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GEOLOGY

Def^{n}: The word Geology come from latin literature (Greek word). By the word 'Geo' means earth and by the word logus means study of science. Hence, Geology is the science of earth or study of earth science.

It deals with the surface features of the earth such as, mountain, volcano, interior of the earth, different geological agent such as Wind, Water and glacier (ice river).

Branches of Geology: The geology is a well diversified subject different scientist and engineers dealt to subject in different way therefore there are many branches, sub-branches and allied subject of the subject Geology.

Branches:

1) Physical Geology: It deals with work of different agent on the surface of the earth known as geological process (Agents are air, surface water), Underground water (U/g) etc. The physical geology also known as "dynamic Geology".

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ii) Structural Geology : Which deals with the structure of the earth and some time interior of the earth surface and action of internal and external force on the surface of earth practically it deals with disturbance on the earth crust.

iii) MINERALOGY : Rocks are natusally combinati of mineral therefore mineralogy is the subje which deals with mineral composition of the rock masses.

iv) Petrology : Earth crust is divided in to 3 - types of rock such as igneous, sendimentoy and metamorphic. Petrology deals with the origine of the earth its classification and distribution.

v) Historical Geology : Its deals with chronology (Time - Scale) of different rocks present on the surface of the earth practically the geological time scale divided in to 3 time zone.

i) Primary (Palazoic)
ii) Secondary (Mesozoic)
iii) Tertiary (Cainozoic)

The historical geology also known as Statigraphy. It deals with avalution of the earth such as succes

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and its geological time zone.

vi) Palaeonotology : It deals with rilics (resedue) of animals and plant mattesials and its geological time scale. Geologicaly, practicall it given an idea about fossils.

vii) Economical Geology : It is very diffesent type of branch of the subject it deals with the market values of minerals & also the rock. From the point of view of geologist and mining engineer coal is rock known as sendimentary rock. But from the point of view of Economics and business purpose coal is considered as mineral in ~~geology~~ (railway).

viii) Engineering Geology : It deals with diff. type of rock and building material to be used in any engineering project such as construction of dams, extension of railway ~~trat~~ track.

ix) Mining Geology : This is a special study of geology which deal with formation of rock, ore, its origine, classification and planing for method of work.

Sub- Branches (sub- division):

~~It is the subject which is combination of geology and physics basically its deals with magnetic behaviour of the ores available.~~

It is either combination of any two science and related with its parent science the following are main branch of geology:

i) **Geophysics**: It is combination of geology and physics basically its deals with magnetic behaviour of the ores available either at the surface or underground it also deals with electric, gavimetry, seismic study of the earth surface and underneath earth surface.

(ii) **Geochemistry**: Which is combination of geology and chemistry. Geochemistry is a science which deals chemical properties of different ore body available either at the surface or below the surface.

iii) Geomorphology: Recently the subject is included in the branch of geology but practically it is sub-branch it deals with investigation of mountain, valley, basins, plane etc.

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Allied BRANCHES:

The allied branches are those branches which has got some relation either with main branch or sub branch. The following are the allied branch

i) Rock MECHANICS: It deals with effect or behaviour of diff. force, stress or pressure on the rock practically rock mechanic is engineering science the effect of diff. stress depends on somepositon of the rock.

ii) Geo Mechanics: It is very new field of geology and has relation with rock mechanics it deals with natural force which play on the surface of earth on the global or regional level.

iii) Oceanography: It deals with very new different waves of oceans, geological history of ocean, chemical composition of water of ocean, physical behaviour of water of ocean economical value of ocean.

iv) Meteorology: It is nothing but study of the atmosphere on the surface of the earth such as temp, weather, possibility of rain.

Geology

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Scope of Geology:

By the word scope we mean benifit or advantage of any profession, system and subject etc.

Practically the word scope is used for professional or scientific both the words self explanatory.

We are mainly concerned with scope of geology & but not geologist.

The scope of geology are mainly classified in to five main category which are given below:

i) In the field of Mining Engineering: This is the most important scope for a mining engineer since, the service of geologist can not be negletated for the proper working of mining Industry.

The subject helps right from prospecting to extraction of mineral or orebody. (Development of mines and extraction).

ii) In the field of Civil Engineering: Many a times a civil engineer can not proceed without the help of geologist since, basically the work of civil engineer depends on surface of the earth which contain plane, hill, mountain, waterbody etc.

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For the construction or extention of railway track line geology of the area must be known before hand.

In the same manner construction of various damps requires suggestion of geologist. Since natuse and structural feature of the area to be known before hand. Since the rock need to bear heavy load.

Same is the case with the construction of building so that building should not be constructed in earth quake prone area.

(ii) In the field of Hydro Geology:
Hydro geology is the main subject comes out from main subject geology which deals with drainage of water on the surface of the earth. Practically there are some problem of the water supply system or supply water or also Irrigation. In that case advise and instruction of geologist are mostly required.

(iii) In the field of study of mineral spring (fountain): In most of the past of western country such as America different types of mineral springs are invented. Such type of springs are helpful in curing various dearese.

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These has been suggested by geologist such as mineral springs are known as 'Spa'. Basically the water of such Spa are used for curing of different skin desease and also other desease.

v) (a) In the field of Chemistry and Medical Science: In many parts of the world the water may contain presence of hasmful minerals or chemicals such as Arsenic.

Similar in many part of the world it has been found that these is deficiency (salt) of important mineral such as calcium is required for maintaining construction of bone and its health. The subject geology helps in such cases so that civilization can not go in dangerous condition.

In this way Survice of geologist can not be ignore.

b) Silica is a dangerous chemicals which causes lung (tissue) problem such as a dangerous desease known as silcosis result. It is geologist which have given the harmful effect of inhaling silcosis.

Basically the problem is associated with mining industries.

All the above facts are basic concept about scope of geology.

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Excluding above facts ~~are basic concept about scope of geology~~. Some other problems are also dealt with geology such as controlling of blasting in city and town.

Sometimes for detection of poison in food items service of geology required such as some rocks or clay change their colours with touching of poison for this purpose plate are made of such rocks to detect poison.

EARTH

- Age of Earth
- Structure of earth
- Origine of earth

DISCRIPTION OF THE EARTH: Civilized persons are concerned with system of mother earth on which we live.

Accordingly, we are interested to know

(i) Age of the Earth
(ii) Structure of the Earth
(iii) Origine of the Earth

All the above facts are contradictry since to know age of the earth is absolutly impossible. Hence, some process are adopted to know the age. Same is the case with structure and origine. Hence, there are ~~change~~ divergence of

openion regarding the above 3- physical knowledge.

① **Age of the Earth :** It is believed that birth of the earth ~~that~~ has taken from hot gaseous or molten state.

To definite scientific process are adopted to described Age of the Earth. They are :

i) Indirect method : Which is related with geological events.

ii) Direct method : This is nothing but decay of radio active element. Half life period of almost all the radio active elements are known accordingly earth age is decided.

Both the above method is no the very correct - but for scientific phenon and research earth age is considered to be 4500 million yea

i) Indirect method : In this method various systems are used which are scientificaly known as clock They are.

② **Varve clock :** The varve clock is a system of sendimentry deposits in glacial region. In scientific sense colour of deposits changes also size of the material changes this has been studied

by geologist (In India this was studied in Kashmir valley of Himalya range).

In this method only up to 800 yrs. can be calculated.

(b) Sendimentry clock: This is a system in which rate of depesition of sendimentation is studied. Sendimentation formed in no. of layers during the geological histary. The layers are different in different geological time scale. Such as psimary, secendry and tertiary (Palaroic, mesozoic and cainzoic).

Study revels that in about 800 yrs. only 1 fit deposition is posible hence this method is to sumextend better salinity clock.

c) Salinity, Clock: The earth crust made of diff. types of rocks which contains salts of various nature. The salinity of sea definitly comes from eroision and depositions of surface rocks.

Bactically the rate of salinity is calculated by eroision and depesition from land to water body by adopting such method the earth age was calculated only 100 million yrs. This is definitly in correct.

All the above facts and description

are made on the basis of physical events on the earth surface. Hence, two other method also are used by geologist to get approximately actual age of earth. They are:

i) Rate of cooling of the earth:
It is believed that earth was formed from hot state. The temp. at the Initial stage of the earth was considered 3900°C. It has been decided that earth has ~~been~~ taken 400 million years to be at the present state this is also imperfect.

Evolutionary changes in Animals—
This is a very important concept since biological scientist believe that evolution must have taking place the 1st for animal unicellular to change in to multicellular or complex nature. It has spent alot of geological time scale on the basis biologist are decided that earth age to be 1000 million years.

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Radio- active Method:

Radio- active method is a system used for determination of age of the earth. It is known that radio active substance decay to convert into any dotter element. The decay starts at a constant rate. It also takes some million years to convert In this case the unit of time is taken as one year (Unit doesnot come in day or month) Accordingly half- life period is estimated.

The below mentioned method are adopted normly to calculated age of the earth.

i) Uranium - Lead Method: It means conversion of uranium in to led. We have to isotopes normly of uranium those are

U^{238} & U^{235}

Both elements are converted in to led after decay. but the half life period differs for Uranium - 238. The half-life period is 713 million years. Hence U^{238} has been considered for calculating age of the earth.

ii) Thorium - Lead Method: like Uranium, thorium also yields lead but the half period of thorium is 13900 million yrs.

iii) Pottasium-Argon Method: Practically there are 3- isotopes of pottasium K^{39}, K^{40} and K^{41} of the three isotopes K^{40} is radio active. Due to decay of K^{40} it is converted in to Ar^{40} it is convert in to Ar^{40} the half life period of K^{40} to convert Ar^{40} is 11850 million years.

iv) Rubidium Strontium Method: The Rb^{87} is radio-active due to decay it converts in to Sr^{87}. The half-life period for conversion is 50000 million years. This is the most valuable information. Specially for metamorphic rocks

v) Carbon-dating system or Radio carbon system: All the living animals takes in carbon during life time this is C^{14} actually this isotopes of carbon is radio active after death all the animals emits C^{14} at the constant rate. The dating is about or may be up to 70000 years. but half life period of C^{14} is 5570 years after studing all the above phinomenon the half life period of the earth was considered by geological scientist as 4.5 billion yrs.

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* Interior of the Earth:

i) Crust (ii) Mantle (iii) Core

The earth is an oblate spheroid. The radius of the earth is considered as 6371 Km but geologist have of the openion that the equatorial radius is 6378 Km and polar radius is 6356 Km but exact radius 4000 miles

The earth has been divided in to 3-segment based on the discontinuity. Discontinuity is a line of seperation b/w two segment. These are scientific name of discontinuity based on the name of geologist of scientists. According to Mohorovicic discontinuity is a line of seperation b/w crust and Mantle.

Guttenburg discontinuity is the line of seperation between mantle and core. All these are primary discontinuity but in between this primary discontinuity some other secondry discontinuity exist.

