

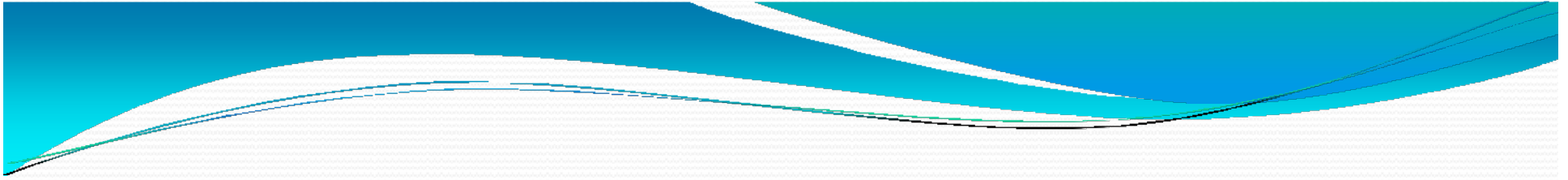
GROUND WATER EXPLORATION TECHNIQUES

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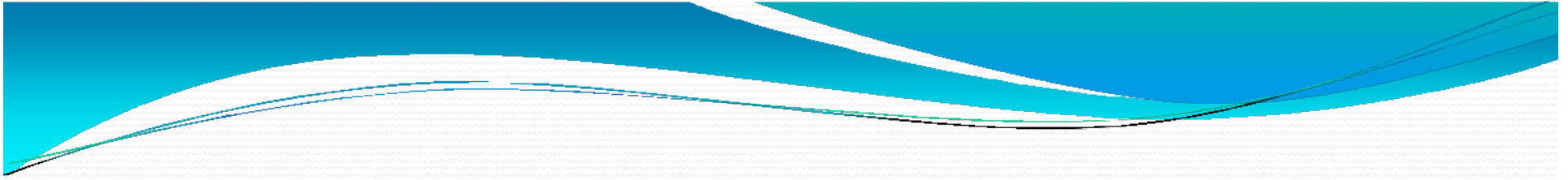


INTRODUCTION

- ❖ For the development of ground water resources in a given area, knowledge of the **occurrence and movement of ground water** is required.
- ❖ In addition the hydrological parameters of the **aquifers are needed to decide the location and type of wells.**
- ❖ The geological conditions of the area will influence the occurrence and movement of groundwater.



- Hydrology refers to the study of the laws of occurrence and movement of ground water, its chemistry and its relation to the geologic environment.
- Groundwater prospecting and exploration helps in locating groundwater and understanding some aquifer properties.



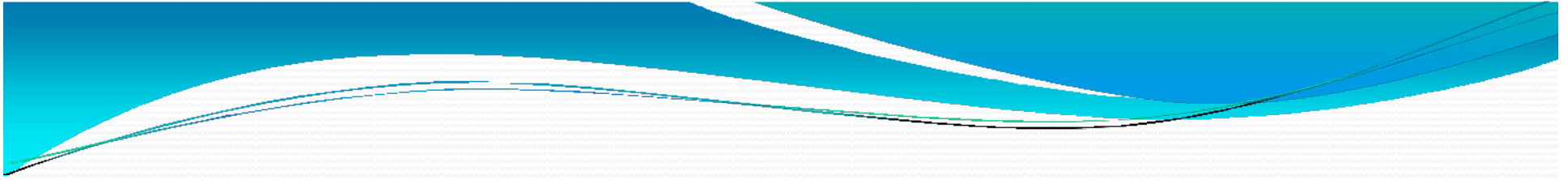
- Methods for exploration of groundwater may be classified as follows:

- Geophysical methods

- Electric logging
- Gamma-ray logging
- Electrical resistivity surveying
- Electrical resistivity method
- Seismic refraction surveying



- Geophysical methods provide indirect evidence of the sub-surface formations that indicates whether the formations may possibly be aquifers.
- They measure other properties of the materials which determine whether a formation may be sufficiently porous and permeable to serve as an aquifer.
- Geophysical methods are classified as surface-type and bore hole type operations, depending on whether the measurements are made at or above the ground surface.



- The commonly use geophysical methods of groundwater are the electric resistivity method and seismic refraction method.
 - **NOTE: Gravel , sand, sandstones and limestones are best water carriers** even though all such deposits may not yield significant quantities of water.
 - **Clay formations, shale and crystalline rocks** does not yield enough water for exploration.



