Introduction

* Branches of Geology: The geology can be divided into several main and allied branches for easy study of different aspects on the earth.

Main branches of geology:

(i) Physical geology :- It is the study of physical features of the earth. Such as volcanoes, glaciers, earthquakes, land slides, rivers etc.,.

ii, Mineralogy :- It is the study of basic fundamental materials which forming rocks and ores.

Mineral :- It is a combination of chemical constituents in the environment which should be having a definite chemical composition, atomic structure, structure, texture.

iii, Petrology :- It is the study of rocks which having different classification structures, textures etc.,.

Igneous Rocks - It is the rocks which are formed by solidification of molten magma (or) lava.

Sedimentary Rocks - These are the rocks which are formed by sedimentation of various materials such as soil, dust, sand, leaves & dead bodies of plants.

(iv) Structural Geology :- It is the study of various structures of rocks such as folds, faults, joints and unconformities.

(v) Historical Geology :- It is the study of history of rocks and geological features of the earth.

(vi) Palaentology :- It is the study of plants, trees, animals.

(vii) Economic Geology :- It is the study of advantages of geology with respect to economical conditions.

Allied branches of Geology:

(i) Engineering Geology:- It is the study of rocks, geological agents, structures of geology, groundwater. It is much related with civil engineers in the respectives of buildings, roads, dams and other major civil constructions.

(ii) Hydrology:- It is the study of ground water and its movement, position and characteristics.

(iii) Geo-physics:- It is the study of physical properties of rocks such as hardness, strength, resistances etc.,.

Normally geo-physical methods are:

(a) Gravity method.
(b) Electrical method.
(c) seismic method.
(d) Magnetic method.
(e) Radio metric method.

(iv) Geo-chemistry:- It is the study of chemical properties of rocks.

* Importance of Geology in civil Engineering with case studies.

The civil engineers aim at safety, stability, economy and life of the structures that they construct. civil engineering constructions like dams and bridges will their foundations on geological formations of the earth's surface. otherwise, the cost of construction will increase.

These critical details of civil engineering importance i.e.,

Durability and competence of foundation rocks.

Their depth of occurrence

availability of building materials.

Weathering :

Weathering process :- It is defined as the process of disintegration (or) decomposition of rocks due to different physical, chemical and biological factors of nature. Due to weathering, rocks become smaller.

Physical factors:

(i) Wind :- It is a major factor which disintegrating the rocks by means of over striking with particles.

ii, Gravity :- It is also a factor which causing disintegration of rocks. When heavy bodies falling from long heights.

iii, River :- It is a major cause of disintegration when it is continuously striking with high velocity, pressure head.

Biological factors:

(i) Trees and plants :- Whenever the roots of the plants and trees will Penetrate into existing cracks of rocks Will causes disintegration.

(ii) Animals :- when insects are digging the rocks for the purpose of food storing, nests this will causes disintegration.

(iii) Bacteria :- whenever dead bodies are decomposing there will be definite formation of toxic acids. It will causes disintegration.

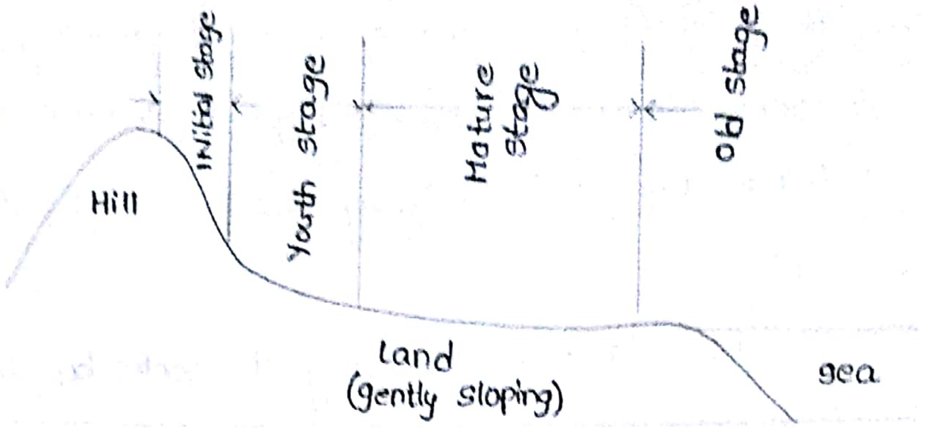
Chemical factors:

When high concentrated dissolution acids are formed in between the rocks due to environmental changes. These acids have high capacity of disintegration.

* Geological Agents :

Geological agents are the main reasons for the changes in the environment. Normally geological agents Volcanoes, earthquakes, land slides, Valleys, glaciers, Thunders, Tsunami etc.,.

River Development and their process:



Initial stage:- In this stage the precipitated rain will flow rapidly over the steep slopes of hill. Due to this high velocity, the erosion of rocks will takes place. In this stage the flow will like divided small stream here no sedimentation takes place.

Youth stage:- In this stage the divided streams will flows over the foot and combined together. In this stage the velocity is high and erosion will be more when compared to initial stage. The sedimentation will not takes place.

Mature stage:- In this stage the river is mainly developed into larger body. Here the velocity will be less when compared to initial and youth stages. The sedimentation will take place. For civil Engineers mature stage is very important for utilizations like irrigation, Domestic etc.,.

Old stage (or) Final stage:- In this stage due to gradient formation the velocity of river flow is almost zero. The final stage due to lack of energy the river can be divided into streams, Here sedimentation will be high.

Mineralogy And Petrology

* Mineral :- A mineral may be defined as a natural, inorganic, homogeneous, solid substance having a definite chemical composition and regular atomic structure. Under favourable conditions the regular internal atomic structure of minerals results in the development of definite external geometrical shape i.e., crystal.

* Rock :- It defined as the formed by solidification of molten magma (or) lava is called 'Igneous rocks.' These are the rocks which are formed by sedimentation of various materials such as soil, dust, sand, deadbodies of plants & animals is called 'Sedimentary rocks.' These are the rocks which are formed by combined of both igneous and sedimentary rocks.

* Different methods of study of minerals :-

Every mineral has its own chemical composition and atomic structure. Common methods of study and identification of minerals are based on (i) Their physical properties (ii) their chemical composition (iii) their optical properties and (iv) their x-ray analysis.

(i) Study of physical Properties :- physical properties of minerals like colour, shine, resistance to scratching, density, fissility etc., can be studied with the reference of small mineral specimens.

(ii) Study of chemical Composition :- Every mineral is to have its own distinctive chemical composition, which is not be found in any other mineral. Therefore, by chemical analysis if composition is known to identify the mineral.

(iii) Study of optical Properties :- The properties of minerals like colour, relief, cleavage, shape and pleochroism are studied under polarized light are studied under crossed nicols with the help of other accessories

X-ray Analysis :- It can analysis makes use of the definite atomic structure. They are similar to light waves but have a shorter wavelength to the distances between atoms in a crystalline mineral are used in the x-ray analysis.

* Physical Properties of minerals:

Quartz: Group.

1. colour - Its colour is pale pink.
2. Form - Its surface is massive
3. Streak - Its streaking colour is white
4. lusture - Its shiny nature is metallic
5. Cleavage - Its existing Cracks is Absent.
6. Fracture - Its surface nature is even to uneven
7. Specific gravity - Its sp. gravity is High
8. Hardness - Its hardness is 7.
9. Degree of Transparency - Its transparency is thin edges are transparent to translucent.

Quartz -

1. colour - Its colour is 'Green'.
2. Form - Its surface is 'massive'.
3. Streak - Its streaking colour is 'green'
4. Lusture - Its shiny nature is metallic
5. Cleavage - Its existing cracks is Absent
6. Fracture - Its surface nature is even to uneven
7. Specific gravity - Its sp. gravity is High
8. Hardness - Its hardness is 7.
9. Degree of Transparency - Its transparency in thin edges are transparent to translucent.