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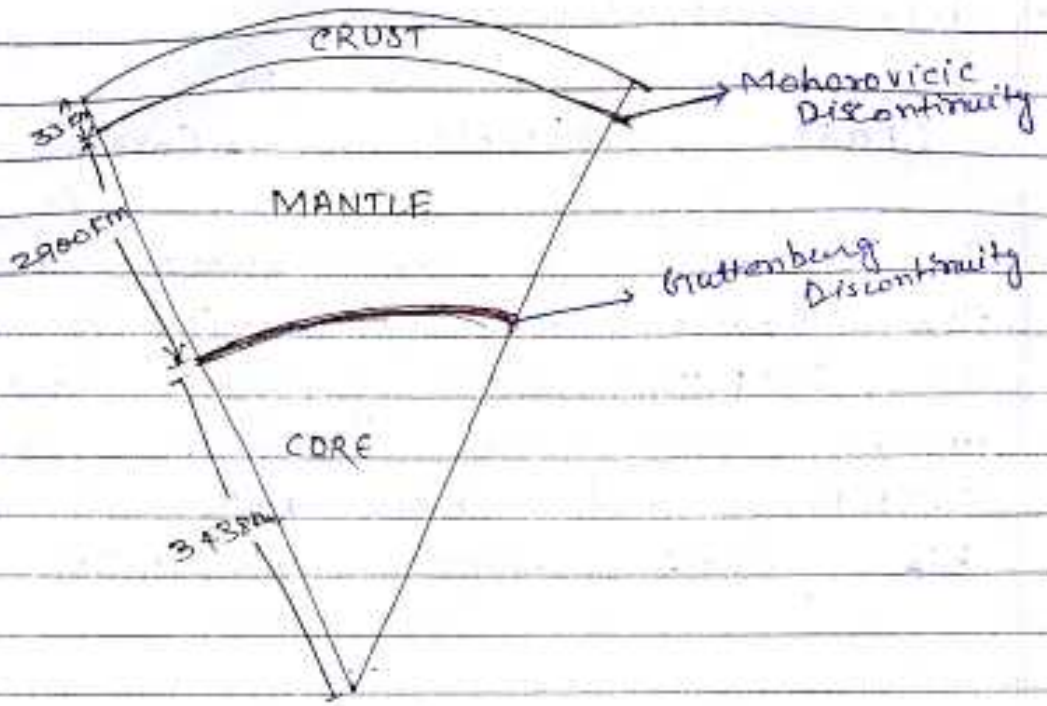
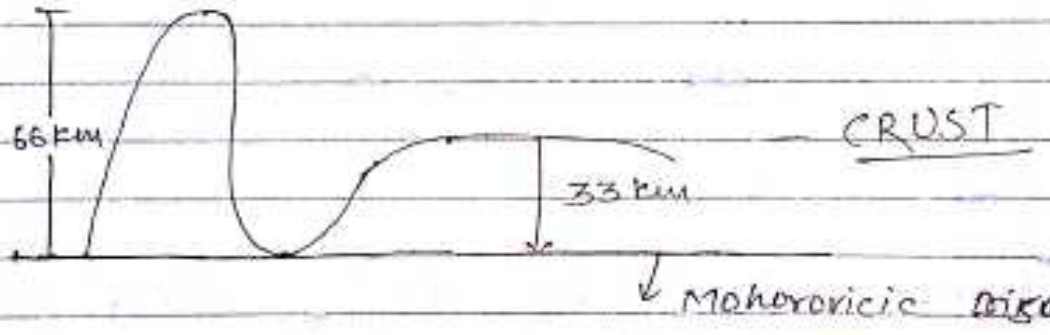




* Detail Description of the interior of the earth:

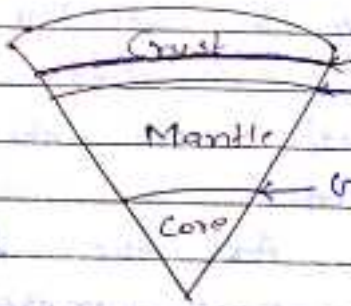
There are 3- segment of the earth- crust, mantle and core. The all 3- segment are separated by two breaks known as discontinuity. These are:

① Mohorovicic discontinuity which separate crust and mantle. this is the 1st major break. The second major break is b/w mantle and core is known as Guttenburg dis.

also known as Guttenburg Weichest discontinuity.

Crust — Crust is the top most layer of the earth its thickness depends on surface structures of the earth on the surface there are plain, mountain and oceans or seas accordingly. thickness varies below the ocean there the thickness of the crust may be 0 to 5 km but in the organic (mountainous) region thickness is much more geologist predicted. This segment may be 66 km but average thickness of crust is only 33 km.

There are secondry discontinuity within the crust known as conrad discontinuity



The conrad discontinuity separate the crust in to two parts Sial and Sima the words sial stands for silicon and Aluminium the word Sima extend for Silicon and magnesium.

Sial - Practically sial is the upper continented crust it is made of old type of rocks i.e. igneous, sondimentry or metamorphic rocks. This thickness

is 11 km normly (It means the conrad discontinuity lies at a depth of 11 Km. normly. Definitly the behaviour of this thickness shows surface features of the land mass.

Sima — Practically this is lower continental crust its thickness is about 20km – 22km. The word Sima is stands for silicon and magnesium.

~~MANTAL~~: MANTLE:

The Mantel starts below Mohorovicik discontinuity and ends up with Gutten burg discontinuity. The thickness of the Mantle is above 2900km some where the thickness may be 2860 Km practically the thickness of mantles depends on thickness of the crust of the ~~crust~~ earth i.e. how far crust extends.

As the thickness of the mantle is much more as compare to crust and core hence it contains maximum parts of the earth volumewise 83% of the total volume and mass wise 68% of the total mass.

As the mantle exist in b/w core and crust hence it must contain maximum internal energy of the earth.

Within the mental there are some other discontinuity known as

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2nd order discontinuity this continuity exist due to ~~gravitational force~~ chang in density and due to gravitational force. The reseaschers have found a no of 2nd order discontinuity which has as follow:

a) Density break - At above 80Km depth the density of rock change 3.36 and 3.87 (Distance are measured from 1st order discontinuity).

b) Gravity break: It means change in acceleration due to gravity. It is believed that at above 150km depth the acceleration due to gravity change from 979 cm/sec^2 further it has been believed that the value of accelesation due to gravity at 979 cm/s^2 till the depth of 1200 Km (all the depth is measured from moherovicit discontinuity).

c) Repetti discontinuity: This is the special type of discontinuity and related with sesmic (earthquake) vibration. From this point the intensity of vibsation increases rapidly i.e. increasing starts from this point. The depth of this discontinuity is 950 Km.

d) **Gravity break**: This is a peculiar type of discontinuity since at about 1200 km depth gravity becomes minimum i.e. 974 cm/s² after reaching minimum value it suddenly rises to about 1070 cm/s² and continued till the Guttenburg wichered discontinuity i.e. close to core boundry it means Gravity break occurs twice within the mantle i.e one break at ~~1200~~ 150 km and other break at 1200 km depth.

The break which starts from 150 km depth is in decreasing order of the gravity but the break which exist at 1200 km is in increasing order.

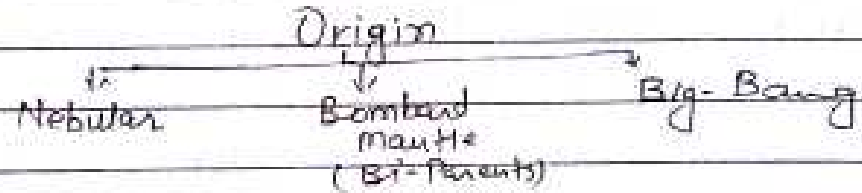
* **Core**: The core is the inner most part of the earth. The total depth of the core from Guttenburg discontinuity is 3440 km about. The core is divided from 3 parts and starts from Guttenburg wichard discontinuity and continuous till the centre of the core as described below:

a) Outer Core → This extends from Moherovicik discontinuity to 4980 km is measured from crust

b) Middle Core: It extends from the distance of 4980 km to 5120 km the distance measured from crust. At this stage the material is either in semifluid or fluid stage due to high temp. and pressure prevails.

c) Innes Core: The rest of the thickness existed as the innes core normal its thickness is 1260 km. The central temp. is about 6000° c predicted - at this stage the solid meted nickel and cobalt or any metal formed will be liquid stage.

ORIGIN OF THE EARTH



Origin of the Earth:

2015 → 1 Queries

The man-kind have very little concept about origin of the earth since the to earth has been created some 4500 million years ago on the basis of the indirect research. Some theory have been put forward by geological scientist. of all the theory the fonowing 3-theories are most important and accepted

by the scientist.

i) Nebular theory: Nebula is a smoke like appearance matter. Normly consist of mixture of inflamable gases along with other substances.

At the down of the history of the earth the nebula was in a very hard condition and having maximum momentum in course of time. The nebula took the form of circules globe or plate. All the molecules within the nebula were in rapid movement due to very high centrifugal force present between at the circumference of the nebula. Some portion of definite thickness comes out forming a circular ring which is separated from main part of the nebula known as central part.

In due course of the continuous movement of the outer part the ring is converted in to a compact globe. The mechanism is known as coalesced.

Coalesced —

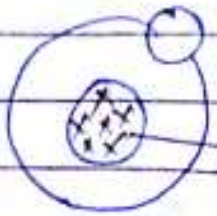
It is a process in which a no. of molecule or disperse of any gaseous substance normly compacted to form a large mass.

Basically, as time passes gradual cooling of the globe took place and Probably due to tidle force or angular momentum the globe continue to revolve round the rest of the nebula. In this manner 10- rings was form. The innes- most is converted to the sun. Outes 9 form planets but practically the innes most nebula did not move but kept in a fix position to form sun. Except sun that innes most nebula other planets gradually pull down from gaseous to liquid and alternatively to solid state.

The above theory has got some drawbacks since if the mechanism of the formation of earth as explained there, the mechanism should had confirmed in recent years but this is most happening.

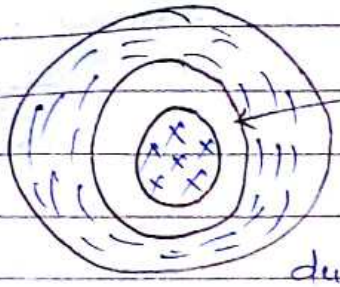
Nebula

White cloud in the time of Oct- Nov.



Formation of planet [earth]

star



Seperation of nebula due to centrifugal force.

ii) Bi- parential Theory: (Bombadment)

It is believed that the origin of the earth not completely known. Some scientist believed bi- parential theory which states that there mass have been true big star without the galaxy after passing million years two stars must have approach very close to each other hence the name bi- parential theory. Further bumbardment between the two stars must have taken place to form planets and earth hence the name bombardment theory.

In this theory tidal force must have taking place for the formation of earth and the other planet. When two stars are came very near to each other tidal distortion must have taken place within the sun. As the sun is believed to contains gaseous substances planets must have thrown out from the sun. It means eruption has been taken place within the body of the sun. It is known as in those

time ~~empty~~ eruptive force were present in the sun and a no. of bolt were taken out from the sun. Such bolts ~~travelled~~ travel very long distance within the space the gaseous bolt so travel started to chill.

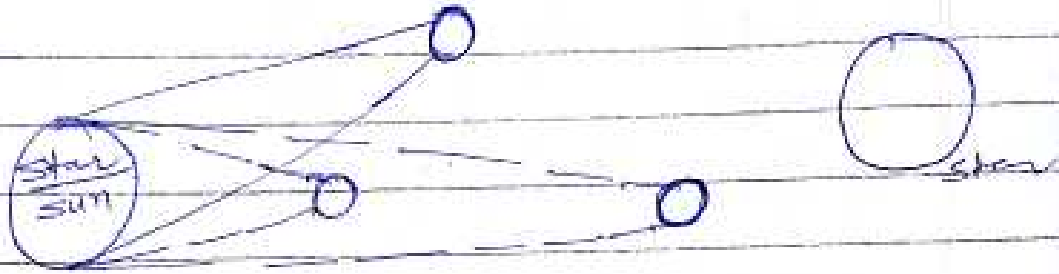
In this manner a no. of bolts chill out forms different planets including earth. Such chilled out solid materials are known as planetisimals. Such planetisimals started to move round the sun in eliptical orbits nearly.

Further there might have been very small planetisimals which itself does not rotate round the sun but does not planetisimals started to coalesced to form bigger planetisimals. Such bigger planetisimals started to rotate round the sun later forms diff. planets and also solar system. This is scientifically known as planetisimals hypothesis. In practical sence it is believed that earth was form from sun and originaly it was in gaseous state and took million of years to come present states.

Some scientist believed that though tidal force play an important part in the formation of the earth but pushers bombardment between the two stars

might have taking place to eject a no. of plautesimals material.

All the above theory are hypothetical only no prove can be given.



(iii) Big-Bang Theory: The American scientist not believe any theory put forward by any geological scientist of the world. The Amesian geologist believe that in the galaxy which results into formation of different planets. In a hapahazard manner in course of time such scattered particle of big masses took their own shape and started to rotate round the sun. This is generally believable.

STRUCTURAL GEOLOGY

Dip — Dip is the inclination of any strata hence it is measured by angle of inclination of the bed or strata.

Geologically dip is the amount of inclination with respect to horizontal plane. Dip is a vector quantity hence it has got value and direction.

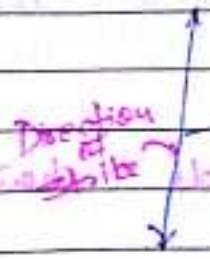
Geologically the value of dip must lie within 0° to 90° since, dip of horizontal bed is 0° and that of vertical bed is 90°.

Types of Dip — Depending on inclination and slope dip is classified in to two types:

i) True Dip

ii) Apparent Dip

i)



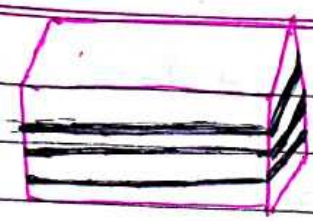
i) True dip : True dip is the maximum amount of inclination of slope.
Actually this is the maximum slope with respect to horizon. Further it is the quickest distance between any to points to travel.

