

HINDU COLLEGE, GUNTUR

(A NAAC ACCREDITED 'A' GRADE INSTITUTION)

DEPARTMENT OF GEOLOGY

2021-2022

SYLLABUS OF GEOLOGY



GEOLOGY SYLLABUS

UNIT-1

INTRODUCTION: Definition of hydrology, Hydrogeology, scope and application of Hydrogeology. Hydrological evaporation, Condensation, Precipitation, Infiltration, Transpiration. Evapotranspiration.runoff, Connate water

Ground water: origin, Occurrence, and age of ground water, vertical distribution of sub-surface water, zone of aeration-soil water, vadose water, capillary fringe. Zone of saturation -water table. Perched water table. Recharge and discharge areas

Unit-2

QUALITY OF GROUND WATER: Physical, chemical and biological characteristics of

groundwater. Suitability of ground water for drinking, Irrigation and industrial purposes. Pollution of ground water; Pollution in relation to urban, industrial and agricultural sources. Brief account of saline water intrusion.

UNIT-3

GROUND WATER INVESTIGATION: Scope of investigations, Methods of groundwater explorations, Brief account of geologic, hydro geologic, Geobotanical investigations, Introduction to Remote sensing techniques. Geophysical exploration: Basic principles of Geophysical exploration methods; electrical methods- schluntberger and wenner configuration, Resistivity profiling and vertical Electrical sounding.



HINDU COLLEGE GUNTUR

NAAC 'A' GRADE

DEPARTMENT OF GEOLOGY

CIRTFIFICATE

This is to certify that Mr. /Miss B.JEEVESH

Attended online certificate course on KNOWLEDGE OF GROUND WATER

From 07 February 2022 to 12 February 2022 and qualifies for award of certificate

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Coordinator

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Principal

HYDROLOGICAL CYCLE

- Precipitation-Runoff+Infiltration+Evaporation+Transpiration

PRECIPITATION

- It is the atmospheric discharge of water in the solid (hail,snow) or liquid (rain)form on the earths surface .some of the precipitation is intercepted by the vegetal canopy (interception) and the rest reaches the surface (through fall) .

EVAPORATION:

- Evaporation is the spontaneous process by which the water is transformed into vaporous state from the surface water bodies ,such as sea, lakes,rivers,tanks,glaciers etc.the rate of evaporation depends on several factors it increases with the decrease barometric pressure, increases in air and water temperatures,sunshine ,wind velocity,dryness of air and purity of water.

TRANSPIRATION:

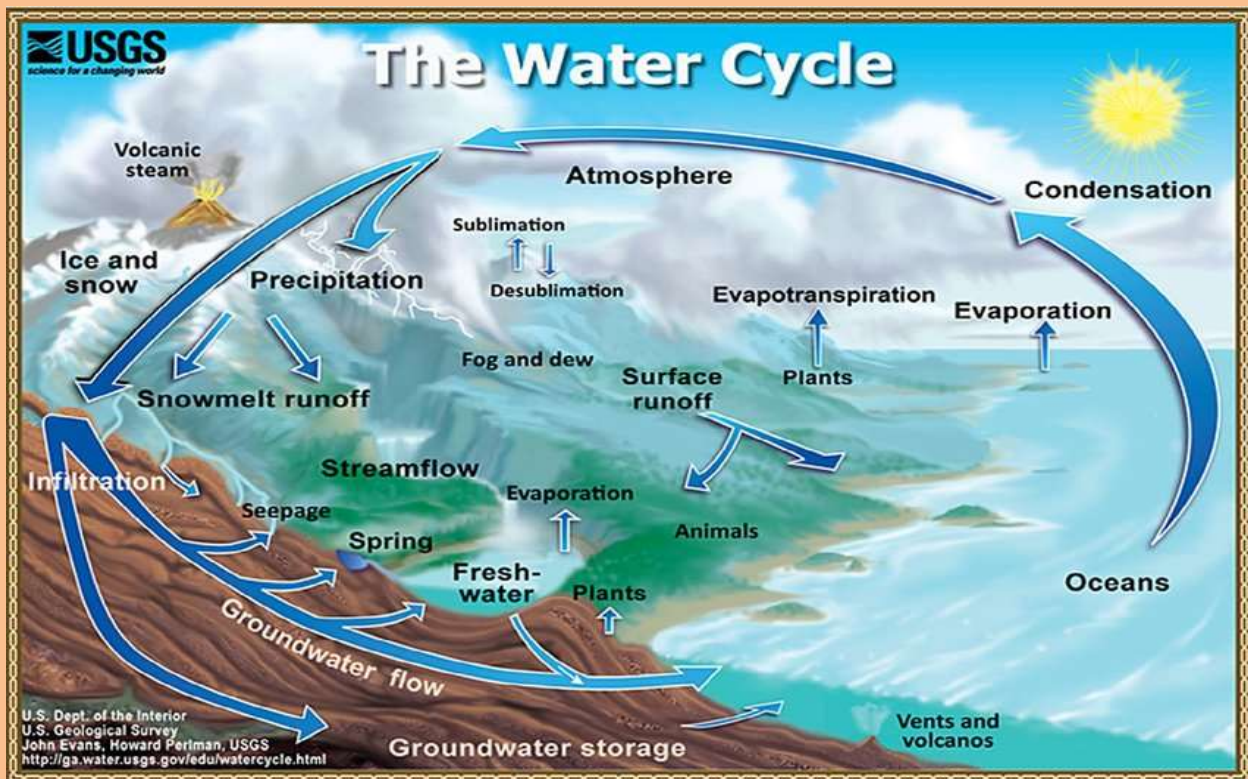
- Part of precipitated water intercepted by plants is directly returned to the atmosphere by evaporation and part of the water reaching the ground and making up the soil moisture is evaporated through the leaves by transpiration . Transpiration rates may be extremely low in xerophytic plants in deserts but very height in hydrophyte plants of particular interest are the transpiration losses of potential ground water supplies through phreatophytes the habitually deplete water from the zone of saturation either directly[or] through the capillary fringe.