Olivine :

Colour - Its colour is olive green
Form - Its surface is massive.
Streak - Its streaking colour is olive green
Lusture - Its nature in shiny is Non-metallic
Cleavage - Its existing cracks is Absent
Fracture - Its surface nature is uneven
Specific gravity - Its sp.gravity is High (or) Medium
Hardness - Its hardness is 6 to 7
Degree of Transparency - Its transparency is opaque.

* Mica group :

Muscovite :

Colour - Its colour is silver
Form - Its surface is 'Lamellar'
Streak - Its streaking colour is colourless
Lusture - Its shiny nature is Metallic (Resineous)
Cleavage - Its existing cracks is present
Fracture - Its Surface nature is uneven to even
Specific gravity - Its sp.gravity is medium
Hardness - Its hardness is 2 to 3
Degree of Transparency - Its transparency thin sheets (or) Transparent

Biotite :

Colour - Its colour is Black
Form - Its surface is lamellar
Streak - Its streaking colour is Black
Lusture - Its shiny nature is metallic
Cleavage - Its existing cracks is present
Fracture - Its surface nature is uneven

Specific Gravity - Its sp. gravity is 2 to 3

Hardness - Its hardness is low

Degree of transparency - Its degree of transparency in thin edges are transluce[nt]

* Asbestos:

Colour - Its colour is grey

Form - Its surface is Fibrous threads

Streak - Its streaking colour is Grey

Lusture - Its shiny nature is Non-metallic

Cleavage - Its existing cracks is present

Fracture - Its surface nature is even to uneven

Specific gravity - Its sp. gravity is medium

Hardness - Its hardness is 4 to 5

Degree of Transparency - Its transparency is opaque.

* Talc:

Colour - Its colour is pale green

Form - Its surface is Massive

Streak - Its streaking colour is pale green

Lusture - Its shiny nature is Metallic

Cleavage - Its existing cracks is Absent

Fracture - Its surface nature is even to uneven

Specific gravity - Its sp. gravity is Medium

Hardness - Its hardness is 1

Degree of Transparency - Its degree of transparency is opaque anite :

Colour - Its Colour is pale blue

Form - Its surface is Fibrous bladed

Streak - Its streaking ~~nature~~ is ~~p~~ colour is pale blue

lustre - Its shiny nature is Metallic

Cleavage - Its existing Cracks is present

Fracture - Its surface nature is Uneven to conchodial

Specific gravity - Its sp. gravity is High

Hardness - Its hardness is 4 to 5 along length

Degree of Transparency - Thin edges are very less transulcent.

* Garnet :

Colour - Its colour is brown

Form - Its surface is Granullar

Streak - Its streaking colour is light Brown

lustre - Its shiny nature is Non-metallic

cleavage - Its existing Cracks is Absent

Fracture - Its surface nature is even

Specific gravity - Its sp. gravity is Medium

Hardness - Its hardness is 6 to 7

Degree of Transparency - ~~Deo~~ Its transparenty is opaque.

* Calcite :

Colour - Its colour is pale pink

Form - Its surface is Massive

Streak - Its streaking colour is pale brown.

lustre - Its shiny nature is sub-metallic

Cleavage - Its existing cracks is Absent

Fracture - Its surface nature is uneven

specific gravity - Its sp. gravity is Medium

Hardness - Its hardness is 3

Degree of transparency - ~~B~~ Transparenty is Thin edges (or) transulcent

Ore forming Minerals:

Pyrite :

Colour - Its colour is Goldish yellow.
Form - Its surface is Massive
Streak - Its streaking colour is pale yellow
lusture - Its shiny nature is Sub-metallic
cleavage - Its existing cracks is Absent
Fracture - Its surface nature is even to uneven
specific gravity - Its sp. gravity is High
Hardness - Its hardness is 6 to 7
Degree of Transparency - Transparency is opaque.

* Hematite :

Colour - Its colour is Grey
Form - Its surface is rhombic massive
Streak - Its streaking colour is Grey
lusture - Its shiny nature is metallic
cleavage - Its existing cracks is Absent
Fracture - Its surface nature is uneven to even
Specific gravity - Its sp. gravity is High
Hardness - Its hardness is 5 to 6
Degree of transparency - Transparency is opaque

* Magnetite :

colour - Its colour is black
Form - Its surface is massive
Streak - Its streaking colour is Black
lusture - Its shiny nature is Sub-metallic
Cleavage - Its existing cracks is Absent
Fracture - Its surface nature is uneven
specific gravity - Its sp. gravity is high
Hardness - Its hardness is 5 to 6
Degree of transparency - Its transparency is opaque.

Pyrolusite :

colour - Its colour is Black
Form - Its surface is Massive
Streak - Its streaking colour is Black
lusture - Its shiny nature is Non-metallic
Cleavage - Its existing cracks is present
Fracture - Its surface nature is uneven
Specific gravity - Its sp.gravity is medium
Hardness - Its hardness is 4 to 5
Degree of Transparency - Transparency is opaque

* Graphite :

colour - Its colour is Drak grey
Form - Its surface is Massive
Streak - Its streaking colour is Dark grey
lusture - Its shiny nature is sub-metallic
Cleavage - Its existing cracks is Absent
Fracture - Its surface nature is even to uneven
specific gravity - Its sp.gravity is low
Hardness - Its hardness is 1 to 2
Degree of Transparency - Transparency is opaque

* chromite :

colour - Its colour is Black with dark brown
Form - Its surface is Massive
Streak - Its streaking colour is Black
lusture - Its shiny nature is Non-metallic
Cleavage - Its existing cracks is Absent
Fracture - Its surface nature is Uneven to Conchodial
Specific gravity - Its sp.gravity is Medium
Hardness - Its hardness is 5 to 6
Degree of Transparency - Transparency is opaque

Tourmaline:

colour - Its colour is Black
form - Its surface is Granullar
streak - Its streaking colour is Black
lusture - Its shiny nature is sub-metallic
cleavage - Its existing cracks is Absent
fracture - Its surface nature is even to uneven
specific gravity - Its sp.gravity is low
Hardness - Its hardness is 6 to 7
Degree of Transparency - Transparenly is opaque

* Gypsum:

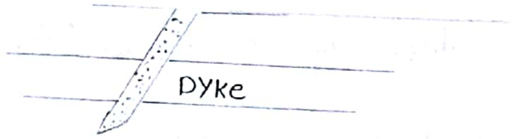
colour - Its colour is colourless with dark spots
Form - Its surface is Fabrious Bladed
Streak - Its streaking Colour is colourless
lusture - Its shiny nature is Metallic
Cleavage - Its existing nature cracks is present
Fracture - its surface nature is even to Conchodial
specific gravity - Its sp.gravity is low
Hardness - Its hardness is 2
Degree of Transparency - Transparency is thin edges are transparent

Classification of Rocks :

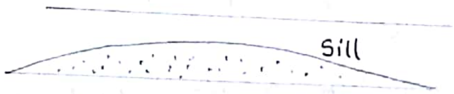
(i) Igneous rocks:

Forms of Intrusive Igneous Rocks:- The rocks which are formed benath the earth surface

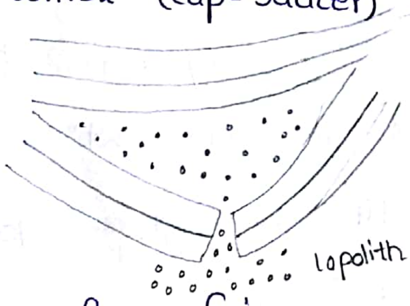
(a) Dykes - The rocks which are appeared as vertical solid materials are called as 'Dykes'



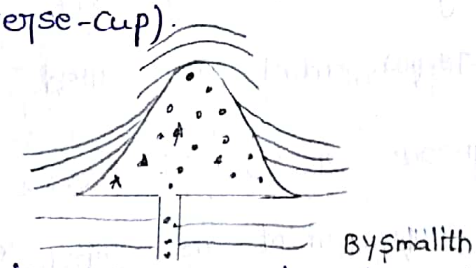
(b) Sills - The rocks which are formed by horizontal solid material formed by solidification of molten magma.