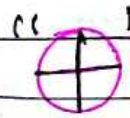
ii) Apparent dip : Any direction other then true dip is known as apparent dip. The amount of apparent dip must be less than true dip.

Strike – It is the line along which any inclined beds intersects horizontal plane is called strike.
It has direction but not magnitude.
On the basis of direction of dip and direction of strike it is clear that both the direction makes right angle with each other. This relation holds good form true dip. It means true dip is in a direction which is ⊥ar to the strike line.

There 3- symbols showing dips

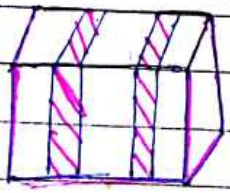
1) " 0° " - This is shown as

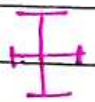




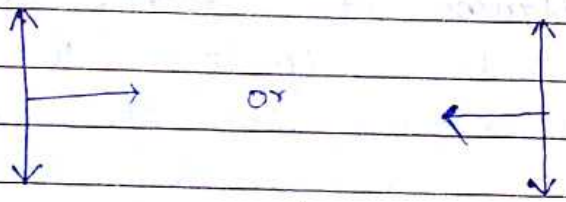
in this case all the beds are horizontal.

(b) '90°' — This is shown as

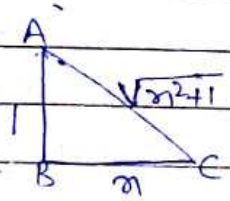




c) "Any other angle"

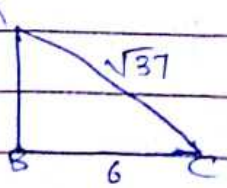


Angle needs to be mentioned



Dip is denoted by 1 in n, where 1 is the vertical displacement and n is the horizontal displacement.

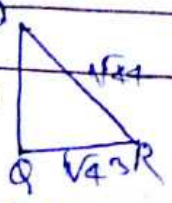
e.g. (i)



Inclination 1 in 6.

$\sqrt{37} = \sqrt{1+6^2} = \sqrt{37}$

(ii)



~~$\sqrt{44} = \sqrt{1+(\sqrt{43})^2}$~~

inclination 1 in $\sqrt{44}$.

Conversion - Degree to ration

$\cot^{-1}\theta = n$

Inclination $= 1 \text{ in } n$

$\tan^{-1}\theta = \frac{1}{n}$

Relation between dip and Strike :-

The direction of strike and the direction of dip must be at right angle. In general dip means true dip that maximum inclination of the bed.

* Importances of Strike and Dip:

In Geology the strike and Dip regulates a no. of features the following are the importances :

i) We know that true dip is the direction of any bed in which maximum inclination happens.

We know that flow of any liquid or semi ~~liquid~~ solid material takes place in deep most point therefore younger bed formed in the direction of dip.

Formation of younger bed also indicates position of true dip.

ii) There are different structural features existed at either surface of the earth or within the crust

hence nomenclature of all such features are given on the basis of direction of dip, amount of dip and also direction of strike such as dif fault, strike fault etc.

In short dip is the indicative of formation of younger bed and dip and strike both are used for nomenclature of different surface features

FOLD

Behaviour of the layer :

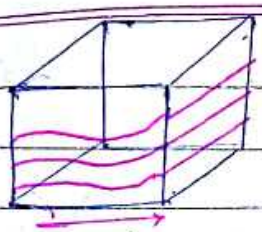
Sedimentory rocks are form as layer, Such layer may be parallel or not pasallel with one another that is the seperation line may form a characters of parallelism or - non pasllelism accordingly the sbuctus are defined in basically two parts.

(1) Conformal or Conformable.

(1') Non - Conformal.

i) Conformal : These are the formation of the layer in which seperating planes are pasllel to each other whichever their prolongetion (आगे बढ़ना) may be, it means straigh or curve, Normaly curve.

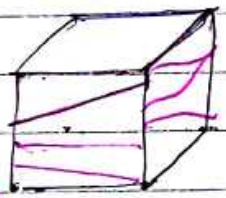
Solitude- शून्य



Conformal or Conformable.

ii) Non- Conformal :

If the parallelism of the strata is lost then it is called non- conformal.



Non- Conformal

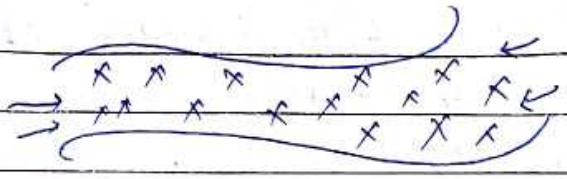
FOLD — Fold is nothing but distortion of the strata normally at the surface or within the crust.

Fold is a typical bending of the rock strata due to compressional force act on both side of the rock strata. The action of the force must be in opposite direction with each others at a result of which wavey undulation must occur.

Technically a series of alternate crest and troughs are formed

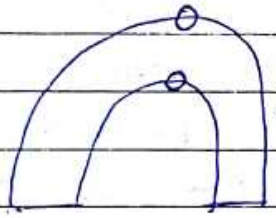
The following figures are indicative of the folds-

i)



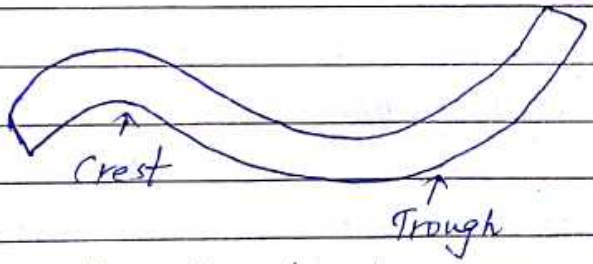
Previous stage of the strata subjected to compressional force.

ii)



Bending occur at a particular point due to force applied on both sides

iii)



Normaly bending occur at two positions (upward and downward)

Some terms :

Basic Idea - If an imaginary plane is made to pass through crest and trough i.e. bending part of the fold then it devides the fold in two parts, the amount of two part may be equal or may not be equal but division must be their, now the cutting planes may be horizontal or vertical for all the definition the imaginary cutting plane is considered as vertical plane.

If both sides of the cutting plane is a mirror then it is called symmetry, the cutting plane may form symmetry figure or not symmetrical figure.

Axis : The imaginary planes devide Fold as a symmetry as possible, then the line of intersection of the axial plane with the Fold is known as axis.

Axial plane — The imaginary plane which devides fold in to any two parts is called axial plane.

Crest — The upper part of the fold which is convex in nature and dips away from the axis is called crest.

Trough — The lower part of fold which takes concave surface and dips inside facilitates the formation of younger bed is called trough of the fold.

Anticline — It is the upper part or convex surface of any fold. It is reverse of syncline.

Syncline— It is the lowest part or concave surface of any fold. It is reverse of antiline.

Limbs— Limbs are stached of the rock between crest and trough. The crest and trough must be adjacent with one another

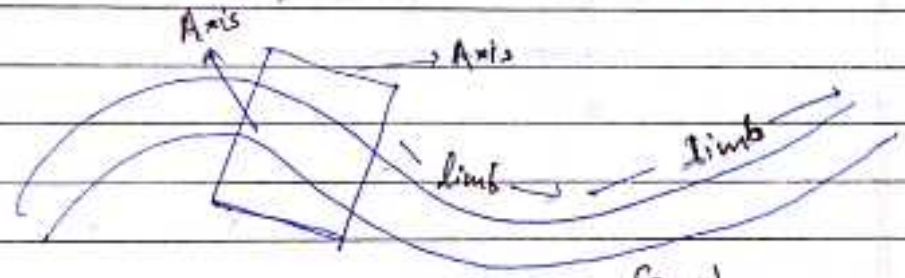


fig-1

fig-(ii)

Classification of folds—

The Folds are classified in following basis

i) Symmetry
ii) Thickness of limbs
iii) Appearance in cross section
iv) Attitude of the fold
v) Mechanism of the fold
vi) Origin of the fold
vii) Inter limb angle.

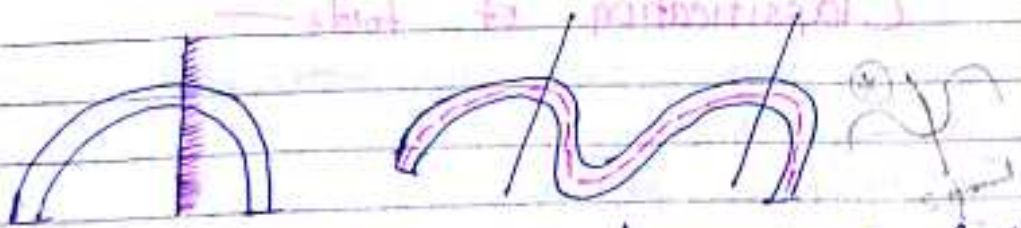
1) Symmetry — On the basis of symmetry it means the mirror image of one part with the another part.

In general anticline, syncline part occurs simultaneous. Accordingly on the basis of symmetry the folds are classified as

i) Symmetrical Fold — In this case the axial plane must be vertical to make any limb mirror image of the other limb this is also known as upright fold.

This may occurs in syncline and anticline.

ii) Asymmetrical Fold — If the axial plane is not vertical but makes a dip there a fold is formed this is called asymmetrical fold. It is also called inclined fold. The main idea is there will not be mirror image

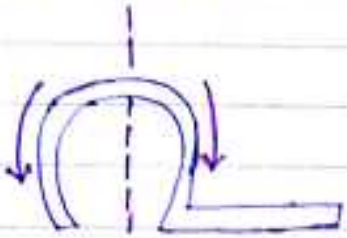


i) Symmetrical fold ii) Asymmetrical fold

iii) Recombent fold — It is also known as overturned fold. In this case both the limbs are overturned or top limb lie in the bottom limb.

Recombent fold

iv) Isoclinal fold — If in any over-turned fold the amount of dip formed for both the limbs are same then it is called isoclinal fold.

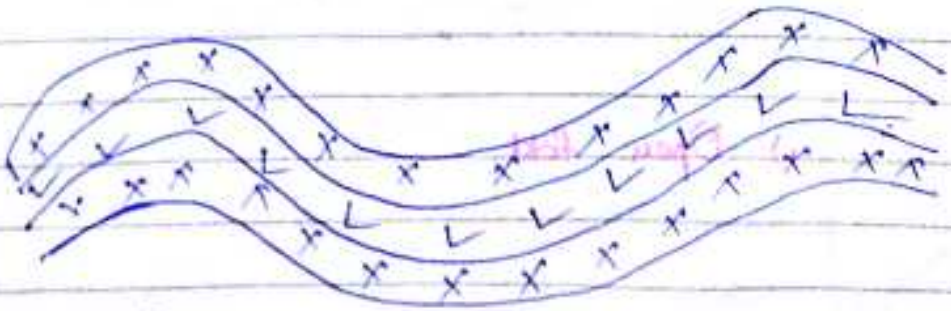


2. On the basis of thickness of limb—

In general thickness is greater as synclinal also at the anticlinal part in this manner there are basically two types of fold based on thickness-

i) Parallel folds (ii) Similar folds

i) Parallel fold—



In this case folds are made in a such a manner that the folds are all most concentric i.e. all the folds have same centre but radius is

increasing. Practically the thickness of the bed is more or less same practically the thickness of the bed is more or less same practically the artificial ~~fu~~ parts becomes very sharp

ii) Similar folds — The out look of the similar folds are more or less same but thickness varries at different parts of the fold. Though all the bending part are concentric with a fix centre.

5. On the basis of the interlimbed angle folds are classified as -

i) Open fold ii) Close fold iii) Tight fold

for defining such type of fold ~~3 - by~~ angles are considered such as 70°, 30° and below 30°.

i) Open fold — This is also known as gentle fold. When the interlimb angle is more then 70° then it is called open fold. The upper limit of the fold is not given.

Wed

Close Fold — If the inter limb angle is between 30° & 70° then it is called close fold.

Tight Fold — When the interlimb angle is less than 30° then it is called tight fold.

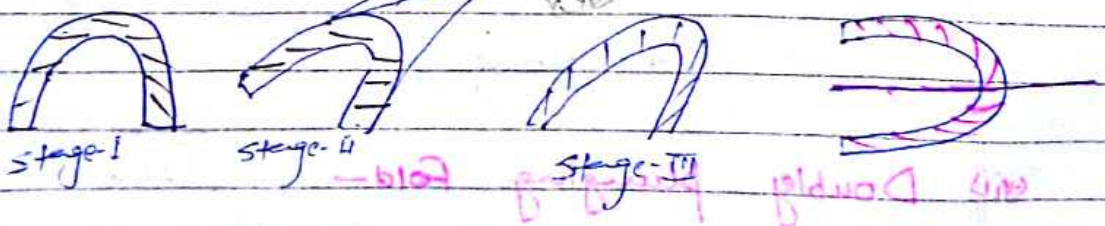
4. On the basis of attitude of the Fold

Based on attitude fold can be classified into four types—

i) Plunging Fold— When the axial plane or axis becomes horizontal due to overturn then it is called plunging fold.