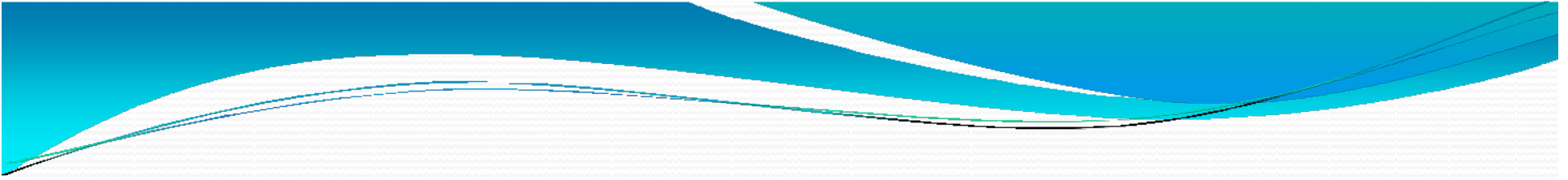
Electrical Resistivity Method:

- Measurement of electrical resistivity show values that vary with certain aquifer characteristics.
- Clean sand with fresh water show relatively high resistivity.
- A sand containing clay shows a lower resistivity.
- By measuring the electrical resistivity of two materials, the higher the resistivity the better is the aquifer.
- **High resistive sands, gravels may be differentiated from low resistive materials such as clay.**

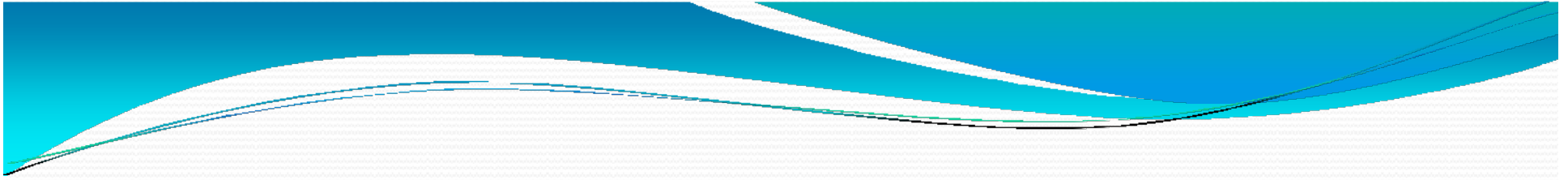


Electric logging

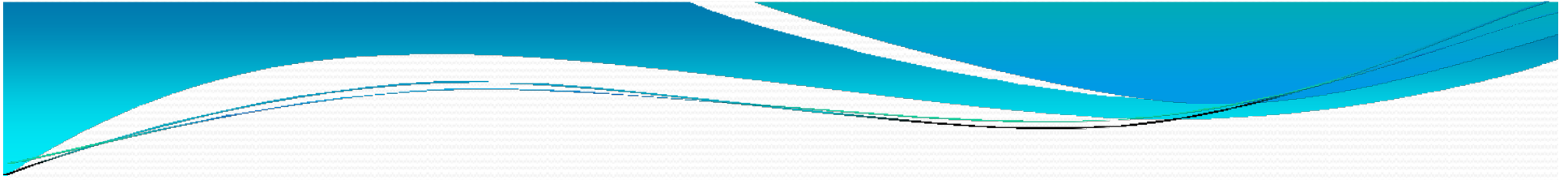
- It is the most common methods.
- An electric log consists of a record of the apparent resistivities of the sub-surface formations and the spontaneous potentials generated in the bore-hole, both plotted in the terms of depth below the ground surface.
- These two properties are related indirectly to the character of the sub-surface formation and to the quality of water contained in them.
- They can only be measured mud filled, **uncased bore-hole** (**borehole that has no pipe or lining**).



- Many types of electrode arrangements are employed for electric logging.
- Instrumentation for logging varies from simple hand operated portable equipment to truck mounted, power driven equipment.
- Equipments depends on:
 - Depth of hole and its diameter



- Interpretation of aquifer quality is affected by various parameters such as:
- Diameter of the bore hole
- Types of fluid in the hole
- Chemical quality of the formation of water,
- Porosity of formation
- Degree of mud into the formation
- Electrode arrangement used in the operation