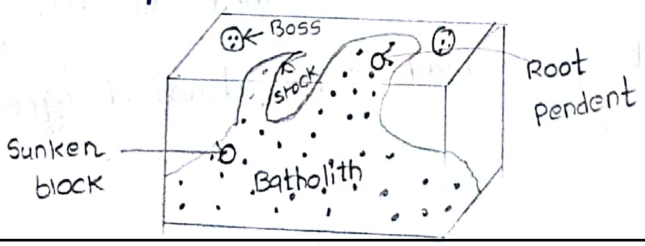
(c) Lopolith - It is a form of igneous rocks when molten magma solidified in the shape of 'convex' (cup-saucer)



(d) Bysmalith - It is a form of igneous rock when molten magma solidifed in the shape of 'concave' (reverse-cup).



(e) Batholith - It is a form of igneous rock when the solidified magma in an 'Irregular shape' is called as Batholith.



...ns of ... rocks:

(a) lava flows - when the molten ... www.FirstRanker.com the earth ... temperature Variations they will be settled in the form of waves. They are called 'lava flows'.

(b) Pyroclasts - when volcanoes erupted the lava will settles at different places on the earth surface. These are known as 'Pyroclasts'

Classification of Igneous rocks based on silica percentage:

(i) Acidic Igneous rocks - The rocks which are having more than 70% of silica are known as 'Acidic Igneous rocks'

ii, Intermediate Igneous rocks - The rocks which are having 55 to 70% of silica are known as 'Intermediate Igneous rocks'

iii, Basic Igneous rocks - The rocks which are having 40 to 55% of silica percentage are known 'Basic Igneous rocks'

(iv) Ultra-basic Igneous rocks - The rocks which are having less than 45% of silica are known as 'Ultra-basic igneous rocks'

Based on silica saturation:

(i) Over-saturated igneous rocks - The rocks which are having more % of silica to the requirement are called 'Over-saturated Igneous rocks'

(ii) Saturated Igneous rocks - The rocks which are having silica percent equal to the requirement are called 'saturated Igneous rocks'

(iii) Un-saturated Igneous rocks - The rocks which are having silica % less than the requirement are called 'Un-saturated Igneous rocks'

Based on Depth of availability:

(i) plutonic igneous rocks - the rocks which are formed 'deeper' in the earth surface are known as 'plutonic rocks'

(ii) Hypabasal Igneous rocks - The rocks which are available at 'shallow depths' in the earth surface are known as 'Hypabasal rocks'

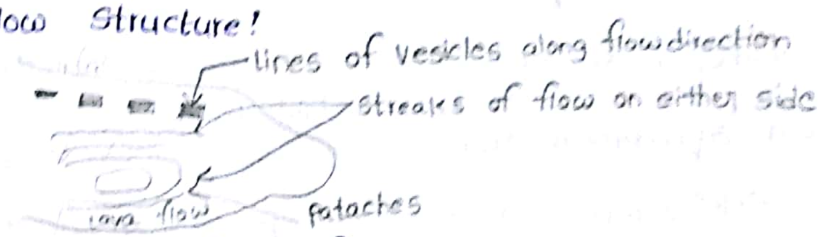
(iii) Volcanic igneous rocks - The rocks which are available (or) formed at 'surface of the earth' are known as 'Volcanic Igneous rocks'

* Structures of Igneous Rocks:

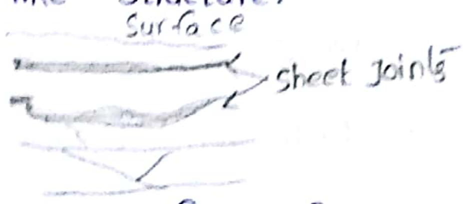
(i) Vesicular structure - The rocks which having vesicles on its surface. These are mainly due to volcanic gases. This structure is called as 'vesicular structure'

(ii) Amygdaloidal structure - In this the existing vesicles are filled with any other substances with strong bonding. is known as 'Amygdaloidal structure'

(iii) Flow structure - The surface of the rocks appeared as flow of the liquid is known as 'Flow structure'

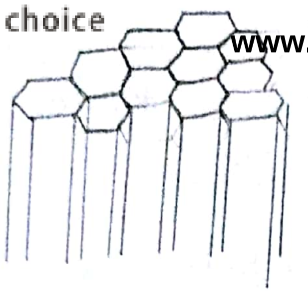


(iv) sheet like structure - The surface of the rock is appearing as sheets is known as 'sheet like structure'



(v) Pillow like structure - The surface of the rock is appearing as like as 'pillow structure'

(vi) Columnar structure - The igneous rocks are formed in the shape of columns is known as 'columnar structure'



* Textures of Igneous Rocks: It is the representation of internal bonding, shape and size

Based on Grain size:

(i) phaneric texture – The grain size of the particles is more than 5mm. Is known as 'phaneric texture'

(ii) Aphaneric texture – The grain size of the particle is less than 1mm. Is known as 'Aphaneric texture'

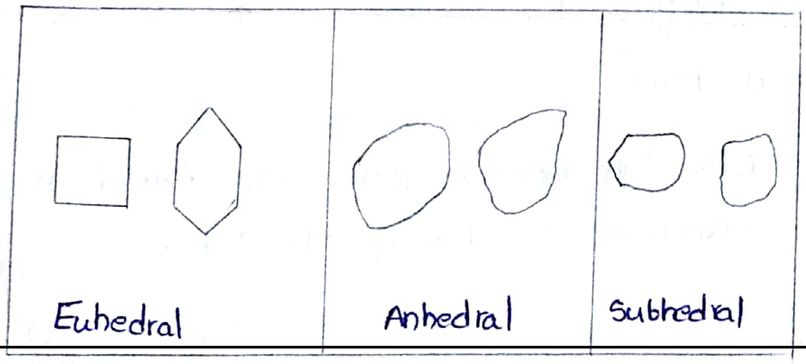
(iii) phaneric Medium texture – The grain size of particle is in between 1mm to 5mm is known as 'phaneric medium texture'

Based on shape of the particle:

(i) Euhedral texture – The particles of the mineral are in a regular shape and equidimensional.

(ii) Semihedral texture – The particles of the mineral are in a semi-regular shape are known as 'semi-hedral texture'

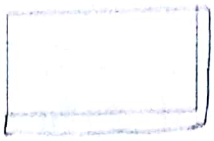
(iii) Anahedral texture – The particles of the mineral are in a irregular shape are known as 'Anahedral texture'



Based on shape:

(i) Equidimensional texture- The particles of the   mineral are equal dimension in all the directions (x, y, z).

(ii) Platy texture - The particles of the mineral are more in x-direction is known as 'platy texture'.



(iii) Prismatic texture - The particles of the mineral are more in y-direction is known as 'prismatic texture'.

* (ii) Sedimentary rocks: The rocks which are formed mainly due to sedimentation of particles due to various geological agents like wind, river etc.,.

Classifications:

(a) Detrital Rocks:- The rocks which are formed by combination of rock fragments and soil (highly fined) particles are called as 'Detrital sedimentary rocks.'

(b) Un-detrital rocks:- The rocks which are formed by sedimentation of pure soil particles are silting materials are called as 'Un-detrital rocks.'

Based on chemical formations:

(i) Siliceous type- It can be formed mainly constituents of silica. which are very frequent in nature. These are strongest in 'sedimentary rocks'.

(ii) Carbonaceous type- These rocks are formed by sedimentation of carbon deposits from coal, trees etc.,.

(iii) calcareous type- These rocks are formed from deposits of calcium. It is a main constituent in ores of lime, deadbodies.

Based on physical formation:

(i) Startified sedimentary rocks - The rocks which are formed by a process of 'Startification.'

(ii) Un-startified rocks - It can be formed by the sedimentation is done by manner is called as ' Unstartified rocks'

(iii) Foliated rocks - The sedimentation process is done in an 'Inclined' manner are known as ' Foliated rocks.'