This is a case of overlaping of two same strata or different strata causing that axial plane horizontal. It appears that top limb lies over the botom limb. The dip of the plunge may be in b/w 0° to 90°.

ii) Non plunging fold—



ii) Non-plunging fold— If the plunging does not show any dip then it is called non plunging fold. Practically, the axis of the fold is strictly horizontal, it means the

axis make 90° with the vertical. As per geology of the surface of the earth, there are two lines are recognised, one is vertical line and another is normal line. In the vertical and normal line these must be an angle, if the strata is inclined due to the severe pressure. At the junction of normal and vertical line the strata tends to turn and breaks from the junction making no dip in any direction.

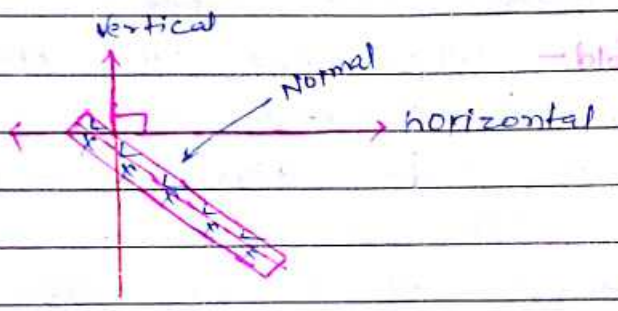


Fig-I

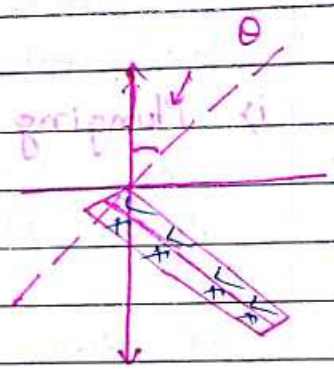


Fig- II

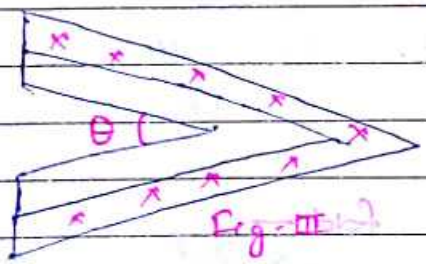
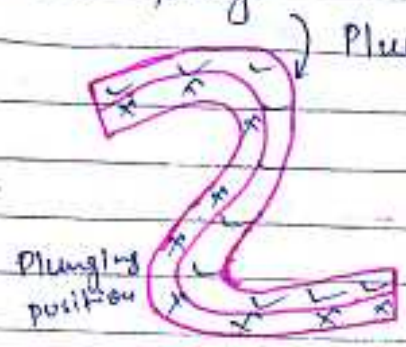


Fig-III

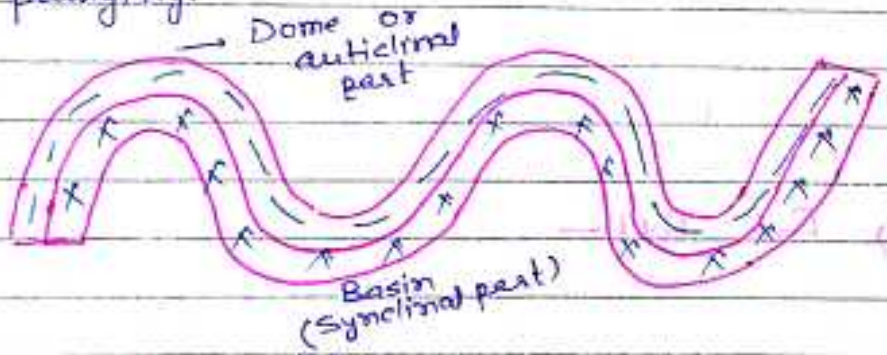
Non plunging

Doubly plunging fold— If the fold occurs in reverse direction of plunge then it is called doubly plunge fold. It is typical overturned fold. Practically the reverse force apply on other side or limb of the plung to make it

another plunge



(iii) Periclize fold or structure — This is a special type of plunging and extension such type of fold includes both structure i.e. syncline and anticline We know that plunging occur both at synclinal part or anticlinal part in short it includes domain basin for the formation of plunging.



5. On the basis of Origin —

On the basis of plane or mountainous region the folds are classified in to two parts.

i) Tectonic fold — Tectonic fold also known as orogenic fold. It occurs in mountainous region due to anticlines. In general minimum two anticlines form a special type of fold which is known as hills.

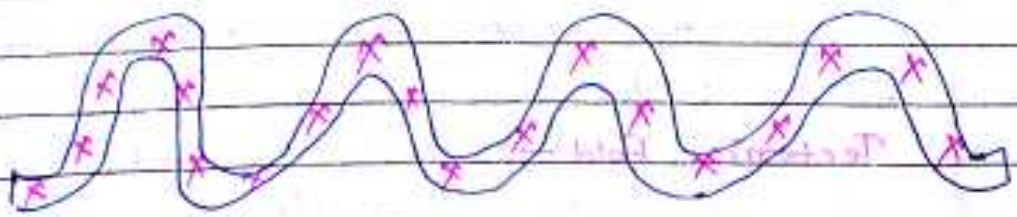
In the orog originic fold depression occurs at the botom this is also known as geneatic fold.

ii) Nontectonic fold — The fold which occurs on the plane but does not form any evident hill then such fold is known as non-tectonic fold.

* Some special types of fold:

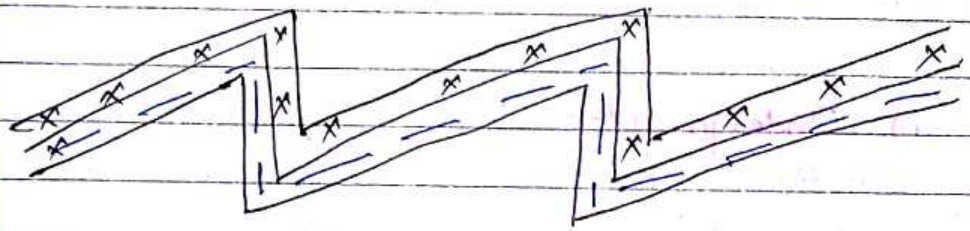
Due to severe pressure at the end of both the limbs. The folds already formed are subjected to further bending on folding. Such type of fold are nothing but the secondry presevation of the originally formed fold at the surface or beneath the surface or very near to the surface. Such folds are form within the earth preexisting.

i) Fan fold — If anticlinal part or synclinal part are formed due to severe bending then such type of fold are known as fan fold.



ii) Chevron fold — This is simply combination of anticline and syncline but the difference is clearly remark over the

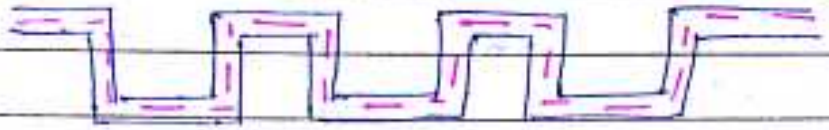
anticlinal and synclinal formed sharp Point or vertix Actually this types of folds are responsible for formation of mountain. and, the anticlinal part it is the peak of a mountain but the synclinal part is responsible for larger water body such as lake. Geologist Billings has suggested such structral feature and defined as chevron fold.



iii) BOX FOLD — In the openion of some geologist the process of formation of chevron fold or Box fold more or less similar. If the compressive force on the limbs are bitless as compare to chevron fold then the result will be box fold.

In the case of box fold synclinal part or anticlinal part do not take the form of curve. Neither it form vertix the geometrical shape is transition between vertix and the curve the antical or synclinal part takes a form of the plane as the result of which each synclinals fold are makes box and also the opposite

side of the anticlinal part forms box, shown from botom to top in other words mirror image explains clearly.



Recognisation of Fold in the field–

The recognisation of fold is based on following situation

i) Underground ii) Surface

1) Underground– In u/g the following indications are availble to get notice of presence of fold.

i) The inclination or gradient is abruptly change of the inclination may be in upward or downward direction depending on formation of anticline or syncline.

ii) The strata becomes shoft as a result of which the roof condition of the coal seam becomes weak or friable (दबाव - दबाव होना) there are the chances of heaving on floor.

iii) Due to formation of a no of cracks seepage of water increases as compare to normal seepage.

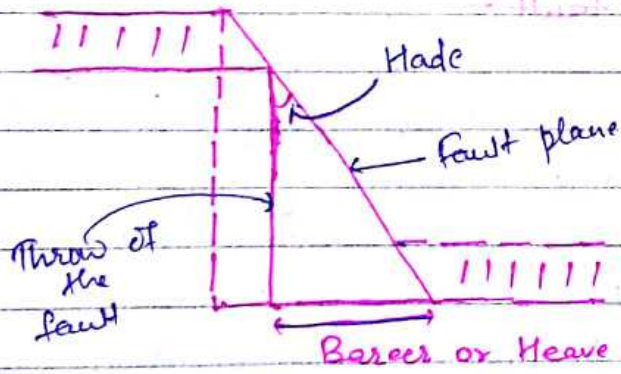
iv) Accumulation of gas, specially fire damp increases.

2. Surface — i) Tunneling for railways and Roadways revels existing of fold since gradient of the floore abruptly change and also previous strata vanishes.

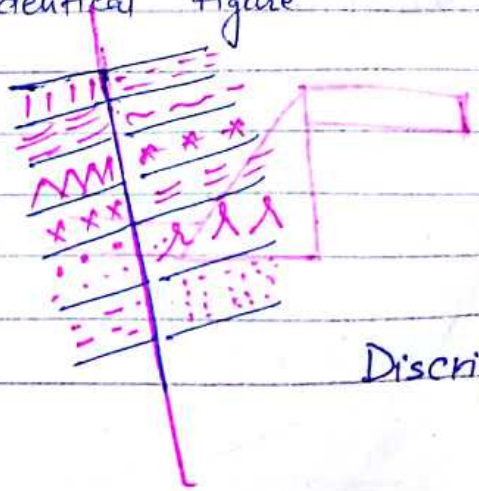
ii) The main indication is age of the bed. The top and botom bed are different in age indicating formation of fold for exaumple in the case of syndinal age of botom bed is more as compare to the top bed which is determined by Bor-hole.

iii) The dip-and strike of the strata are changes due to existance of fold specially dip.

FAULT



Identical figure



Discriptive figure.

Fault is a fracture in the rock strata including coal. The fracture is associated with displacement. The displacement may be vertical or lateral but Vertical displacement is common as compare to lateral displacement.

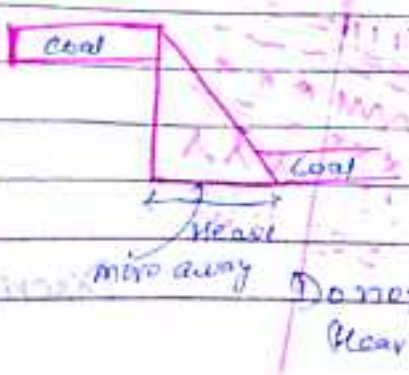
Reason for fault —

There may be movement inside the earth crust. If the strength of inside rock is insufficient then the rock may not withstand due to weak nature hence, displacement must occur.

Classification of fault —

There are many classification of fault but following fault is normaly associated with mining or mineral bed.

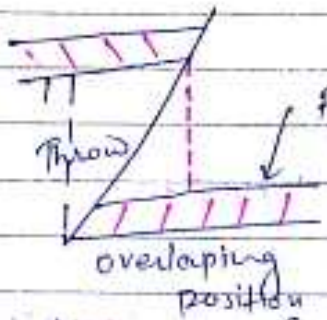
1. Normal fault — This is such type of fault in which broken ends of the strata moves away from one another but do not overlap. Hence such type of fault is normal fault. ~~Region~~ Reason ~~Reason~~ It is such type of fault found commonly in Indian mines. Reason for occuring such fault is tensional force.



ii) Reverse fault— The name suggest that such fault are opposite to normal fault in this type of fault overlaping occur.

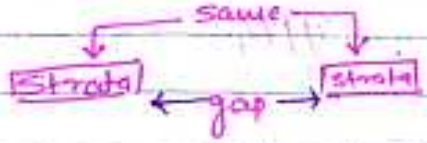
The reason for such type of faults are compressional force

New rock beds are formed over the older rock bed.