INFILTRATION :

- The infiltration characteristic of the soil determine the rate at which water received as rainfall [or water applied on the surface]can move into the surface. The term percolation is used to denote the transit of infiltrated water through the unsaturated zone. Percolating water flows the path of least resistance ,travelling fast under gravity through the larger inter connected voids.

RUNOFF :

- runoff may be defined as the water that falls on the ground flowing from a higher gradient to a lower one . If relatively impervious horizons above the water table out crop at the land surface , water may flow over them to reach streams as interflow . Runoff depends on a number factors namely
- 1. Dimensions and configurations of drainage basins.
- 2. The climatic conditions including intensity ,duration and areal distribution of precipitation.
- 3. moisture content of soil
- 4. topography and land surface slopes.
- 5. infiltration and permeability of soils and subsurface formations.
- 6.type and density of vegetation
- 7.aquifer – streams relationships and
- 8. Human activities relating to land use urbanisation diversion of water



ORIGIN, OCCURRENCE, VERTICAL DISTRIBUTION AND FORMS OF GROUND WATER

Origin

- Ground water is derived from several sources such as meteoric, connate, marine, juvenile etc..
- **MARINE WATER**: Sea water [or] ocean which has invaded rocks and unconsolidated sediments which are in contact with the ocean
- **Meteoric water** : Ground water which originates from precipitation is called meteoric water. This water which is initially supplied by the rains [or] snow as a part of the hydrological cycle is known as meteoric water
- **Connate water** : The water that is entrapped in the rocks during their formations due to sedimentation in an aqueous environment is called connate water.
- **Juvenile water** : it is also called magmatic water which is of only theoretical importance. It is the water formed in the cracks.

Metamorphic water : water that has been associated with metamorphic rocks during the course of metamorphism is called metamorphic water

OCCURRENCE OF GROUND WATER:

- ground water occurs in the earth crust in different forms depending upon the lithology, stratigraphy and structures
- Lithology is the physical makeup of mineral composition, grain size and grain packing of the sediments or rocks that make up the geological system. stratigraphy describes the geometrical and age relations between various groups, beds and formations in geological system of sedimentary origin.
- Structural features such as fractures, cleavages, folds, joints and faults are the geometrical properties of the geological system produced by deformation after deposition or crystallisation.
- The major geological units in terms of ground water occurrence and potentiality are as described below
- Unconsolidated
Fluvial deposits : fluvial deposits are the materials laid down by physical process in river channels [or] on flood plains

Aeolian deposits : sediments that are transported and deposited by wind are known as Aeolian deposits .

Glacial deposits : they include glacial till , glacio – fluvial sediments , glacio lacustrine sediments.