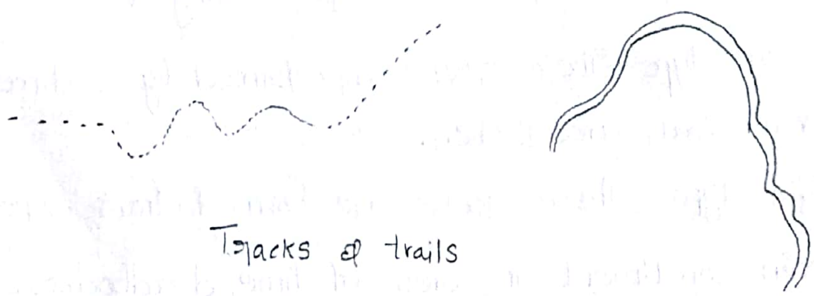
* Structures and Textures of sedimentary rocks:

(i) Ripple marks - The marks which are formed by collision (or) impression of water on the surface of sedimentary rocks are called 'Ripple marks'

(ii) Sun cracks - The marks, cracks which are formed by temperature, thermal effect of sun on the rocks.

(iii) Rain Prints - The prints which are formed by impact of percolation of rain water is known as ' Rain prints.'

(iv) Tracks (or) Trails - The prints which are formed by digging (or) weight of the big animal.



Tracks & trails

(iii) Metamorphic rocks: It can be formed by the combination of igneous and sedimentary rocks with in the presence of temperature, pressure & chemically active fluids.

Types of Metamorphism:

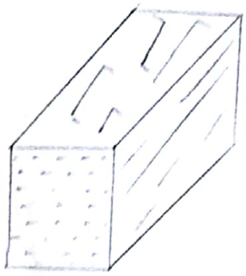
(i) Thermal metamorphism - The metamorphism which is takes place mainly due to presence of temperature is called 'Thermal metamorphism'

(ii) Dynamic metamorphism - The metamorphism which is takes place mainly due to presence of pressure is called 'Dynamic metamorphism'

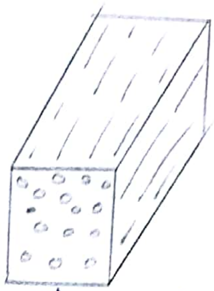
(iii) Uni-form metamorphism - The metamorphism which is mainly due to the presence of both equally is called 'Uniform metamorphism'.

* Structures:

(i) Foliation - When the temperature and pressure acting on a rock are parallel to each other. The formation of layers will be parallel in all directions.



(ii) Lineated - whenever the rocks are forming with the presence of temperature and pressure in different directions this structure is called as 'lineated structure'.



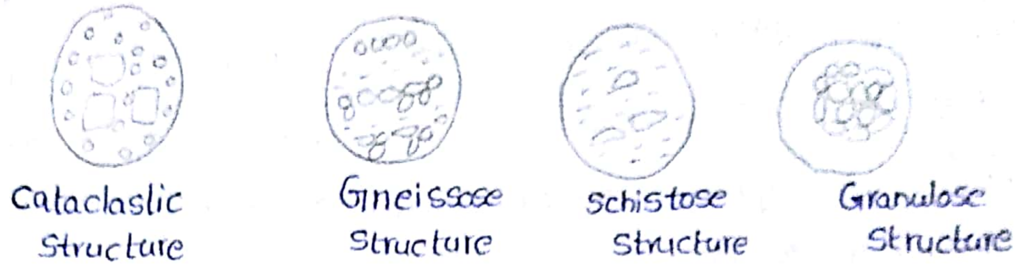
(iii) Gneissos structure - The rocks which having equidimensional minerals in all directions. In this the minerals are platy and prismatic.

(iv) schistose structure - In this the minerals are arranged in fications (or) lineations. In schistoses structure no segrelation takes place

Cataclastic structure - The structure which is formed by direct pressure. In this the minerals are arranged in parallel directions.

(vi) Interlocking structure - In this the minerals are interlocked with another minerals.

(vii) Granulose structure - The structure which is formed by equidimensional minerals. In this no segretation no foliations takes place.



UNIT - III

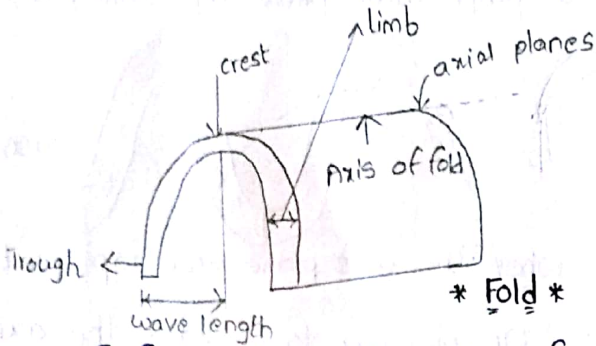
Structural Geology

* Strike And Dip - When strata are affected by tectonic forces and structures have developed, they can be studied by their altitude. It gives details of the position of occurrence (3-dimensional) in place. It comprises two factors known as Strike and Dip.

* Outcrop :- A geological formation exposed on the surface is called an outcrop. It is also used as a general term to refer to exposed folds, faults, joints etc.,.

* Folds :- It is a structure of rocks which bents upward (or) downwards due to temperature and pressure effect.

Parts :



(i) Axies of fold - It is the axis of fold where the folding action takes place at the centre of the total fold

(ii) Axial plane - The total folding plane with respect to the axis of the fold is known as 'Axial plane'

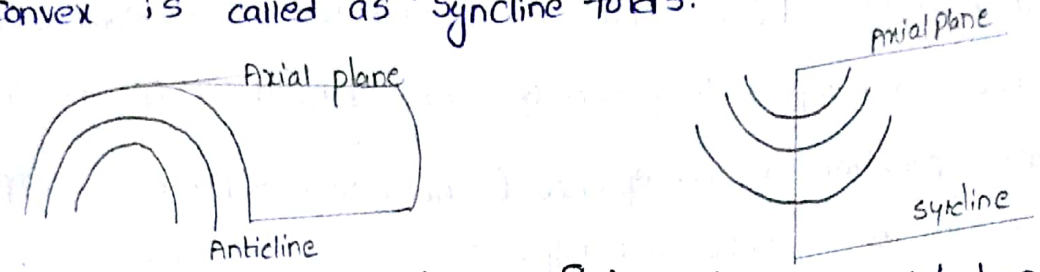
(iii) Crest - The top portion of the fold is known as 'crest'

(iv) Trough - The bottom portion of the fold is known as 'Trough'

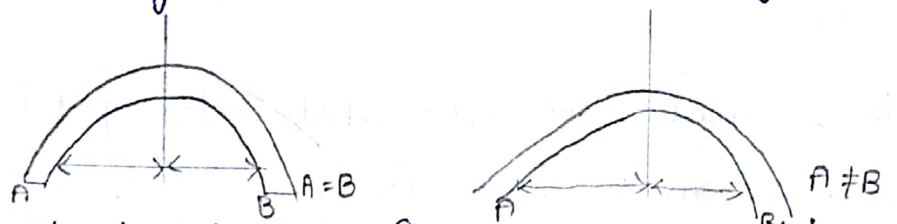
(V) Wavelength - The successive distance between crest and trough is known as 'Wave length'

(vi) Limb - The part between successive crest and trough is known as 'limb'

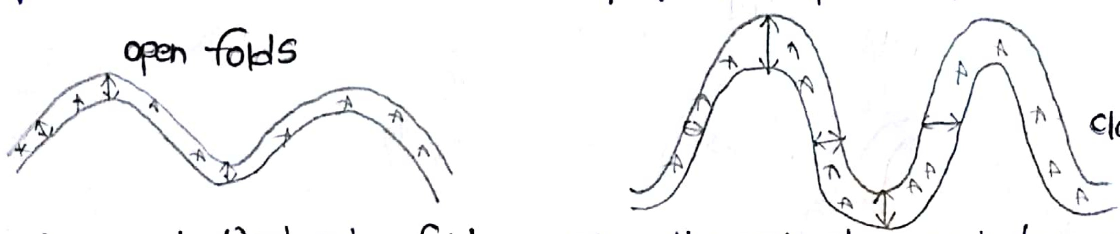
(i) Anticline and Syncline :- The fold which is bent upward is called as 'Anticline'. Syncline folds which are bent downwards are in the shape of convex is called as 'Syncline folds'.