(Heave does not form due to overlaping)

iii) Trans-current fault— This is such type of fault in which bed seperation occurs but no vertical displacement take place In other word broken ends of the rock mass remain at the same level but instead of vertical movement it's move away from one another in a horizontal plane in this manner a gape is formed



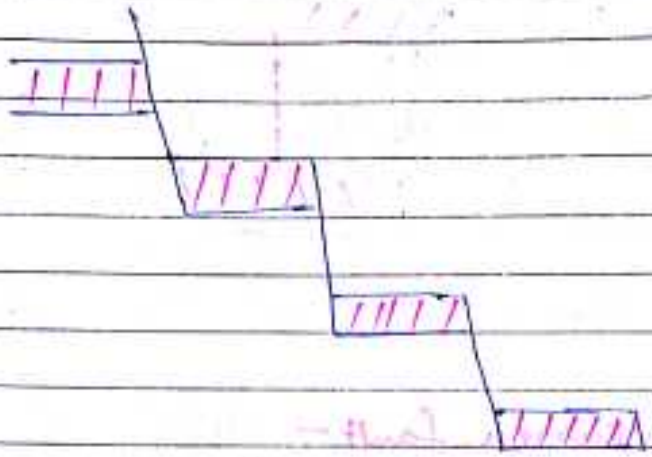
No vertical displacement

iv) Step- fault → This fault is nothing but it is successive normal fault.

In other words several faults are met one another at a particular

place and takes a form of step or stair case is known as step fault.

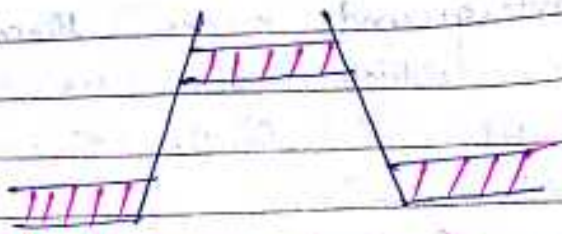
Reason- This occurs due to very much wide bed which can not withstand severe upward force beyond a particular particular zone (stabilization takes place after having a no. of steps).



v) Trough Fault - It is the combination of down throw and upthrow fault, if a down throw fault follows by upthrow fault then such structure is called trough fault.

vi) Ridge Fault - Like trough fault ridge fault is also combination of down throw & upthrow fault. It is just reverse of trough faults.

If an upthrow fault follows a down throw fault then it is called ridge fault.



Some definition:

Down throw fault- When a man travels on a rock bed and after meeting fault plane finds fault in upward direction then it is called down throw fault.

Note- It means the significance of downthrow and upthrow fault is that at a same place in earth both the fault occurs simultaneously. The difference is which one is touch first according up and down throw are classified.

Fracture plane: It is the fracture plane of the rock bed or which throw or fracture occurs.

Hade- It is the angle between the fault plane and throw of fault.

Heave- Practically it is the gap ~~between~~ in which strata and coal seam is missing it occurs in normal fault.

For underground mines, there are several indication which gives us idea for recognisation of fault. Some of them are given below —

i) Missing of coal seam and minerals — Practically coal seams are deposited in a definite area but during coal getting operation or mineral getting operation, all on a certain sudden coal seam is found missing and in place of coal seam, existance of rocks is very prominent (clear).

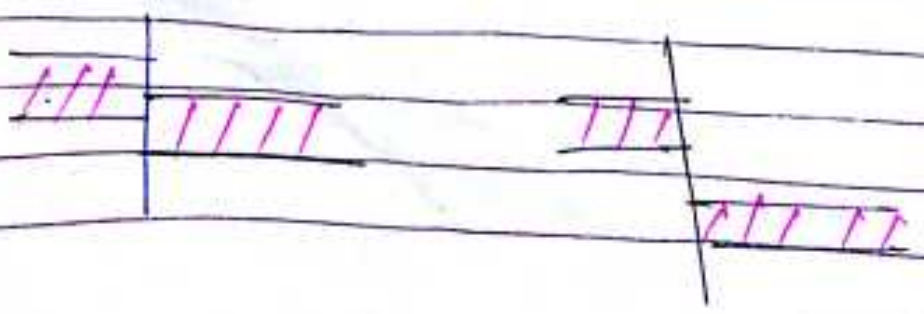
ii) Change in gradient of the floor and also indication of the roof.

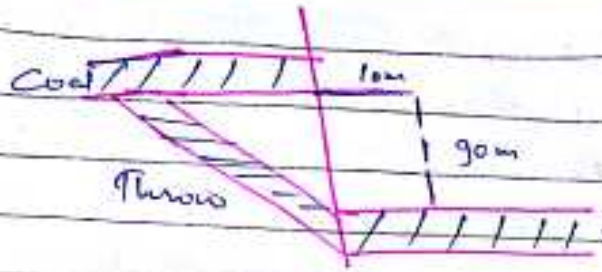
iii) Heavy seepage of water indicates presence of fault.

Seepage of waters are formed in the fault plane itself and through the fault plane water is coming down. More the throw, more will be the quantity of water in the adjoining faulted zone.

iv) Emission of gases specially methane through the faulted zone.

v) Reducing in thickness of coal seam many a times, throw of the fault includes coal seam itself.





It causes reduction of the coal seam and very much indication of fault plane.

vi) As the fault result due to severe pressure, therefore the zone in and around fault plane must be crust. In other word crust zone indicates fault planes.

vii) Very bad roof condition-

It is at well known that the vertical pressure from the above of the rock strata is one of the main cause of creating fault, hence roof must be under heavy pressure therefore roof condition must have to be worst condition.

viii) Pressure of joints or cracks -

Technically, joint is crack without vertical displacement, these types of joints are prominent before touching fault plane.

M.V.V.I

* Recognisation of fault in the field :-

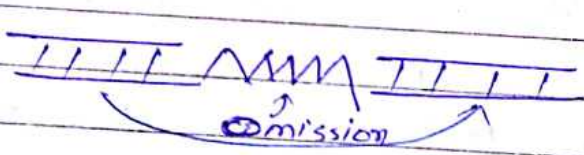
There are differences for recognisation of fault in the field which is important for surface mining (Opencast mining).

i) Abrupt change in the strata at surface if the strata changes from one rock nature to other rock nature then presence of fault may be expected.

Company
- Trading
- Captive

ii) Many atimes fault is clearly visible on the surface itself causing formation of mountain.

iii) Omission of strata and repeatation of strata indicates existance of fault.



iv) Change in sedimentary bed from one kind to another kind is clear evidence of presence of fault.

v) Mineralisation is the evidence of presence of fault. Actually fault is the displacement and formation of heave. At the place of heave minerals are depositied.

* Physiographic evidence —
At the surface there are different features such as formation of spring and mountains, formation of monocline etc.

Some other Classification of Fault

The following are the classification based on geometrical formation.

i) **Strike fault** – If the fault occurs in the direction of strike of the bed, then it is called strike fault.

ii) **Dip fault** – If the fault occurs in the direction of dip of the bed then it is called dip fault. Actually in this case, strike of the bed and dip of the fault parallel.

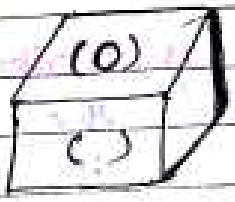
iii) **Diagonal fault** – If the fault occurs between dip of the bed and strike of the bed, then it is called diagonal fault.

iv) **Bedding fault** – If the fault occurs in the direction of bedding plane, called bedding fault.

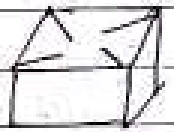
v) **High angle fault** – When the angle of the dip of the fault plane is more than 45°, then it is called high angle fault.

vi) **Low angle fault** – If the angle of dip of the fault plane is 45° or less than 45°, then it is called low angle fault.

vii) Arcuate fault – Actually this is a special structure and normally not found. In this case circular or arc like structure are found at the surface.



viii) Radial fault – It is more or less similar to arcuate fault but the structure resembles like radiation emitted from central force portion.



* Conformable – If the groups of strata have parallel bedding plane that is parallelism is not lost then it is called conformable or conformable strata.

* Unconformable – If the group of strata form have no bedding plane parallel i.e. parallelism is lost then it is called unconformable or unconformable strata.

* Unconformity – Geologically lack in conformity or conformable is known as unconformity. The conformity is a plane of discontinuity between two rocks or group of rocks that separate two system of rocks.

The older rock lies beneath the younger rock.

* Classification of unconformity —

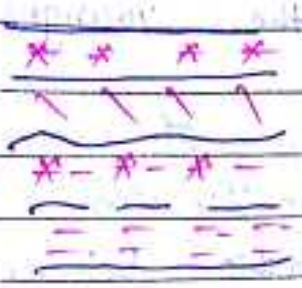
The classification basically based on the relationship between younger rock and older rock with the help of seperating plane. If disposition take place. In general 5 type of classification of unconformity —

i) Angular unconformity
ii) Disconformity
iii) Non- conformity
iv) Blended unconformity
v) Local unconformity

i) Angular unconformity — This is a typical unconformity in which younger bed and older bed makes an angle with the help of seperating plane. Angle may be same or may not be same for all strata

ii) Disconformity — It is more or less similar to conformable bed but practicaly it is not show since seperating plane does not make any parallel line instead it forms

a zig-zag line.



iii) Non-Conformity — The non-conformity is associated with plutonic rock or igneous rock beneath the earth surface. Hence, the seperating plane does not have clear cut definition.

iv) Blended unconformity — It is a mixture of different unconformity actually the older rock erodes and after erosion the newer rock form hence definetly parallelism is lost between younger rock and older rock.

v) Local unconformity — It is so named because the angle between the formation of younger rock and older rock is very less. Decomposition does not exist. In general when any older bed is dried and younger bed some time deposited

over the very recent form rock. Now known as older rock.

JOINTS

Defⁿ Technically joints is crack without displacement.

Hence, in general joint is defined as a fracture within a rock but there will be no relative movement. The joints are available in almost all types of rock. (If the displacement occur then it is a fault)

Reason for joints —

The reason for joint are tensional or compressional stress. It exist within the rock surface but tensional stress or compressional stress are less than stress required for fault.

Classification of Joints —

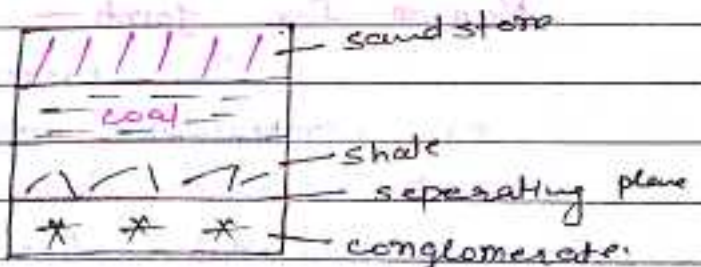
Depending on the stress joint are classified in 3- types.

i) Tensional joint
ii) Sheet Joint
iii) Tectonic Joint

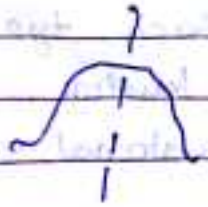
i) Tensional joint — Such type of joints are formed due to tension exist within the rock. The tensional joint are normally

available with igneous rock since igneous rocks are made from molten magma on cooling the magma is converted in to igneous rock. During cooling construction takes place and again repeat sepesation of magma repeat the process. Therefore tension exist forming columnal structure of igneous rock.

ii) Sheet joint — The name suggest that the joints developed in sets and more or less parallel to each other. They may originate due to depesition of rock mass when cover is removed from the older rock by erosion.



iii) Tectonic joint — The tectonic joint is associated with the formation of mountain. Actually most of the mountain formed due to folding of the rock mass. Cevere compressional stress during folding results crack but no displacement take place. Such cracks are known as tectonic joint.



Special surface structure -

There are various special surface structure of them two are very important
i) Inlies structure ii) Outlies structure

i) Inlies structure - An inlies is pattern of older strata which is surrounded by newer rock or strata. In all side it is normally form as denuded of older rock in all side of the structure newer rock is available.

The portion which is denuded part may form dome shaped due to severe structure.