SEDIMENTARY ROCKS

Sand stones : sand stone forms the best repositories of ground water. Sandstone beds owe their origin to various depositional environments.

- **Carbonate rocks** : carbonate rocks mostly consist of limestone , dolomites and dolomitic limestone . Geologically young carbonate rocks commonly have porosities that range from 20 to 50 percentage
- **Shales** : shales are the poorest aquifers . Although they are porous they are impermeable.

CRYSTALLINE ROCKS

- **Igneous and metamorphic**: igneous and metamorphic rocks are relatively impermeable hence they serve as poor aquifers . Where such rocks occurs near the surface under weathered conditions.
- **Volcanic rocks** : volcanic rocks can form highly permeable aquifers.

VERTICAL DISTRIBUTION OF GROUND WATER

The subsurface occurrence of ground water is divide into the following zones.

Zone of aeration

Soil water zone : water in the soil water zone exists at the zone of saturation except temporarily when excessive water reaches the ground surface as from rainfall or irrigation

Intermediate zone : in intermediate vadose zone lies in between soil water zone and capillary zone .

Capillary zone : this zone s also known as capillary fringe . It extends from water table upto the limit of capillary rise of water

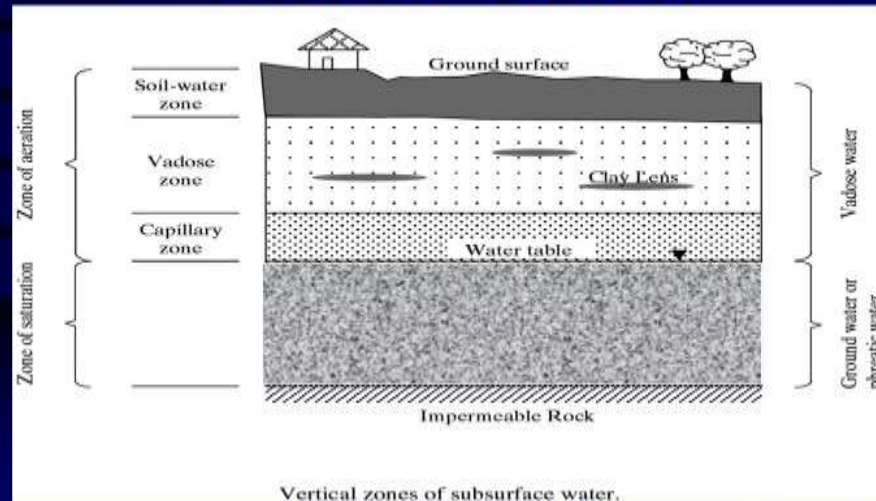
ZONE OF STURATION

In the of saturation ground water fills all of the interstices. Hence the porosity provides a direct measure of the water contained for unit volume.

Water table : the surface below which rocks a permanently ssturated with water is known a water

table . The actual position of the water table show seasonal variations. During the rainy season more water is added than is lost . So water table rises and it wil be nearer to the surface

Vertical Distribution of Ground Water



FORMS OF GROUND WATER

Wells : a hole dug into the ground to a considerable depth which reaches the water table is called a well.

Artesian wells : the aquifer is permeable bed and is overlain underlain by permeable beds.

- **Geysers** : a geyser is a special type of thermal spring that intermittently erupts a column of steam and hot water.
- Areas can be delineated into recharge and discharge areas depending upon whether water in these areas is added to or abstracted from the zone of saturation.

AQUIFERS

Aquifers : a geological formation that yields significant quantities of water is defined as Aquifer. ex : unconsolidated sands and gravels