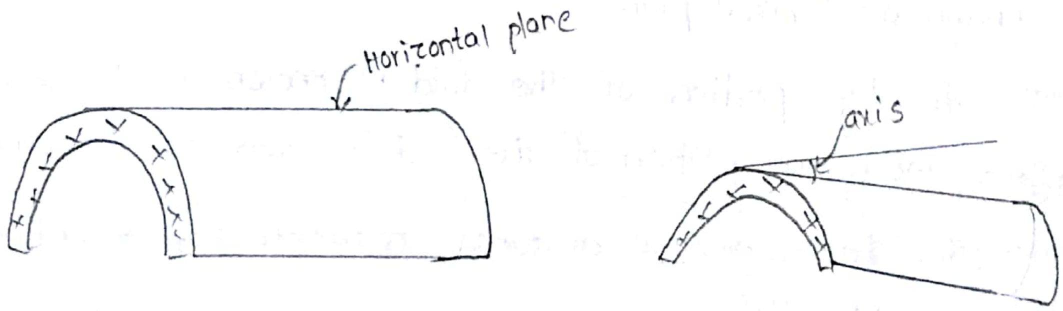
(ii) Symmetrical and Un-symmetrical folds:- when the axial plane divides a fold in two equal halves. Which are mirror image to other folds. If the two halves are not mirror images, then the fold is called 'Un-symmetrical fold'.



(iii) Open and closed Folds :- The folds which are equal in nature (shape, size) and continued further are called as 'open folds'. The folds which are having unequal thickness and closed in a particular place are called as 'closed fold'.



(iv) plunging and Unplunging folds:- When the axis plane and top portion of the fold are matched are called as 'Un-plunging fold'. When the axis plane and the top portion of the folds are un-matched are called as 'plunging folds'.



Non-plunging fold   plunging fold

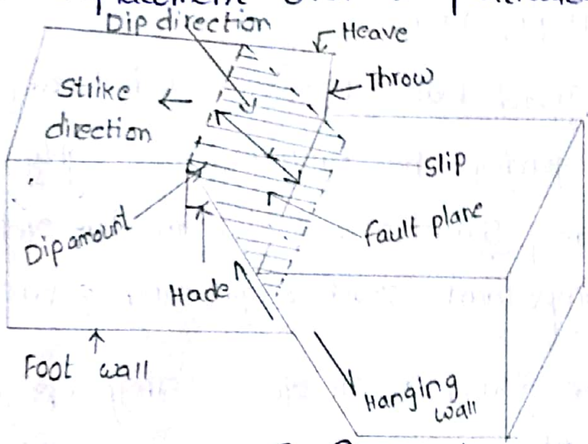
Mechanism - folding of rocks takes place by different ways of accomo-dation of stress. slip (or) shears occur in between the beds. This process is similar to slipping of cards when the set (deck) is folded. Not allowed to slip over one another, folding set cannot takes place.

* Impartance in civil Engineering:

The physical effects produced in rocks due to folding are very important from the civil engineering, Particularly in the location of dams, reservoirs, tunnelling etc., and some economically important ore deposits.

* Faults :- It is a structure of geology which aren't seperated and their will be some displacement over a particular point (or) place.

Parts:



Foot wall - It is a part of fault where it is in rest position and the displacement can be done on it.

Hanging wall - It is a moving wall which based on the foot wall.

slip - It is the displacement of hanging wall on the faulting plane.

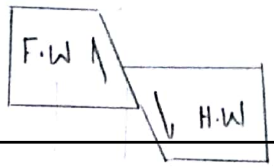
Faulting plane - It is a plane where faulting action is takes place.

Heave - In the action force in vertical direction is known as 'Heave'

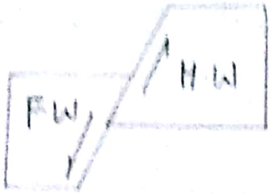
Throw - In the action force in Horizontal direction is known as 'Throw'

Types:

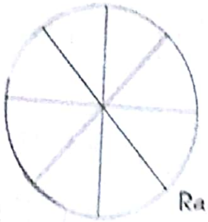
(i) Normal faults - The faulting action takes place from top to bottom is called Normal faults.



faulting action takes place from bottom to top are called 'Reverse fault'.



iii. Radial fault - The faulting action takes place in all the directions are called as 'Radial faults'



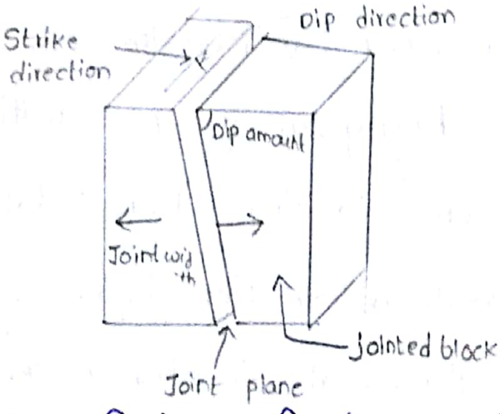
Radial faults.

* Importance in civil Engineering:

They also face ground water problems and hazards of earthquakes and landslides. All these render the fault places highly dangerous to withstand any civil Engineering structures over them. The relevance of faultin with reference to some important civil Engineering structures.

* Joints:- It is a fracture found in all rocks. They are cracks formed due to various reasons. Thus, Joints occur generally as a no. of parallel and oriented is known as 'Joints (or) Joint set'

Parts:



Joints are like faults refer to the fractures in rocks. Hence, like faults inclined, vertical joints by their attitude. In Joints, the fractured block are named as strike and dip direction.

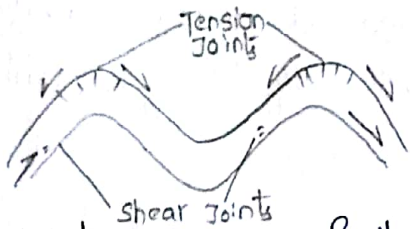
Types:

(i) Strike joints - When joints are parallel to the strike direction or dip direction of adjacent beds, they are called strike joints.

(ii) Oblique joints - If the strike direction of joints is parallel neither to the strike nor dip direction of adjacent beds, then such joints are called oblique joints.

(iii) Bedding joints:- If the altitude of joints coincides completely with the altitude of adjacent beds, they are called bedding joints.

(iv) Tension joints - The wedge-shaped fractures are formed due to tensional forces is called 'Tension joints'.

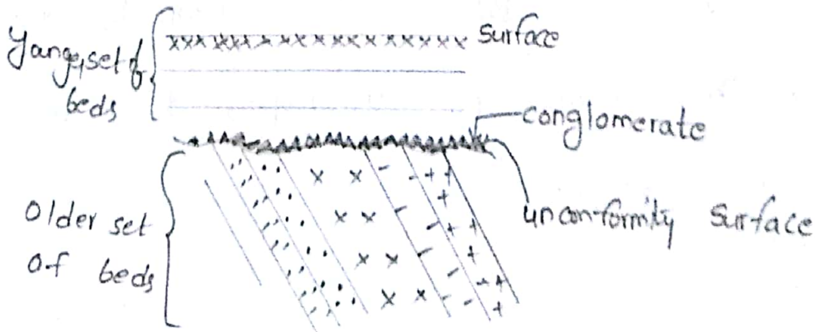


(v) Shear joints - In the faults and limbs of folds are the places where shearing forces occurs is called 'shear joints'.

* Importance in Civil Engineering: When compared with faults, joints don't have any brecciation, there is no risk in displacement of ground. So, joints like faults can be easily dealt with in improving the sites to make suitable for important in civil Engineering structures.

* Unconformities :- In sedimentary rocks without any major break, they are said to be a set of conformable beds in between two sets of conformable beds, it is called an 'Unconformity'.

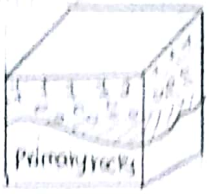
Parts:



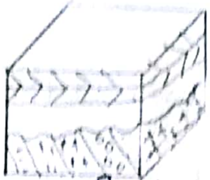
[illegible] of formations belonging to two different ages i.e one set is older and other set younger having a depositional break. It have an unconformity surface too. A few may have conglomerates along unconformity surfaces.