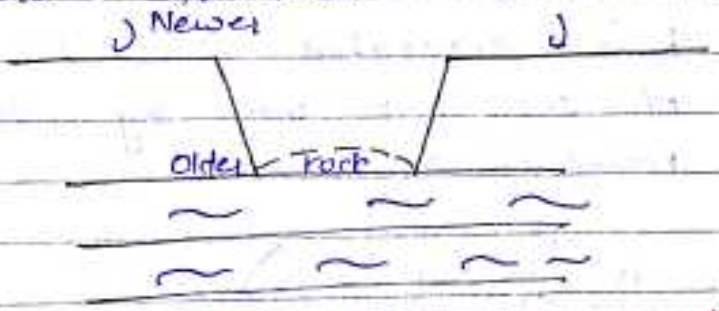


Fig- (a) Surrounded by newer rock strata
Normal strata

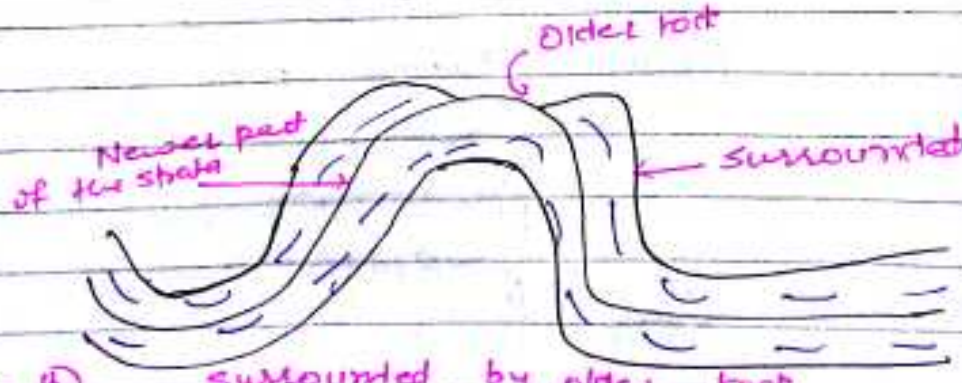


Fig- (b) surrounded by older rock
Folding strata

NOTE - Fig-@ shows normal strata or available in formation of rives, sea or water bodies.

Fig-(b) shows formation of mountain in this figure the top of the mountain or pick area is denuded or eroded as a result of which the bottom older rocks are exposed in the atmosphere. geologically it is an anticline. → Inlies

ii) Outlies Structure - Outlies is a special type of structure in which part of the rock bed or some time series of bed has been seperated from the principle part of the rock mass by denudation and remains isolated

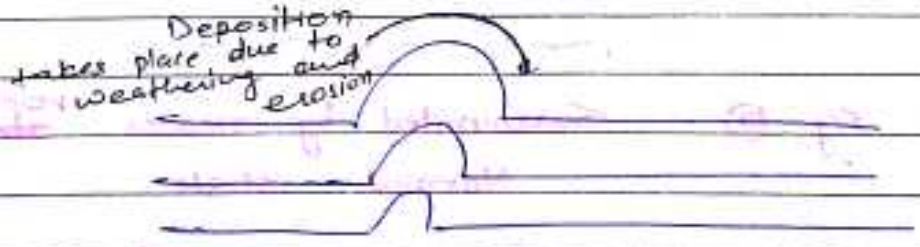


fig- a Normal rock

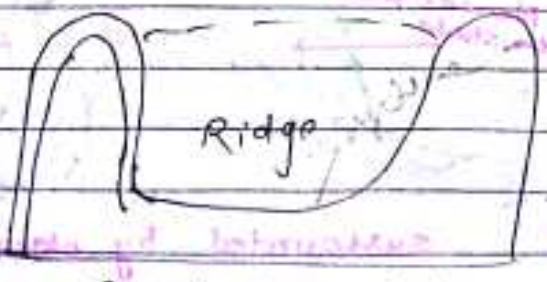


fig-b Folded rock bed

The fig-a shows existence of outlier for normal strata. In this case the central portion of the composite strata get disturbed many a time uplifted and both the side of the inclined so form is a route for deposition of different material due to weathering which is the formation of new rock old rock left on the surrounding

Fig-b shows several folded zone practically two anticlines are formed living behind a gap in between. The gap is a place of deposition of different material hence the structure will be surrounded by older rock.

* Cleavage Plane — As per nature of the minerals it is of two types
① Amorphous ② Crystalline
The word cleavage is not applicable to amorphous mineral, but it is definately applicable to crystalline mineral (Cleavage is also called 'cleat' special in coal mining technology). The shape of the crystalline mineral may take any geometrical form which is Hexagon, Heptagon etc. It depends purely on system of formation.

Cleavage is a special properties of mineral or any type of rock which

is ≠ introduced during formation either of the surface or below the surface.

It is a properties of mineral by virtue of which it has got a tendency to break in a particular direction. after breaking it gives plane and smooth surface.

Practically due to cleavage crack are form such crack are known as cleavage crack.

A mineral may posses cleavage or may not posses cleavage even if it is crystalline in general all ~~one~~ almost all the crystalline mineral form cleavage plane but amorphous mineral are completely devoid of cleavage plane.

Cleavage plane may be horizontal or vertical or both at a time. If both type of cleavage plane are available then it breaks easily. Coal seam normally has parallel cleavage plane since it is a bedded (horizontal) deposit but other minerals normaly is a Vertical deposit hence cleavage plane are also vertical but it may have both type of cleavage plane.

Date
Page

शिला-विज्ञान
PETROLOGY

General description —
The science which deals with rock is called petrology. Since, in latin petro means rock

Rock — Rock is the composed of mineral it may be mono mineral or multi mineral.
The speciality of rock is it form earth crust.

Distribution of rock on the earth crust — about 95 to 98 percent rocks available at the surface of the earth consist of igneous and meta igneous types.
The rest 5% to 4% rocks are sedimentary or meta sedimentary

* Classification of rock — Geologically the rock is classified on the basis of its nature of formation accordingle there are 3-type of rock available at the surface of the earth.

i) Igneous rock — Related with fire or ignition hence the name igneous.

ii) Sedimentary rock — Related with precipitation or sedimentation of liquid or semi

liquid material.

Metamorphic rock — The word metamorphic means change actually changes occurance from the Igneous or sedimentary rocks. The two rocks the igneous rock and sedimentary rocks are called primary and secondary rock.

1) Igneous rock — The rocks which are formed from molten magma is called igneous rock.

Practically, the Igneous rock is formed by the solidification or consolidation of molten magma. The Igneous rock may form below the earth or at the surface.

* Grouping of Igneous rocks — Depending on the formation the Igneous rock are group in to two group.

i) Intrusive rock — As we know that the Igneous rock may form below the earth hence the Igneous rock which forms below the earth is called intrusive rocks.

Further intrusive rock may form at great depth or shallow (sir) depth, Accordingly the Intrusive rock are classified into two classes or types:

a) Plutonic or Abysal rock —

The igneous rock which form at great depth due to consolidation of magma is called plutonic or abysal rock.

b) Hypabyssal or Hyp-abyssal (Medium depth) rock —
The igneous rock which formed due to consolidation of magma at shallow depth is called hyp-abyssal rock.
Practically hy-pabyssal rock are formed in between the plutonic and extrusive rock.

ii) Extrusive rock: The igneous rock which forms due to consolidation of magma at the earth surface is called extrusive rock.
Geologically the magma when comes right up to the surface due to fissures available in the earth crust spread on the surface of the earth and cooles down form extrusive rock.

* Features of Igneous rock
i) The igneous rock are massive compact and very hard.
ii) The surrounding rock are burned out in coal seam, where dyke was found.
It has been observed that surrounding coal is burned out to seam extend.
iii) The bedding plane is completly absent it means the igneous rock is spread out in a irregular boundry.
iv) Fossils are not found.
Feldsper are available.

ii) Sedimentary Rocks — It is secondary rock form from any type of pre-existing rocks.

The formation includes 3- geological process-

(i) Weathering (ii) Transportation (iii) Deposition

Weathering is also a process of erosion.

During erosion the pre-existing rocks disintegrate, later on these integrated rock are transported by various agencies wind, water, glaciers etc.

Transportation is a not a continuous process depending on the earth surface profile. It deposited somewhere, may be a short distance or long distance. The resulting product is known as Sedimentary rock.

After deposition the disintegrated becomes compact.

* Types of Sedimentary rocks —

There are two types of sedimentary rock depending on the position of the formation of sendimentary rock from the place of pre-existing rock.

i) Sedentary Rocks — If the place of formation of sedimentary rocks are near the pre-existing rock where from it was form is called sedentary rock.

The disintegration, decomposition

and compaction takes place at the same place without transportation.

ii) Transported rock — This is general system of formation of sedimentary rocks in this case all the process erosion, transportation and deposition are taking place and the rock is formed at a place which is at a distance from the place of pre-existing rock.

Occurence of Igneous Rock—

There are different form or occurence of igneous rock. Basically we have two categories of igneous rocks.

i) Intrusive ii) Extrusive

The occurence mainly depends on the following factors or conditions -

a) Viscosity of the rock.

b) Weather the igneous rock is in the form of concordant or discordant body.

c) On the nature of surrounding rock mass that wheather faulted or folded.

Occurence of Intrusive Rock—

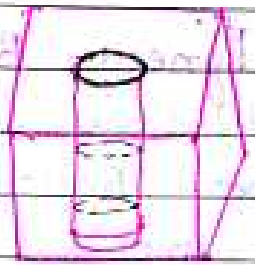
i) In the unfolded zone
It may be discordant or concordant.

Discordant bodies —

i) Dyke— These are the discordant igneous body and it is related with the crosscutting relationship with the country rock.

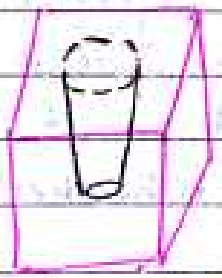
Unfolded zone.

ii) Ring Dyke – This is a special type of dyke in which its outcrop takes the form of nearly completed or completed circle.



outcrop- ring shaped

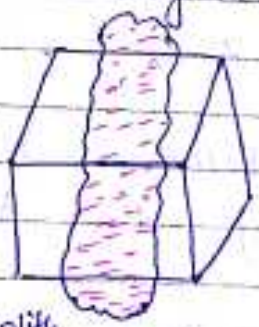
iii) Cone Sheet – Cone sheet also a particular type of dyke in which it takes the form of a cone (geometrical)



NOTE: All the above figure are discordant dykes but occur in unfolded region.

Folded Zone — The intrusive rock occurs in folded zone as an discordant body definitely diffess from unfolded zone.

i) Batholith — Practically this is very large intrusive body in size and shape. When there is folded zone then the intrusive rock spread largely & after touching a particular point it goes down. In general largeness is not known.



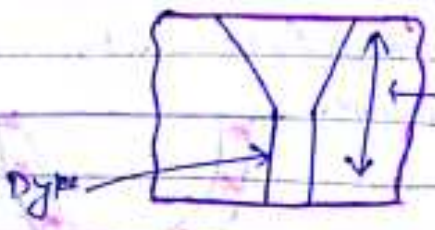
Batholith

(Boundry is very large)

ii) Chonolith — It is an igneous body present in highly folded zone but the boundary is irregular and normally not large as batholith.

Some geologist suggest that chonolith is any igneous rock whose boundary is irregular.

iii) Ethmolith — Ethmolith is igneous rock mass infolded zone but the shape of the zone is something like tunnel.



iv) Harpolith — It is also intrusive igneous rock which is sickle shaped and formed due to stretching either during the injection of magma or after the injection magma.

Concordant (parallel) bodies —

These are the intrusive rock which run parallel to the structure of the country (earth) rock. They are—

i) Sill — This is tabular sheet normally thin and parallel to the structure of country rock.

It is believed that the magma has pentrated long the bedding planes to form sill.

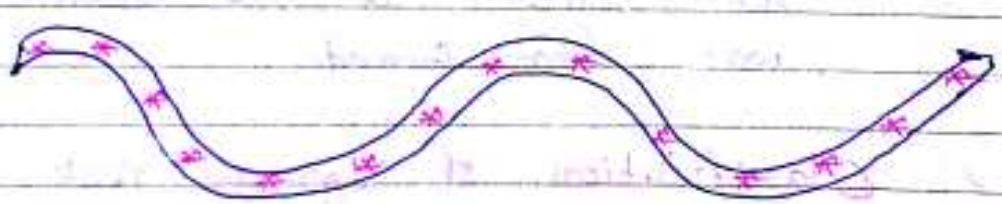
ii) Locolith — It is the convex shape igneous body i.e. the lower surface is flat and top surface is convex. The structure depends upon structure of country rocks of the joint fichess (crack) (Bladeout) within the country rock.

iii) Lopolith — Lopolith is just reverse of locolith and take the form of a saucer (तश्तरी). Its top surface is flat and bottom surface is concave.

iv) Bysmalith – If the magma breaks through overline rocks and comes to the surface then consolidation takes place at the surface such type of structure is known as Bysmalith.