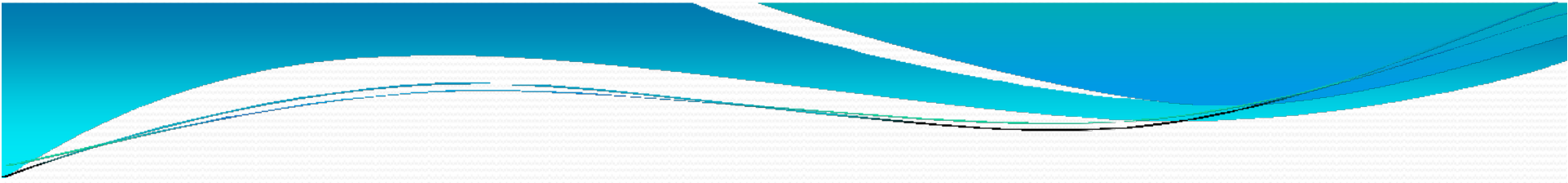


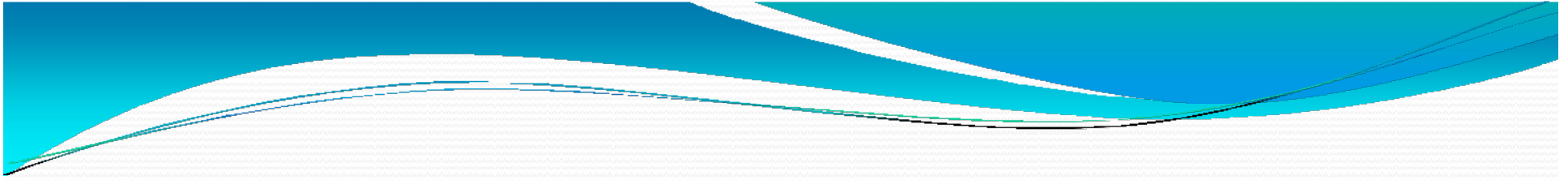
- The chemical quality of water is an important parameter.
- The formation resistivity varies inversely with the dissolved solid content of the formation.
- A clean sand saturated with water having 600 ppm dissolved solids will show a formation resistivity about half that of the same sand containing water with 300 ppm dissolved solid.



Gamma- ray logging

- It is based on measuring the natural radiation of gamma-rays from certain radioactive elements that occur in varying amounts in sub-surface formations.
- The log is a diagram showing the relative emission of gamma-rays, measured in counts per second, plotted against depths below the surface.
- The curve obtained is similar in appearance to the resistivity curve of an electric log.

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- Equipment is same as that for electric logging, except the well probe and detecting device.
 - Logs can be made using a suitable counter for the down- the hole sensing unit.
 - The counting circuit at the surface converts the number of electric pulses per second received from the probe into voltages which are continuously recorded on a strip of tape or film as the probe is pulled up the hole.



- Gamma ray logs can be obtained in cased and uncased wells.
- Change in water quality have little effect on the gamma-ray log, so the log is valuable in identifying the position and thickness of clay formations where the alternating sand formations may contain brackish water.



Electric resistivity surveying

- In this the measurements of earth resistivity are made from the ground surface.
- The relative values of electrical resistivity are interpreted in terms of the general geology of the subsurface at limited depths.
- Measurement of resistivity are made using four electrodes set in ground through two of the electrodes and the potential drop across the other two is noted.
- The most common arrangement is the electrodes equally spaced along a straightline.