Types:

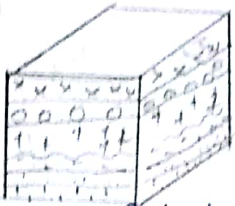
(i) Non-conformity - Underlying older formation and the overlying younger formation are sedimentary rocks, the unconformity is called "non-conformity."



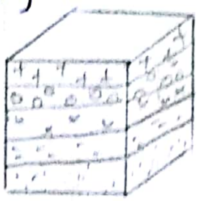
ii) Angular Unconformity - When the younger and older sets of strata are not mutually parallel, then the unconformity is called 'Angular unconformity'.



iii) Disconformity - If the beds of younger and older sets are mutually parallel and the contact plane of two sets is only an erosion surface then the unconformity is called 'Dis-conformity'.



(iv) Para conformity - When the two sets of beds are parallel and the contact is a simple bedding plane, the unconformity is called 'para conformity'.



* Importance in Civil Engineering: In the conformity beds are due to sedimentary in the Engineering structures it can be important in foundational structures.

UNIT - IV

Ground Water & Earthquakes, Landslides

* Water table :- The percolation of rain water leads to the development of a zone of saturation above the bed rock, The upper surface of this zone of saturation is called 'water table.'

* Cone of depression :- When water is pumped out in a considerable measure from such a well, the level of water in it goes down, leading to the depression in the water table around the well in the form of inverted cone. This phenomenon is called the Cone of depression.

* Geological Controls of Ground water movement : Ground water movement in the zone of aeration takes place under the influence of gravity.
(i) The permeability character of rocks is one of the most factor of ground water movement.
(ii) It is kind of secondary porosity associated with the rocks. Well-developed joints.
(iii) The other important geological Control is the attitude of bedding.
(iv) The buried river channels and unconformities also influence the ground water movement.

* Ground water exploration :- Ground water does not occur every where below the earth's surface. The general shortage of surface water and demands of water spent to explore and to locate places is known as 'ground water exploration.'

Techniques:
(i) Geological Investigations - It comprises the study of a given area from different angles are now to predict the scope of groundwater occurence there

(ii) Geophysical Investigations – It is made on the surface, quickly, with the portable instruments. In [illegible] the 'electrical resistivity method' is employed the remaining "seismic refraction method" are used for this

(iii) Hydrological investigations – Such investigations are relatively simple but very important in the assessment of the ground water potentiality in any region.

* Earthquakes terminology: The place of origin of the earthquake in the interior of the earth is known as 'focus'. Which lies above the centre of the earthquake is known as 'epicentre'. Imaginary lines with joins is called 'seismic vertical'. These lines joining the same intensity is called 'isoseismal'. The enormous energy transmitted in all directions in the form of waves, as 'seismic waves'.

Classifications:

(i) Earthquakes with a focus depth less than 60 km are called 'shallow earthquakes'.

(ii) If the depth is more than 60km but less than 300km are called 'Intermediate earthquake'.

(iii) which have a focus depth more than 300 km are called 'Deep earthquakes'.

Causes:

In earthquake causes are described as tectonic (or) Non-tectonic.

(i) Tectonic earthquakes – The earthquake are exclusive due to internal force i.e., due to disturbances of geological formations taking place in the earth's interior.

(ii) Non-tectonic earthquakes – The earthquake cause are generally due to external (or) surface-causes. Which occurs due to volcanic eruptions are also termed as non-tectonic earthquake.

Seismic Belts and Shield areas :- where are earthquakes are frequently and shield areas are those places occurs either slowely. In a place is an indication of understand stability here. Under startigraphy, the regions where Archaean formations occur very stable and mo8e from earthquakes is called Shield areas. These are are frequently places those are called 'seismic belts'.

* Ricther scale :- These scale are repo8ted by the news media in earthquake Using the size of surface wave particular type of seismograph is called 'Richter scale'.

* Intensity :- the intensity of an earthquake refers to the degree of destruction caused by it. Its also measure of severity of the shaking of ground and its attendant damage.

* Precautions of building constructions in seismic areas:
When increasing the stability of buildings in seismic areas. They as follows:
(i) Building should be founded on hard bedrock or fractured rocks due to earthquake vibrations.
(ii) The foundation and the superstructure should be tied up by reinforcements.
(iii) Buildings situated in cuttings on hill sides, near steep slopes ground always suffer mo8e when an earthquake occurs.

* Landslides :- The term landslide is self-explanatory and refers to the downward sliding of huge quantities of land masses is called landslides.
Classifications:
All the types of earth movements can be classified as.
(i) Earth-flow (ii) landslides (iii) subsidence.
(i) Earth flow → Solifluction refers to the downward movement of wet soil along the slopes under the influence of gravity is called 'Earthflow.'
(ii) landslides → If a mass of earth (or) rock moves along a definite zone or surface, the failure is called a landslide.

Slides ... It may be both natural and artifical causes. It may take place due to plastic outflow of underlying strata, or due to the compaction of underlying material or due to collapse.

* Causes :- They are two causes namely internal causes and immediate causes
1. internal causes → It is responsible for the actual slip of the land mass due to frictional resistance to movement and inertia is known as 'internal cause'.
2. Immediate Causes → The overcoming this frictional resistance or inertia by providing necessary energy in the form of sudden jerk is known as 'Immediate cause'.

* Effects :- If the landslides occur at vulnerable places they may cause
(i) Disruption of transport by damaging roads
(ii) obstruction to the river flow in valleys, leading to their overflow floods.
(iii) Damage to sewer and other pipelines.
(iv) Burial of buildings and other constructions.

* Measures to be taken prevent their occurence at landslides:
To prevent the occurence of landslides. The main factors which contribute to landslide occurence are slope, water content, structural deffects, unconsolidated or loose character of the overburden, lithology, and human interference.

Unit-5
Geo physics

Gravity Methods

The gravity field of the Earth can be measured by timing the free fall of an object in a vacuum, by measuring the period of a pendulum, or in various other ways. Today almost all gravity surveying is done with gravimeters. Such an instrument typically consists of a weight attached to a spring that stretches or contracts corresponding to an increase or decrease in gravity. It is designed to measure differences in gravity accelerations rather than absolute magnitudes. Gravimeters used in geophysical surveys have an accuracy of about 0.01 milligal (mgal; 1 mgal = 0.001 centimetre per second per second). That is to say, they are capable of detecting differences in the Earth's gravitational field as small as one part in 100,000,000.

Gravity differences over the earth’s surface occur because of local density differences between adjacent rocks. The variations in the density of the crust and cover are presented on a *gravity anomaly map*. A gravity anomaly map looks at the difference between the value of gravity measured at a particular place and the predicted value for that place. Gravity anomalies form a pattern, which may be mapped as an image or by contours. The wavelength and amplitude of the gravity anomalies gives geoscientists an idea of the size and depth of the geological structures causing these anomalies. Deposits of very dense and heavy minerals will also affect gravity at a given point and produce an anomaly above normal background levels.

Anomalies of exploration interest are often about 0.2 mgal. Data have to be corrected for variations due to elevation (one metre is equivalent to about 0.2 mgal), latitude (100 metres are equivalent to about 0.08 mgal), and other factors. Gravity surveys on land often involve meter readings every kilometre along traverse loops a few kilometres across. It takes only a few minutes to read a gravimeter, but determining location and elevation accurately requires much effort.

Gravity measurements can be obtained either from airborne (remote) or ground surveys. The most sensitive surveys are currently achieved from the ground. Variations of gravity are due to local changes in rock density and therefore depend on the type of rocks beneath the surface. Sedimentary rocks are, for example, less dense than granite, which is in turn less dense than basalt.