Highly folded zone:

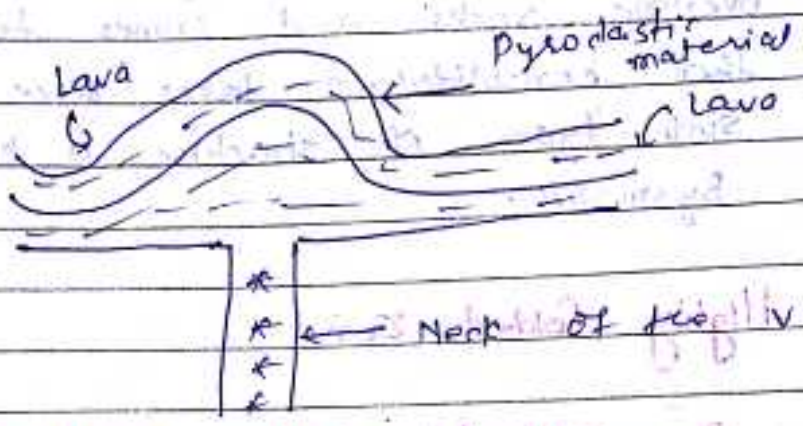
i) Phacolith — Phacolith is an igneous rock mass which occurs in folded strata. The rock is deposited in anticlinal and synclinal part of the fold that is crest and trough of the folded zone. The maximum is deposited in anticline and syncline The shape of the body is like a lens may be convex or concave according to the cutting to the cutting position.



* Occurence of Igneous rock as extrusive body:
This is associated with the volcanic activity.

a) Concordant extrusive body
Lava flows in pyroclastic material which are product of volcanic body activity is known as extrusive igneous rock. Basically lava flows. takes the structure of the earth surface. Hence, this is known as concordant

extrusive body



b) Discordant extrusive body—

This is also product of volcanic activity. In the volcanic neck lava flows of pyroclastic material consolideted.

Since, volcanic neck forms discordant relationship with the country rock, Hence, it is called discordant igneous rock.

Further, it is very near to the surface of the earth where it was ~~formed~~ formed.

Classification of Igneous rock—

Classification of rock family mainly based on the physical properties of the rock, chemical properties of the rock and also geological situation. Hence, a singned rock can be classified in to many classes depending on the above mentioned properties or situation.

The igneous rocks are classified on the following basis—

i) Chemical ii) Origin iii) Mineralogical property
iv) Association v) Genesis.

1) On the basis of chemical properties —
The standard chemical used for classification silicon dioxide (SiO_2) known as silica.
The % of silica determined classification in this case. The rocks are classified as

(a) Acedic — When the % of silicon dioxide more than 66%. then it is called acidic.

(b) Intermediat — If the % of silica is more than 55% but up to 66%. then it is called intermediate.

c) Basic rock — If the percentage of silica is more than the 44% & up to 55%. then it is called basic rock.

d) Ultra basic rock: If the percentage of silica is less than 44%. then it is called ultra basic rock.

2. On the basis of origin — Origin means position of the formation of the below earth surface accordingly it has classified into ~~three~~ two type.

a) Extrusive rock — When the igneous rock form on the surface then it is called extrusive rock.

b) Intrusive rock — It is the rock which are form beloid the earth surface practical the igneous rock are classified on this basis. Since, in general extrusive rock are form due to volcanic eruption Hence, to classified igneous rock in to extrusive rock but little meaning. Hence, igneous rock are fundamently devide in to two type:

i) Plutonic rock: When the igneous rock are formed dip down the earth then it is called plutonic rock. Some geologist defined it is abyssal.

ii) Hypabyssal — Practically formation of Hypabyssal rock in between plutonic rock and surface of the rock.

3. On the basis of mineralogical properties — Practically these are the physical properties of the rock. Such as colour melting point and specific gravity.

Accordingly the rocks are classified into two types —

i) Felsic igneous rock — The igneous rock which has light colour, low M.P. and less specific gravity — is called felsic rock.

ii) Mafic — The igneous rock which has high M.P., dark colour and more sp.gr. is called mafic rock.

The above 3 classifications

are important to be considered the other classifications are.

4. On the basis of Association —

The association means association with what hence the word is not very clear. But geologically association means the place of occurence of the rock mass further the surface feature depend on structural condition. In general the association is consider as plateau (High-rise) or plane. Accordingly it is classified as ⓐ plateau related and ⓑ plane related.

5. On the basis of Genesis —

We know that the strata may be concordant and discordant.

Accordingly it has been classified as: ⓐ Generation by cross-cutting relationship i.e. discordant structure.

ⓑ Generation by parallel relationship known as concordant relationship

Sedimentary Rocks

The sedimentary rocks are those rocks which are derived from pre-existing rocks. It means the rocks which are already available in the surface of the earth.

The following process are involved for formation of sedimentary rocks.

(a) Erosion (b) Transportation (c) Deposition

The first process during formation is erosion and final process is deposition, Transportation is the intermediate process

* Mechanism of formation of sedimentary rocks-

First of all the sedimentary rocks are disintegrated. The disintegrated means break up of the pre-existing rocks in to smaller parts.

The smalles parts then subjected to Erosion or weathering. The erosion is most important part of the sedimentary rock formation. Later on such disintegrated rocks are transported by natural agencies. Such as wind water and glaciers. The transportation takes place up to well defind distance. It means transportation continuous till conditions favorable for deposition takes place.

Later on materials deposited normally in the basin or dip area further compaction results conversion of transported material in to sedimentary rock

Coal is a rock not mineral since geological formation suggest that it is sedimentary rock but for commercial purpose or business purpose such as in railway coal is considered as good as mineral since transportation

inlays

charge (Freight) involves.

Some of the sedimentary formation does not involves transportation, deposition at the place where pre-existing rocks for the formation of sedimentary rock whose form.

Types of Sedimentary rock—

Depending on the formation of sedimentary rock we have two types of sedimentary rock.

(I) Sedentry (II) Transported.

(a) Sedentry rock— The literal meaning states that it is the rock mass deposite or form at the site of pre-existing rock. The pre-existing rock is the rock form which all the sedimentary rock are form.

Practical this is the residual deposite which does not suffers any transportation.

(b) Trauported rock— This is the rock in which disintegration and the decomposition of the pre-existing rock take place at the particular place ~~and~~ at the particular place and deposition or formation of sedimentary rock take place at a different place which is at a considerable distance from the place of decomposition. It means transportation must have taken place

between the place of decomperition and place of deposition hence the name trausported rock

* Important features of sedimentary rock—

i) Due to the nature of formation the sedimentary rock are soft.

ii) It is stratified i.e. beded.

iii) Fossils are commonly formed.

iv) Different type of marks such as mud cracks are visible some times.

v) The common mineral for formation are normly the minerals which from clay is formed calcite, hamatite, dolomite etc.

vi) Where sedimentary rock were form at that place where top and botom rocks are not affected.

* Classification of sedimentary rocks—

Basically sedimentary rock are classified on the basis of method of deposition.

Practically we have two types of deposition.

① Residual deposition

ii) Trausported deposition

i) Residual deposition— The residual deposition are those type of deperition which is associated with the sedentary rock or sedintary deposition such deposites are form due to accumulation and comporition

Consolidation of the material decomposed. (Consolidation means compaction of disintegrated material with use of Cementing (Cementing) matrix)

The following rocks types are treated as residual deposit.

(1) Terra-rosa (clay) — It is nothing but converted form of clay, in general clay is mixed with lime stone as a result of which a residual form which is insoluble

ii) Laterite— These are also residual deposite, this is found in tropical region practically known as bauxite.

2. Transported deposition— As per physical property rocks are classified as
   (a) clastic material
   (b) Non-clastic material.

(a) Clastic material— They are fragmental rocks such rocks are carried and deposited by mechanical means water. As a result of which the transporting medium does not react with clastic meterial.

Such clastic material after cementing forms different rock type. The formation of the rock types depends on size of the fragment. The size of fragment may be fine, medium or coarse.

i) Fine – The size of the fine material normally less than sand, as a result of which clay is formed. They are known as silt rock.

ii) Medium – In this case the size is more or less equal to sand grade resulting rock is grit or sand stone.

iii) Coarse – The last and final size is coarse material. In this case size of the individual material is boulder. They are known as conglomerate when the side is rounded and breccia, side of fragment are pointed.

(b) Non-clastic material – In this case size of the particle are very less as a result of which different salts are formed as calcium sulphate, calcium chloride, calcium carbonate etc.

There are other types of sedimentary rocks form which are form due to chemical or biochemical reaction. This is form due to decomposition of organic origin such as formation of coal or other type of chemical active salt.

Metamorphic rock- Metamorphic means change ~~these~~ their form due to reason of pressure and temperature.

This rock are those rock which are form due to application of pressure and temperature on igneous or sedimentary rock.

The metamorphic rock does not have own identity mainly depends on the basic rock from which it has been form.

Agent of metamorphic—

The following agents are mostly responsible for the formation of metamorphic rock.

(a) Temperature (b) Pressure
(c) Chemicaly active fluid.

Importance features of the metamorphic rocks:

(i) In general it is very hard as compared to igneous and ~~metamorphic~~ sedimentary rock.

ii) If it is form from igneous rock grains are interlocking.

iii) If it is form from sedimentary rock then it is beded.

iv) We know that fossils are found in sedimentary rock but when a ~~metamorphic~~ sedimentary rock is converted into

metamorphic rock their fossils are in general destroyed.

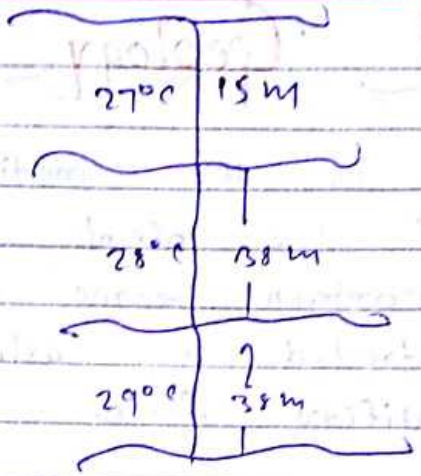
v) Whatever might be the igneous rock or sedimentary rock which took place in metamorphism its quality completely change in general.

vi) On the surface of the earth the share of sedimentary rock is very less it is about 3-5 percent.

Agent of metamorphism—

① Temperature — If we go down of the earth their will be increase in temperature such increase is known as geothermic gradient.

After 15 meter depth the temperature is known as Constant temperature. line is varies from 27°c to 28°c but ~~difference~~ differse in different place in the earth. After covering a depth of 15 m the temp. further increase at a the rate of 1°c for a particular distance cover such distance is normally within the range of 38°c to 40°c due to higer temp. available the original rock (igneous or sedimentary converted to changed rock. This is known as metamorphism.



In this process physical properties change chemical properties not change.

iii) Pressure — Pressure is a another agent which change primary rock in to its changed form.

In general for every 1m depth there will be pressure developed .2 Kg/cm^2 according in general the dimension of the stratified form of its original position.

iii) Chemically active fluid — On the surface of the earth the water carries different minerals such ~~as~~ different minerals are taking parts in reaction between the rock and the water causing decomposition as a result of which new rock of different quality and property develops.

Coal Geology

Coal— Coal is the modified or decomposed part of the plant material it may contain some mineral which are extracted as ash. It is found in stratified form.

Origin of coal— Two theories put forward to indicate origin of coal.

i) Drift theory
ii) Insitu theory

1) In Drift theory plant materials are transported from its place of growth to other place where coal seams are formed. The transformation takes place by flowing water from river lake, sea etc.

The following evidence proofs drift theory

(a) A maximum amount of plant material are accumulated (एकत्रित होना) near the river bed.

(b) Fossils are found in inclined position.

c) No soil are found below the root of the fossils.

(d) In general coal seam are occur near sedimentary rock formation.

Coal Geology

Coal – Coal is the modified or decomposed part of the plant material it may contain some mineral which are extracted as ash. It is found in stratified form.

Origin of coal – Two theories put forward to indicate origin of coal.

i) Drift theory
ii) Insite theory

1) In Drift theory plant materials are transported from its place it grows to other place where coal seams are formed. The transformation takes place by flowing water from river lake, sea etc.

The following evidence proofs drift theory

(a) A maximum amount of plant material are accumulated (एकत्रित होना) near the river bed.

(b) Fossils are found in inclined position.

c) No soil are found below the root of the fossils.