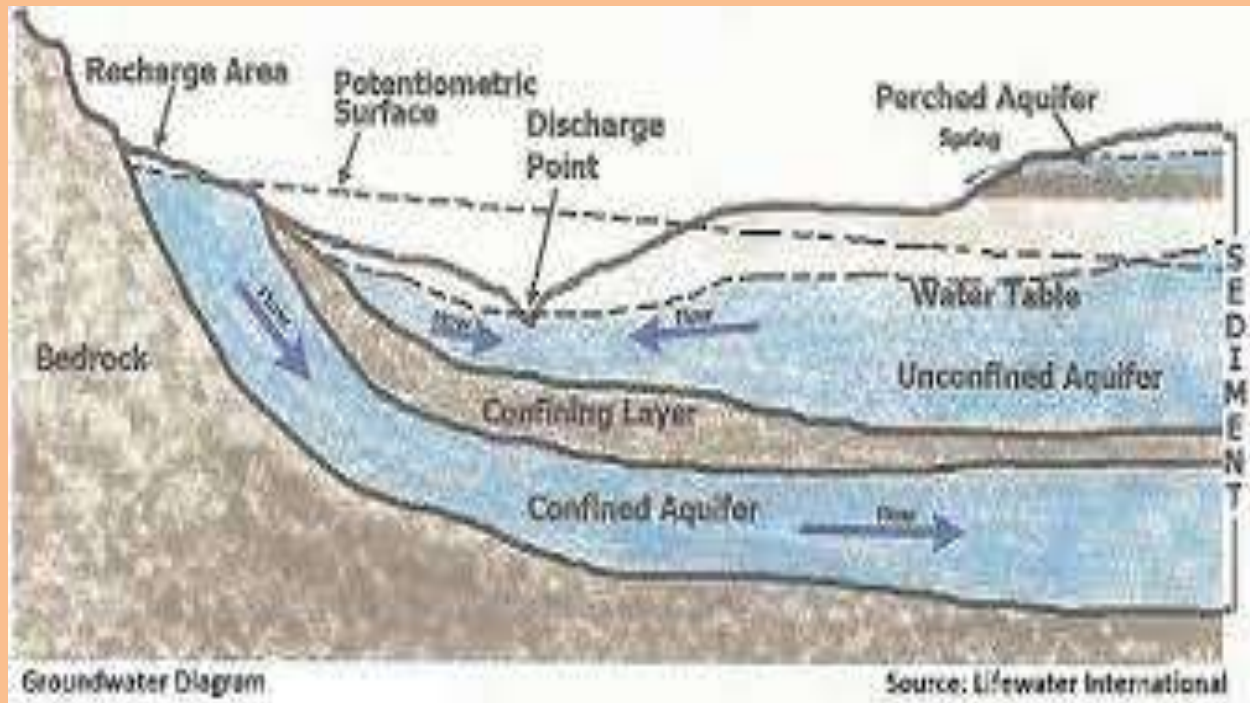
Aquiclude : a saturated but relatively impermeable material that doesn't yield appreciable quantities of water to wells. Ex : clay

Aquifuge : a relatively impermeable formation neither containing nor transmitting water. Ex : solid granite, basalt etc..

Aquitard : a saturated but poorly permeable stratum that stops ground water movement and doesn't yield water freely to wells but it may transmit appreciable water to or from adjacent aquifers.

TYPES OF AQUIFERS

- **Unconfined aquifer** : an unconfined aquifer is one in which water table varies in undulating form and in slope depending on areas of recharge and discharge pump age from wells and permeability.



Perched Aquifer : A special case of an unconfined aquifer involves perched water body as shown in figure . This occurs whenever a ground water body is separated from the main ground water by a relatively impermeable stratum of small areal extent and body of ground water. ex ;clay these sources yield only temporary or small quantities of water.

- **Confined aquifer** : confined aquifer is also known as artesian aquifers or pressure aquifers.
- **Leaky aquifer** : aquifers that are completely confined or unconfined occur less frequently than leaky aquifers.
- **Idealized aquifer** : for mathematical calculations of the storage and flow of ground water , aquifers assumed to be homogeneous and isotropic.

POLLUTION OF GROUND WATER

Definition : pollution is a modification of a chemical , physical and biological properties of water , preventing its normal use in various applications

CAUSES AND SOURCES OF POLLUTION

- Domestic and urban pollution
- **Sewer leakage** : sanitary sewers are intended to be watertight . But in reality leakage of sewage into the ground commonly occurs.
- **Liquid waste** : waste water in urban areas originate from domestic source and industries such water with out giving treatment is discharged into the surface water finally finds way into the ground water causing pollution.
- **Solid waste** : land disposal of solid waste creates an important source of ground water pollution.

Septic tanks and cess pools : in urban and highly populated domestic areas leakage from septic tanks and cess pools cause ground water pollution on large scale.

Roadways deicing salts : chloride ions from runoff from road deicing salts cause high chlorinity in ground water.

AGRICULTURAL POLLUTION

- **Irrigation return flows** : approximately $\frac{1}{2}$ - $\frac{2}{3}$ water applied for irrigation of crops is consumed by evapo- transpiration.
- **Animal waste** : where animals are confined within a limited area of beef or milch production , large amount of animal wastes are deposited on the ground.
- **Fertilizers and soil amendments** : when fertilizers are applied to the agricultural land , a portion usually reaches through the soil and to the water table.