In most cases, the density of sedimentary rocks increases with depth because increasing pressure reduces porosity. Uplifts usually bring denser rocks nearer the surface and thereby create positive gravity anomalies. Faults that displace rocks of different densities also can cause gravity anomalies. Salt domes generally produce negative anomalies because salt is less dense than the surrounding rocks. Such faults, folds, and salt domes trap oil, and so the detection of gravity anomalies associated with them are crucial in petroleum exploration. Moreover, gravity measurements are occasionally used to evaluate the amount of high-density mineral present in an ore body. They also provide a means of locating hidden caverns, old mine workings, and other subterranean cavities.

Density contrasts of different materials are also controlled by a number of other factors. The most important are the grain density of the particles forming the material, the porosity of the material, and the interstitial fluids within the material. Generally, specific gravities of soil and shale range from 1.7 to 2.2. Massive limestone averages 2.7. While this range of values may appear to be fairly large, local contrasts will be only a fraction of this range. A common order of magnitude for local density contrasts is 0.25.

Gravity surveys provide an inexpensive method of determining regional structures that may be associated with groundwater aquifers or petroleum traps. Gravity surveys have been one of the principal exploration tools in regional petroleum exploration surveys. Gravity surveys have somewhat limited applications in geotechnical investigations.

Electrical Methods

Electrical methods are used to map variations in electrical properties of the subsurface. The main physical property involved is electrical conductivity, which is a measure of how easily electrical current can pass through a material. Subsurface materials exhibit a very large range of electrical conductivity values. Fresh rock is generally a poor conductor of electricity, but a select group of metallic minerals containing iron, copper or nickel are very good conductors. Layers of graphite are also very good conductors.

The examples of good conductors mentioned above are quite rare. For most rocks, the electrical conductivity is governed to a large degree by the amount of water filling the pore spaces and the amount of salt dissolved in this water. Pure water has a very low electrical conductivity. On the other hand, seawater, which contains high levels of dissolved salts such as NaCl, is a relatively good conductor of electrical current. Groundwater can vary in salt content from fresh through brackish (slightly salty) to saline (similar in salt content to seawater) through to hyper-saline (more salty than seawater).

Electrical conductivity of rocks is not the only attribute which is of value to exploration geologists. A number of different electrical properties of rocks are measured and interpreted in mineral exploration. They depend on:

a) Natural currents in rocks – Self-potential method

b) Polarizability of rocks – Induced polarization method

c) Electrical conductivity or resistivity of rocks – Resistivity method

d) Induction – Electromagnetic method

Self Potential Method: Some materials tend to become natural batteries that generate natural electric currents whose effects can be measured. The self-potential method relies on the oxidation of the upper surface of metallic sulfide minerals by downward-percolating groundwater to become a natural battery; current flows through the ore body and back through the surrounding groundwater, which acts as the electrolyte. Measuring the natural voltage differences - usually 50-400 millivolts (mV), permits the detection of metallic sulfide bodies that lie above the water table. Other mineral deposits that can generate self-potentials are graphite, magnetite, anthracite, and pyritized rocks.

Induced Polarization: The passage of an electric current across an interface where conduction changes from ionic to electronic results in a charge buildup at the interface. This charge builds up shortly after current flow begins, and it takes a short time to decay after the current circuit is broken. Such an effect is measured in induced-polarization methods and is used to detect sulfide ore bodies.

Resistivity Method: Resistivity methods involve passing a current from a generator or other electric power source between a pair of current electrodes and measuring potential differences with another pair of electrodes. Various electrode configurations are used to determine the apparent resistivity from the voltage/current ratio. The resistivity of most rocks varies with porosity, the salinity of the interstitial fluid, and certain other factors. Rocks containing appreciable clay usually have low resistivity. The resistivity of rocks containing conducting minerals such as sulfide ores and graphitized or pyritized rocks depends on the connectivity of the minerals present. Resistivity methods also are used in engineering and groundwater surveys, because resistivity often changes markedly at soil/bedrock interfaces, at the water table, and at a fresh/saline water boundary.

Electromagnetic Methods: The passage of current in the general frequency range of 500-5,000 hertz (Hz) induces in the Earth electromagnetic waves of long wavelength, which have considerable penetration into the Earth's interior. The effective penetration can be changed by altering the frequency. Eddy currents are induced where conductors are present, and these currents generate an alternating magnetic field, which induces in a receiving coil a secondary voltage that is out of phase with the primary voltage. Electromagnetic methods involve measuring this out-of-phase component or other effects, which makes it possible to locate low-resistivity ore bodies wherein the eddy currents are generated.

A number of electrical methods described above are used in boreholes. The self-potential (SP) log indicates mainly clay (shale) content, because an electrochemical cell is established at the shale boundary when the salinity of the borehole (drilling) fluid differs from that of the water in the rock. Resistivity measurements are made by using several electrode configurations and also by induction. Borehole methods are used to identify the rocks penetrated by a borehole and to determine their properties, especially their porosity and the nature of their interstitial fluids.

Magnetic methods

One of the most important tools in modern mineral exploration methods is magnetic survey. Magnetic surveys are fast, provide a great deal of information for the cost and can provide information about the distribution of rocks occurring under thin layers of sedimentary rocks - useful when trying to locate orebodies.

When the Earth's magnetic field interacts with a magnetic mineral contained in a rock, the rock becomes magnetic. This is called induced magnetism. However, a rock may itself be magnetic if at least one of the minerals it is composed of is magnetic. The strength of a rock's magnetism is related not only to the amount of magnetic minerals it contains but also to the physical properties, such as grain size, of those minerals. The main magnetic mineral is magnetite (Fe_3O_4) - a common mineral found disseminated through most rocks in differing concentrations.

Measurements of the Earth's total magnetic field or of any of its various components can be made. The oldest magnetic prospecting instrument is the magnetic compass, which measures the field direction. Other instruments, which are appreciably more accurate include magnetic balances, fluxgate magnetometers, proton-precession and optical-pumping magnetometers.

Magnetic effects result primarily from the magnetization induced in susceptible rocks by the Earth's magnetic field. Most sedimentary rocks have very low susceptibility and thus are nearly transparent to magnetism. Accordingly, in petroleum exploration magnetic surveys are used negatively - magnetic anomalies indicate the absence of explorable sedimentary rocks. Magnetic surveys are used for mapping features in igneous and metamorphic rocks, possibly faults, dikes, or other features that are associated with mineral concentrations. Data are usually displayed in the form of a contour map of the magnetic field, but interpretation is often made on profiles.

It must be remembered that rocks cannot retain magnetism when the temperature is above the Curie point (□ 500^{o}C for most magnetic materials), and this restricts magnetic rocks to the upper 40 kilometres of the Earth's interior.

When exploring for petroleum, magnetic surveys are usually made with magnetometers borne by aircraft flying in parallel lines spaced two to four kilometres apart at an elevation of about 500 metres. When searching for mineral deposits, the flight lines are spaced 0.5 to 1.0 kilometre apart at an elevation of roughly 200 metres above the ground. Ground surveys are conducted to follow up magnetic anomalies identified through aerial surveys. Such surveys may involve stations spaced only 50 metres apart. A ground monitor is usually used to measure the natural fluctuations of the Earth's field over time so that corrections can be made. Surveying is generally suspended during periods of large magnetic fluctuation (magnetic storms).

Seismic Methods:

Seismic methods are based on measurements of the time interval between initiation of a seismic (elastic) wave and its arrival at detectors. The seismic wave may be generated by an explosion, a dropped weight, a mechanical vibrator, a bubble of high-pressure air injected into water, or other sources. The seismic wave is detected by a Geophone on land or by a hydrophone in water. An electromagnetic Geophone generates a voltage when a seismic wave produces relative motion of a wire coil in the field of a magnet, whereas a ceramic hydrophone generates a voltage when deformed by passage of a seismic wave. Data are usually recorded on magnetic tape for subsequent processing and display. Seismic methods are of two kinds - Refraction methods and Reflection methods.

