtake the direct wave. The waves are reflected on striking the dense medium till at certain point C, The wave become perpendicular to the boundary and the ray which is always normal to the wave front travel along the boundary.



GRAVITY METHOD:

In this method the difference in the density material are detected from the surface. Density measurement indicates voids and thus the possibility of the presence of groundwater. Difference of wall in subsurface strata can't be detected because such difference in density are not measurable at the surface.

This method may be useful for detecting thick alluvial deposits or big intrusive within an aquifer but has not much used for groundwater exploration.

MAGNETIC METHOD :

In this method the magnetic field on the ground surface is mapped and isonomalic contour are drawn. Variation of the magnetic field is normally not associated with the presence of groundwater. This method helps in specific problem like determination of large aquifer barrier which may form aquifer boundary etc.