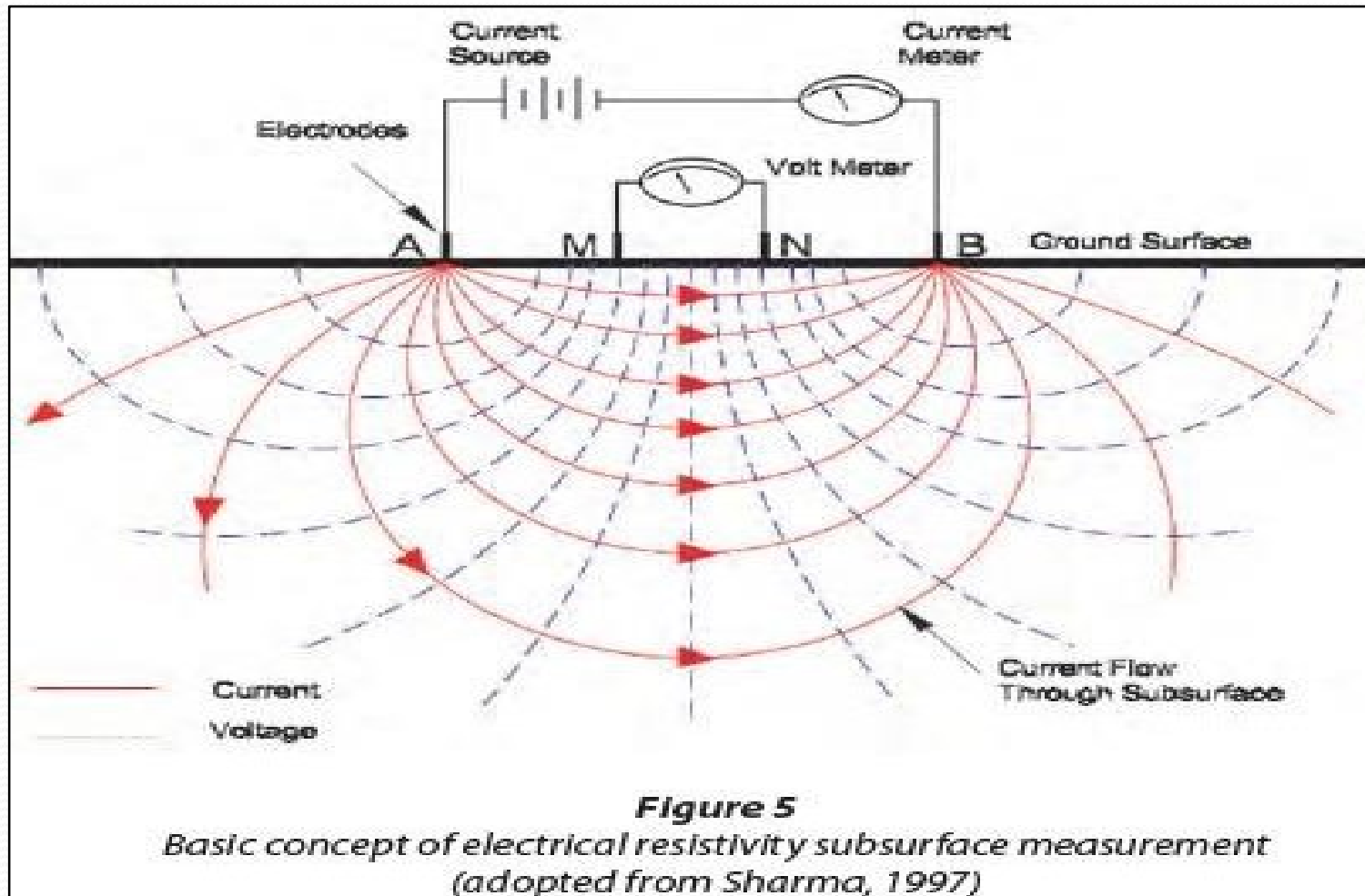
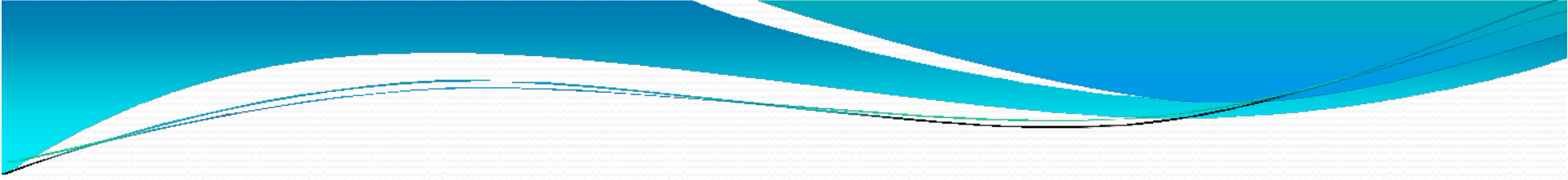


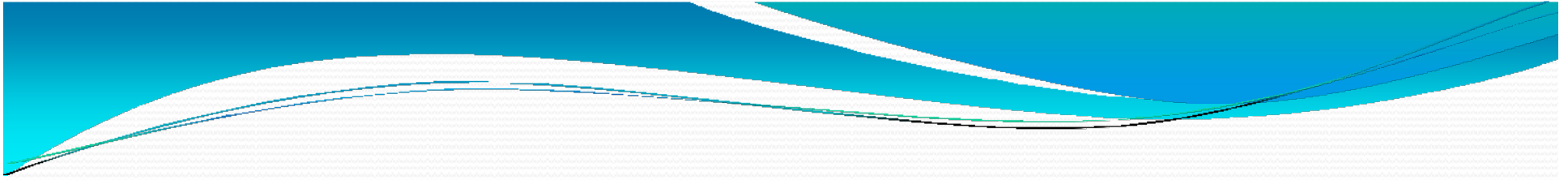
Fig 7.1 Potential difference between two electrodes

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- The apparent resistivity is computed from the potential drop, the applied current, and the electrode spacing.
 - The apparatus is usually designed so that the ratio of the potential drop to the applied current is read directly as resistance in ohms.
 - The values thus obtained is referred to as the apparent resistivity of lithosphere down to a depth which is proportional to the electrodespacing.
 - Apparent resistivity is considered as being a weighted average of the real resistivities of the individual strata within the depth of penetration of the resistance measurement.



Seismic refraction surveying

- The principle of seismic refraction surveying is based on the fact that shock waves travel through different earth material at different velocities.
- Shock waves or seismic waves are produced by setting off an explosive charge in a shallow hole, or by striking the ground with a heavy hammer.
- The denser the material, the faster the waves travel.
- From measurement differences in velocity, the existence of differing layers of sub-surface material is identified.
- This method is suitable where the velocity of the shock wave increases with depth.



- A seismograph is used to detect and time the arrival of the shock wave over a measured distance from the shock point.
- The velocity of the first of the shock wave is then calculated.
- Comparison of the velocities measured at various distance between the shock point and detector instruments provide a basis for estimating the sub-surface geologic conditions.