Pesticides and herbicides : insecticides , pesticides and herbicides are cumulative poisons in agricultural areas and cause ground water pollution.

Industrial pollution

Liquid waste : the major use of water in industrial plants is for cooling , sanitation , manufacturing of different products and processing .

- **Tank and pipe line leakage** : petroleum tanks and pipe lines of chemicals when subjected to structural failure , cause ground water pollution due to leakage.
- **Mining activities** : mines can produce a variety of ground water pollution problems.
- **Oil field brines** : the production of oil and gas is usually accompanied by the discharge of waste water in the form of brine .
- **Trace metal pollution** : in industrial areas heavy metals such as arsenic , cobalt , cadmium , chromium , copper , lead , iron , manganese and mercury enter into the waste water as traces and finally reaches the ground water table to cause pollution.

Spills and surface discharges : liquids discharge on the ground water surface in an uncontrolled manner can migrate downward to degrade ground water quality

- **Stock piles** : solid materials are frequently stock piled near industrial plants construction sites and large agricultural operations.

Other causes

- 1. pollution from salt water intrusion
- 2. pollution from surface water contamination
- 3. pollution from wells
- 4. pollution from atmospheric dissolved gases
- 5. pollution from radioactive substances

6. high concentrations of fluorine etc ..

EXPLORATION OF GROUND WATER

Geological investigations : in ground water exploration among the three kinds of investigations geological investigation is the most important and the main deciding factor.

- **Study of lithology** : this refers to not only the outcrops of rock types occurring but also to their thickness altitude and their porosity and permeability characters .
- **Study of topography** : this refers to the occurrence of high lands such as hills , and low lands such as valleys.The water table will be roughly parallel to the surface i.e.occuring at a relatively higher level in hilly regions and at the depth below valleys in low lands.
- **Study of weathering** : in hard rock areas surface occurrence of insitu rocks as base boulders without soil and subsoil zones is not suitable for tapping groundwater because they not only lack weathered zones but also joints and fractures which may occur on the surface shall become less prominent and disappear at a depth.

Study of geological structures : this refers to the trend or altitude of joints , cracks , faults , shear zones , folds etc .. Which not only contribute to secondary porosity but also act as a channel ways or guides the directions of movement of ground water.Synclinal folding accompanying suitable lithology leads to artesian conditions which are very much sought after in ground water exploration because they generally yield a copious supply of water.

- **Remote sensing and aerial photographs** : photographs of the earth taking from air craft or satellite at various electro magnetic wavelength ranges can provide useful information regarding ground water conditions of region.
- Stereoscopic examination of black&white aerial photographs has gained importance since observable patterns,colours&relief make it possible to distinguish differences in geology,soils,soil moisture,drainage,vegetation and land use.
- **Hydrogeobotanical prospecting** : hydrobotanical studies of vegetation in photographs [water loving] which transpire water from shallow water tables , define depths to ground water.They are good indicators of ground water .Halophytes,plants with a high tolerance for soluble salts and white efflorescences of salt at ground water.Xerophytes

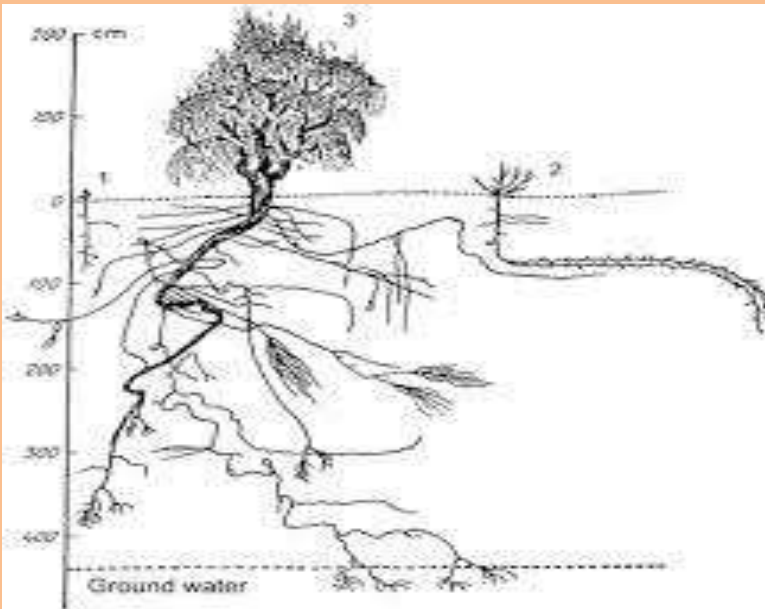
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- **Halophytes**