Seismic refraction methods: Seismic energy travels from source to detector by many paths. When near the source, the initial seismic energy generally travels by the shortest path, but as source to geophone distances become greater, seismic waves travelling by longer paths through rocks of higher seismic velocity may arrive earlier. Such waves are called head waves, and the refraction method involves their interpretation. From a plot of travel time as a function of source to geophone distance, the number, thicknesses, and velocities of rock layers present can be determined for simple situations. The assumptions usually made are that:

a) Each layer is homogeneous and isotropic (i.e., has the same velocity in all directions)

b) The boundaries (interfaces) between layers are nearly planar; and

c) Each successive layer has higher velocity than the one above.

The velocity values determined from time-distance plots depend also on the dip (slope) of interfaces, apparent velocities increasing when the geophones are updip from the source and decreasing when downdip. By measuring in both directions the dip and rock velocity, each can be determined. With sufficient measurements, relief on the interfaces separating the layers also can be ascertained.

High-velocity bodies of local extent can be located by fan shooting. Travel times are measured along different azimuths from a source, and an abnormally early arrival time indicates that a high-velocity body was encountered at that azimuth. This method has been used to detect salt domes, reefs, and intrusive bodies that are characterized by higher seismic velocity than the surrounding rock. Seismic waves may be used for various other purposes. They are employed, for example, to detect faults that may disrupt a coal seam or fractures that may allow water penetration into a tunnel.

Seismic reflection methods: Most seismic work utilizes reflection techniques. Sources and geophones are essentially the same as those used in refraction methods. The concept is similar to echo sounding - seismic waves are reflected at interfaces where rock properties change. The round-trip travel time, together with velocity information, gives the distance to the interface. The relief on the interface can be determined by mapping the reflection at many locations. For simple situations the velocity can be determined from the change in arrival time as source to geophone distance changes.

In practice, the seismic reflection method is much more complicated. Reflections from most of the many interfaces within the Earth are very weak and so do not stand out against background noise. The reflections from closely spaced interfaces interfere with each other. Reflections from interfaces with different dips, seismic waves that bounce repeatedly between interfaces ("multiples"), converted waves, and waves travelling by other modes interfere with desired reflections. Also, velocity irregularities bend seismic rays in ways that are sometimes complicated.

The objective of most seismic work is to map geologic structure by determining the arrival time of reflectors. Changes in the amplitude and waveshape, however, contain information about stratigraphic changes and occasionally hydrocarbon accumulations. In some cases, seismic patterns can be identified with depositional systems, unconformities, channels, and other features.

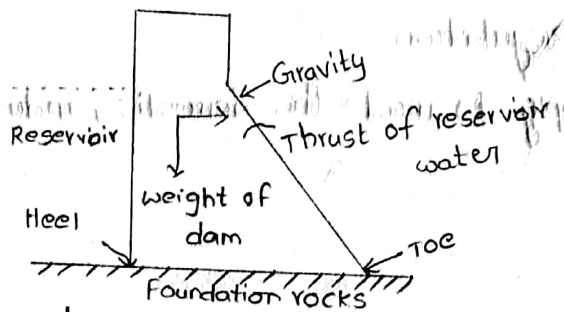
The seismic reflection method usually gives better resolution (i.e., makes it possible to see smaller features) than other methods, with the exception of measurements made in close proximity, as with borehole logs. In most exploration programs appreciably more money is spent on seismic reflection work than on all other geophysical methods combined.

Geology of Dams, Reservoirs And Tunnels.

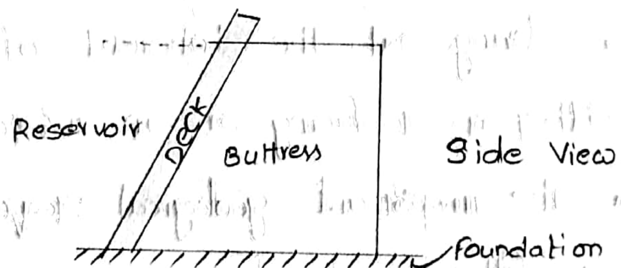
* Dam:- The surface water resources, rivers provide copious supplies of water which can be stored in man-made by across the river is called a 'Dam'

* Types of Dams:

(i) Gravity dam:- These dams are heavy and massive wall-like structures of concrete in which the whole weight acts vertically downwards is called as 'Gravity dam'.

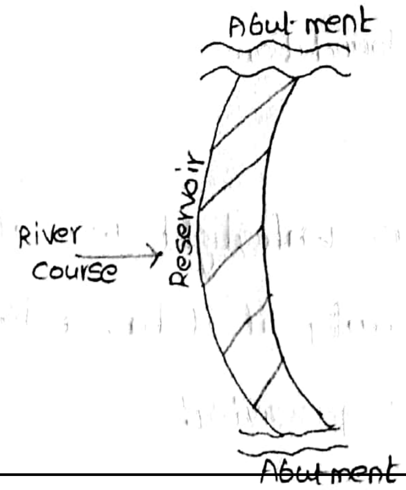


(ii) Buttress Dams:- These are concrete structures in which there is a deck sloping upstream. This deck which takes the entire load is supported from behind by walls called 'Buttress Dams'.



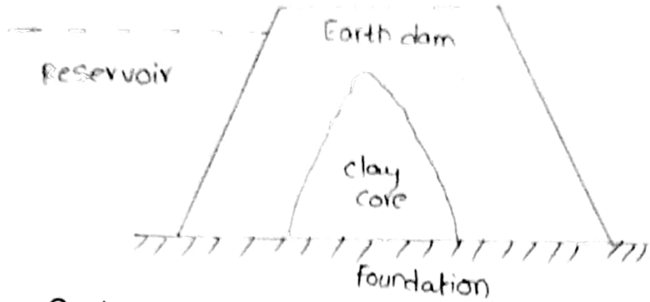
Side View of a buttress dam

(iii) Arch Dams:- This kind of dam is arch-shaped and is always convex in the upstream side and the dam is load transferred to the abutments is known as 'Arch dams'.



Top view of arch dam

) Earth dams:- ... be planned where the underlying is too weak to support masonry dams or where suitable competent rocks occur at a great depth is known as 'Earth dams'.



* Purposes of dams:- Dams are constructed to impound river water for various purposes.

(i) To provide stream regulation
(ii) To provide water supply to meet the domestic, industrial and irrigation requirements.
(iii) To generate power
(iv) To control floods
(v) To provide inland water traffic

* Geological considerations in the selection of a Dam site:

Geological studies bring out the inherent of a site and such studies go a long way either in reducing or in increasing the cost of a dam considerably. The important geological requirements to selection of a dam site are as follows:

1. Narrow river valley
2. occurrence of the bedrock at a shallow depth
3. competent rocks to offer a stable foundation
4. Proper geological structures.

* Reservoir:- To be successful if it is watertight i.e., if it doesn't suffer from any serious leakage of water if it has a long life due to low rate of silting is known as 'reservoir'.

Life of reservoirs:- The process of silting correspondingly reduces the capacity of the reservoir to store water and the total volume of silt and the remainder silty form is known as live storage. The period up to which the reservoir serve its purpose as expected is described as 'life of reservoir'.

* Purpose of Tunnelling :-

(i) It is excavated across hills to lay roads for traffic & transportation of goods.

(ii) In tube railways are planned in very busy and Crowded sites. They advantage of leaving surface Such tunnels are also refferred to as traffic tunnels.

(iii) In diverting the flow of water through the tunnels, dug along the Valleys this kind are known as 'diversion tunnels'.

* Effects of Tunnelling :

(i) In loose and more fractured and porous rocks. This naturally adversely affects the Competence of the rocks Concerned.

(ii) Popping of rocks which means fall of rocks place in brittle and hard rocks of bedding or foliation, during tunnelling ground are affected.

(iii) stability of the ground when the tunnelled ground has unfavourable in ground water Conditions.

* Lining of Tunnels :-

In supports provided for the tunnel in the form of Steel Structures (or) Concrete. The main purpose is to resist the pressure from the Surroundings roof and protect the shape of the tunnel is known as 'Lining of tunnels'.

Influence of Geology for Successful Tunnelling:

The safety, success and economy of tunnelling depend heavily on the geological conditions prevailing at the site. The important factors with interfere with the civil engineering project i.e tunnelling also are lithological, structural and ground water conditions.