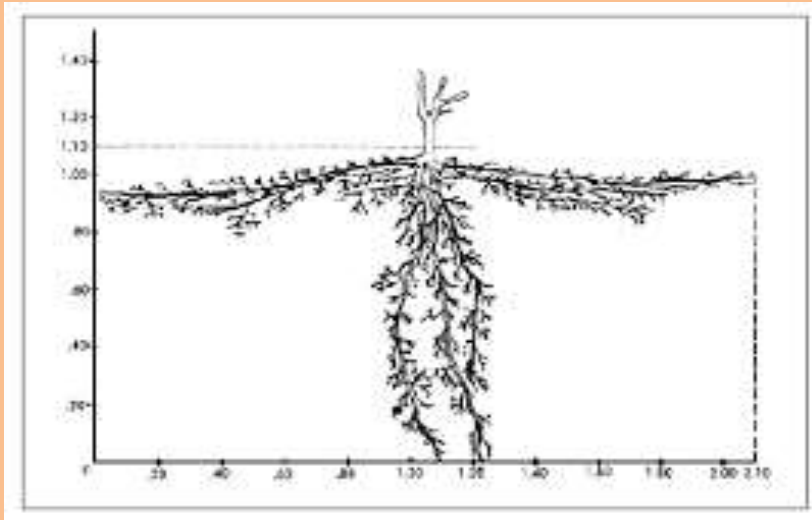
- **Phreatophyte**



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- **Xerophytes**



- **Study of intrusive rocks** : this refers to the occurrence , trend and extend of dolerite dykes , quartz veins etc.,These being hard and resistant may act s barriers to the normal flow of ground water.This results in the accumulation of ground water on one side of the intrusive only.Thus,it is common experience that in some places ground water may be plenty in a particular area and may be scarce in a nerby area.
- **Geological mapping**: this reveals most of the foregoing field data and hence is very important.In this,the actual mode of occurance of rocks along with the associate geological structures and intrusive are shown over the conour map of that area.
- **HYDROLOGICAL EXPLORATION**
Study of water table : in any regions the observations and estimation of the depth of the static water level in a number of wells and bore walls offer valuable informations about the relation position the nature of the slope of the water table ad the probable direction of flow of ground water in he area concerned Study of surface water bodies : This refers to the occurrence of networks of streams , ponds , lakes , reservoirs .Study of springs and see pages.Study of rainfall , climate .

GEOPHYSICAL INVESTIGATIONS:

Geophysical exploration is the scientific measurement of physical properties of the earths crust for investigaton of mineral deposits,geological structures or ground water resources.Orignisation concered with ground water employ geophysical methods.They are most useful when supplemented by surface investigations.Geophysical methods detect differences or anomalies of physical properties within the earths crust.Density,magnetism,elasticity commonly measured.

- **Gravity method** : Gravity methods represents a set of geophysical methods which make use of the natural gravity field of the earth.
- In the waterbearing zone density is less.
- **Principle** : in gravity methods the nature of distribution of gravity , g on the surface is analysed.The gravity is influenced positively if the causative body is heavier,larger and occur at a shallow depth.Thus,in a particular region,if subsurface bodies whose densities are different from the normal value that is expected,it is possible to locate the heterogenous bodies in the subsurface.In the water bearing zone, density is less.

MAGNETIC METHOD

Controlling property : Magnetic susceptibility
principle

- The magnetic methods are based on the fact that the magnetic bodies present in the earth's subsurface contribute to the magnetic field of the earth.As the gravity methods,the contribution of the magnetic body is directly proportional to the magnetic moment of the body and its size,and is inversely proportional to the depth of its occurrence.In general,when the magnetic field of the earth one of its components is measured on the surface bodies possessing magnetic moments different from those of the surroundings rocks contribute to the deviations in the
- In the water bearing zone the magnetic susceptibility is low





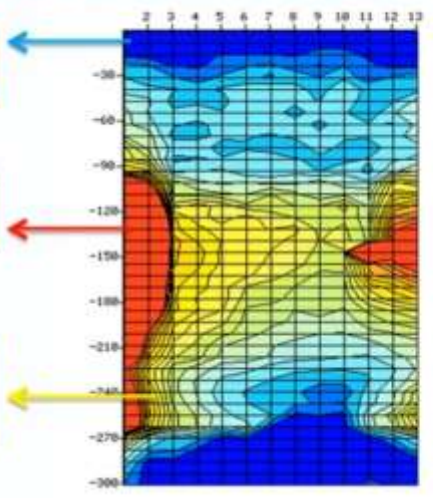


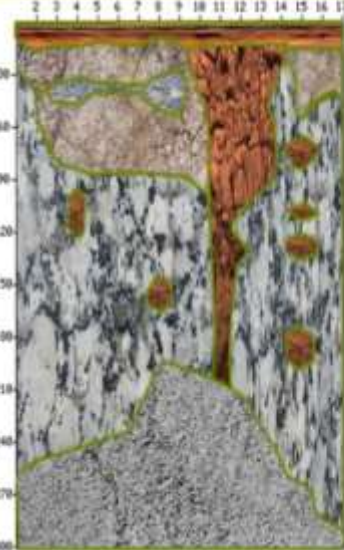
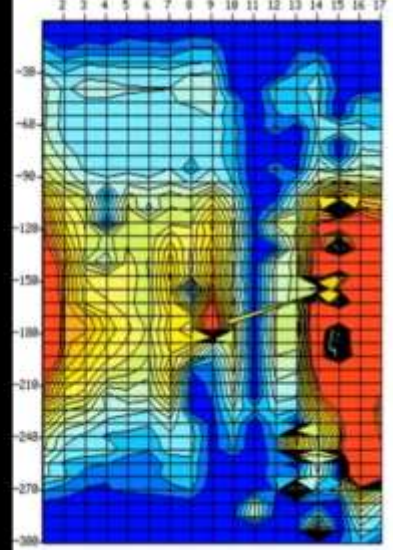
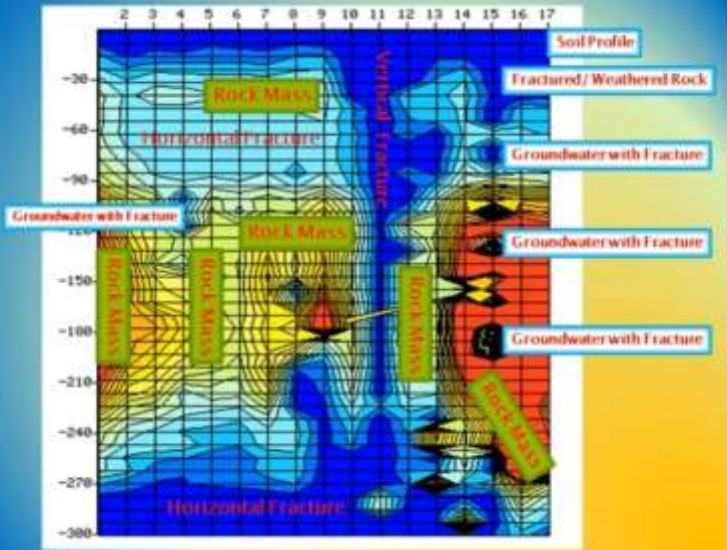
Groundwater view description of subsurface material

Low resistivity / Low Density / Soft / Low potential value

High resistivity / High Density / Very Hard / High potential value

Medium resistivity / Medium Density / Medium Hard / Medium potential value



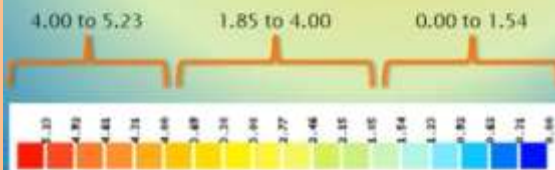


One number
series range
0.1 to 0.10/
0.01 to 0.09/
1 to 1.9
Sample Digit
Series

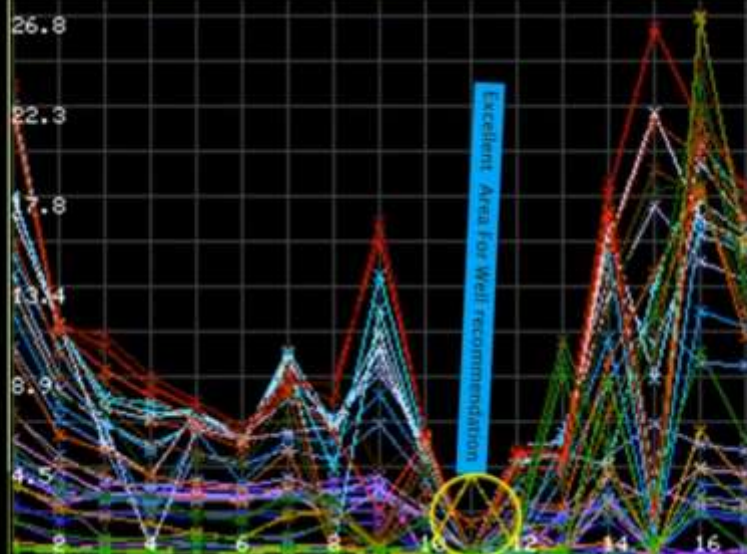
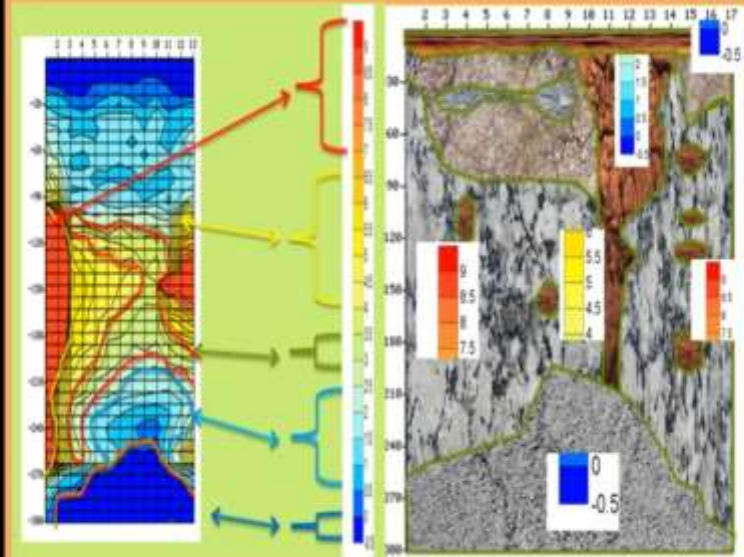
Below Average Values range



Average Values range



Good Values range



ELECTRICAL RESISTIVITY METHODS

Introduction: Electrical resistivity method is an important and useful geophysical method to investigate the nature of substance formation by studying the variation in their electrical properties. This method assumed considerable importance in the field of ground water exploration because of its ease of operation, low cost and its capability to distinguish between the saline and fresh water zones.

Resistivity : Resistivity is a physical property of a substance [like density]. It is an inherent property of the substance and is independent of size and shape of the substance. The resistivity is defined as the resistance offered by a unit cube of a substance to the flow of electric current when the voltage is applied at the opposite faces of the cube.





MODEL DDR-3



The DDR 3 Resistivity Meter is a specialized version of IGIS resistivity meters designed for use in resistivity surveys upto about 150m depth under geophysical favourable field conditions. It utilizes rechargeable batteries as power source to energize the ground thus eliminating the necessity of using the relatively expensive dry cells. The equipment consists of two separate compartments-one for reading the current (G.Unit) and the other for directly reading the resistance/the potential (P-Unit), both housed in a single box.

The equipment, powered by a 24V rechargeable battery can send highly stabilized currents upto 200mA and read the resulting potential with a 100 micro volts resolution or ground resistance directly with 50 micro ohms resolution.

Housed in sturdy Aluminum box fixed in a briefcase, the instrument provides highly reliable digital outputs of ground resistance during field surveys and finds extensive use in ground water exploration, dam site investigation, delineation of geological structural features and in several other related problems.

Applications

- € Ground Water Exploration, investigation of shallow as well as deeper aquifers.
- € Bed rock investigations for dam construction tunnel alignment and powerhouse construction etc.,
- € Mineral exploration
- € Study of geological structural features.
- € Sand and gravel deposit location.
- € Geophysical Field Training

RESISTIVITIES OF DIFFERENT ROCK FORMATIONS

1. There are no fixed limits for resistivities of various rocks.
2. In igneous and metamorphic rocks the resistivities range from 10^2 to 10^8 ohm-m
3. In igneous and metamorphic rocks , the resistivities range from 10^2 to 10^8 ohm-m.