(d) In general coal seam are occur near sedimentary rock formation.

e) Stem with roots are not found up right positions.

f) Presence of sand in coal seams indicate flow of water.

" In this manner indian coal seam are formed. "

2. In situ - theory — By this theory coal seam were formed at the place where plant material grew the coal formation due to this theory is more or less pure as compared to formation of coal by drift theory.

Since, coal seams are produce directly by the subsidence or plant material within the earth. Mixing of other material is less therefore formation of ash is also less.

The following evidence proofs in-situ theory.

a) Maximum no. of plants material are formed near the seam.

b) Fossilised tree trunks are found in erect position.

c) Soils are found near the root of the tree.

d) Pure coal normally found not mixed with maximum amount of other material.

In this theory English speaking countries are formed.

Rank of Coal

Rank of coal means different position or purity of coal.

In general the conversion of plant material to coal at different stage is known as rank of the coal. The Higher the rank of the coal, the higher will be carbon percentage. Process of ranking that is plant to higher rank or final rank depends on elimination of hydrogen and oxygen as per as possible and increasing of carbon as per as possible.

In such manner coal is basically have four rank or stage.

(i) Peat (ii) Lignite (iii) Bituminous (iv) Anthracite.

The source material from which different stage of coal is formed is wood or plant material.

The following table indicates different percentage of different elimeut available for conversion of wood to authracite.

Type	Sp. gr.	C %	H %	O %	N %
Wood	0.91	50	6.0	43.5	0.5
Peat	0.99	57	5.7	35.3	2.0
Lignite	1.25	67	5.5	26.5	1.5
Bituminous	1.30	84	5.5	10.0	1.0
Anthracite	1.45	93	3.0	3.0	1.0

The above table indicate how percentage of oxygen and hydrogen decreases with the progress in ranking and also it indicates increase in carbon with the progress in ranking the above table is given by United Kingdom and internationaly accepted.

Banded Constituent of Coal

- Bright
  - Vitrain
  - Clarain
- Dark
  - Durain
  - Fusain

Coal is not homogeneous in nature but forms in several layers. The layers are normally parallel and clearly visible when light is thrown on the face of a coal seam.

In a nutshell the banded constituent is divided in to two parts
① Bright band ② Dark band

① Bright band — Bright bands are those bands which emits light and normally found in all type of coal and in general

it must be detectable in high quality coal (14= seam coal).

It means when light thrown on such type of band its reflect light.

ii) Dark band — As name suggest it appear is dull and does not emit light when falls under light it means reflection is not detectable.

Detail description of bright and dark band.

① Bright band — On the nature of emitting light and physical quantity bright band divided further as

ⓐ Vitrain ⓑ Clairain

ⓐ Vitrain — It is the most bright band actually this is the layer which is too bright and generally found in high quality coal. It is friable and breaking of the coal consist in cubical form or in rectangular form. When touch by hand or fingure it is very clean i.e fingure and hand has not soil. These are parallel banding plane. British U.S.A

ⓑ Clairain / clarain) — Clarain are also bright band and the brightness is less than vitrain. Both the band can easily be ~~ddetect~~ ~~did~~ deducted by observing their brightness. Like vitrain,

clairain is also available in high quality coal it is paselled to bading plane it also does not soil fingures and hand but not friable as quickly as Vitrain when breaks it forms irregulers shape very soft.

② Dask band — Dask band is divided in to two parts ⓐ Durain and ⓑ Fusain

ⓐ Durain — It is most dull band available in coal seam harder than bright band breaks in irregular shapes, soils fingure and hand and not friable.

ⓑ Fusain — It is also dull in appearance easily friable. It soil fingue when touch the main characteristic is that it is available in all type of coal. Resemble with the charcol. Absorb light but does not reflect.

Occurence of Coal —

In general coal occur in sedimentary bed hence the associated rocks available with the sedimentry bed are sand stone, shell and fire clay all the mentioned rocks are of sedimentary origine.

Many a times igneous intrusions are available with coal seam. They are dyke and sill.

Distribution of coal —

(History of formation of coal or stratigraphy)

Distribution depends on geological time scale - Two geological time scale put forward for distribution of coal in indian geological condition.

(a) Permian age
(b) Eocent to miocene age

Accordingly the distribution of coal is divided in to two classes

i) Lower gondwana coals of permian age
ii) Tertiary coals of Eocent to miocene age.

It has been proved by geologist that 98 % of coal has been formed by lower gondwana coal this is most imperteut formation of coal mostly bituminow in rank.

Tertiary coal have share only 2 to 2.5 % to the countries.

Gondwana Coals — Gondwana coals are available in river valley of Mahanadi, Godaveri and Damodar.

The workable coal seams are confined to Damuda group they occurs in two planes.

(a) Barakar measure of lower permian age
(b) Raniganj measure of upper permian age.

The Barakar measures give better quality of coal but Raniganj measure gives less quality of coal.

The following are the important coal fields of india.

(i) Jharia Coal fields of Jharkhand
(ii) Giridih and Bokaro coal fields of Jharkhand } Barakar measure
(iii) Raniganj coalfields of W.B } Raniganj measure

The above coals seam are coming under Damuda group of Barakar and Raniganj measure. Only Raniganj measure comes under Raniganj measure.

Other semi important coalfields are :

Talchir Coalfields of Orissa -

The other coalfields are found in Chattisgarh and M.P. Some coals which are also important are in hydrabad singrani.

Tertiary coal fields are normally available in Assam, and Himalaya foot hill. Some coalfields are found in Gujrat & Tamilnadu, Maharastra etc.

important

Anthracite Coals are normally found in Himalayan foot hill.

Scanned by CamScanner

Commercial classification of coal —

Basically commercial classification is made to inhance economic value of coal and its market ability in general to satisfy the customer requirement and also for easy handling.

Accordingly coal has to classify on the basis of

(a) Size of the coal
(b) Moisture contain in the coal
(c) Heating value of the coal.

(a) **Size of the coal** — On the basis of size of the coal it has been classified in to 4 different classes.

(i) Run of Mine coal(ROM) —
ROM does not have any distinct or regular size technically it is the blasted coal which are taken out from inside the mine hence, regular size can not be aspected (size is not given).

(ii) **Slack Coal** — When size of the coal is less than 25mm. Practical definition of slack coal are those coal whose size are in between 0mm to 25mm but 0mm size coal does not exist hence any coal less than 25 mm is the slack coal.

(iii) Rubble Coal— When the size of the coal is more than 25 mm but less than 50 mm then it is said to be rubble coal. Such type of coal is great importancy. It is very nicely used in boiles only idea is to get maximum heating value for power generation.

(iv) Steam Coal— This type of coal are widely used in Industries. Size of the coal is more than 50mm but their is no highes limit of size. Further, for the interest in the steel industry and their requirement the size is limited within highes limit 200mm.

(b) Moisture contain in the Coal—
The moisture contain does not have maximum effect. Normally coal contain Ash, volatile matter, moisture and fixed carbon percentage. Previously coal has classified on the basis of moisture but such basis does not have more effect on the heating value of the coal hence ash percentage indicate heating value.

i) Moisture % up to 19 is known as semi ~~cook~~ coking coal with some % of ash. This is grade-I coal.
Grade-II semi coking coal

the moisture percentage is up to 24 %. but must be more than 1%.

ii) Ash percentage up to 36 is hard coke.

Ash percentage up to 31 % superior.

Modern definition of classification of coking coal

The coking coal is those coal which are used in steel industries.

% of Ash	Name
up to 15 %	Steel - I
Exceeding 15 % and up to 18 %	Steel - II
Exceeding 18 % and up to 21 %	Washery - I
Exceeding 21 % and up to 24 %	Washery - II
Exceeding 24 % and up to 28 %	Washery - III
Exceeding 28 % and up to 35 %	Washery - IV

The steel grade coal I & II are the coal which can be directly used in steel plant without washing since ash percentage is limited within 18 %. hence ultimate heat value will be maximum about 8000 Kcal/kg. In Jhariya coalfield coal of 14 seam is of such nature and hence can be directly fed for hot rolling mill (workshop) in any type of steel industries.

The washery coal are those

coal which need to be washed before using in steel industries and ash percentage of such coal in the all the time is more than 18% and hence to make washery coal to steel grade is need to be washed to lower down the ash percentage, so that the ash percentage come with limited value. i.e. below 10 percentage.

(c) Heating value of the coal—

Some coal whose ash percentage very high i.e. more than 35% then such type of coal is normally difficult in steel plant and not in used, such type of coal is known as non-coking coal.

The non coking coal is divided on the basis of heat produced per kg of coal this is known as ultimate heat value. The coal is graded from A to G.

Grade of Non-coking Coal		Ultimate heat Value
A	→	Exceeds 6200 kcal/kg
B	→	From 5601 to 6200 kcal/kg
C	→	From 4941 to 5600 kcal/kg
D	→	From 4201 to 4940 kcal/kg
E	→	From 3361 to 4200 kcal/kg
F	→	From 2401 to 3360 kcal/kg
G	→	From 1301 to 2400 kcal/kg

Non-coking coal are normally used for domestic purpose, railway and some times thermal power station and also in small scale industries. Hence, utilisation is limited to the large scale industries. It is used in micro, mini and medium scale industries.

Structral features of the Coal Seam-

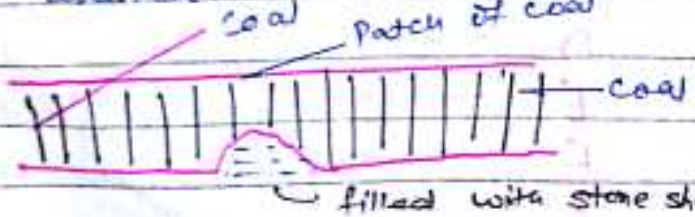
The thickness of the coal may not be homogeneous throughout the mining property it may be very greatly also their may be distribution within the seam. Geological. In general structral features are classified as

(i) Washout (ii) Roll (iii) Swilley

(i) Washout

The washout is the phenomenon within the coal seam when coal seam is total missing or miss from the roof side and a small patch of coal seam is available.

(ii) Roll -



Roll is just reverse of Washout. In this case coal have been missing completely from there but a small patch of the coal is available in the roof.

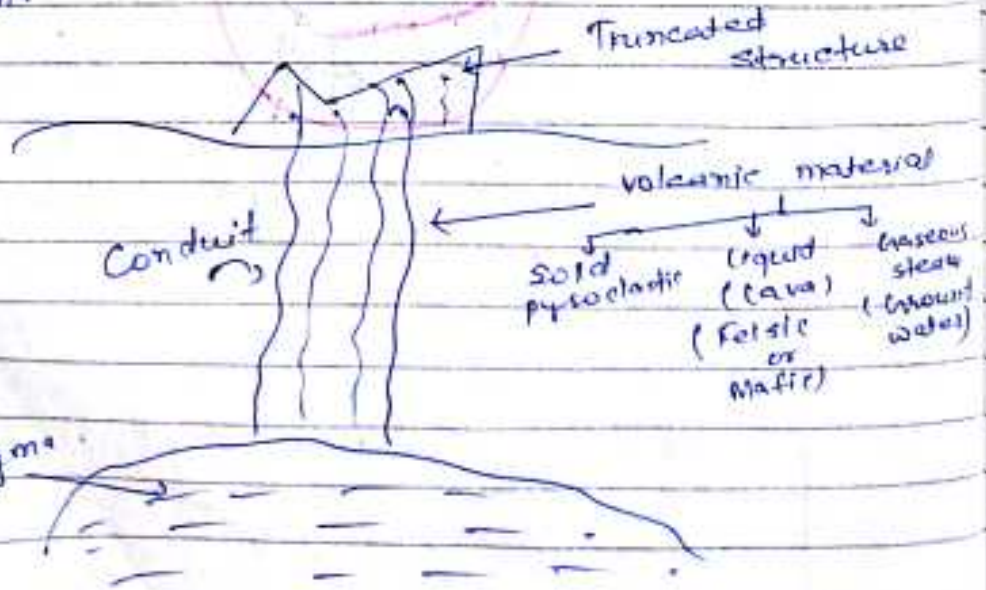
iii) Swilley — This is a special types of structral features available in coal seam. In this case coal seam does not discontinuous and does not missing instead due of very high in compressive pressure within the coal seam. It gets folding but not in a regular structure — of the botom part of the folded zone, has got more thickness than general thickness of coal seam. Such structure is known as swilley. If swilley occurs working becomes difficult.

Swilley

Physical Geology

(i) Volcano (ii) Earthquake
(iii) Geological work

(i) **Volcano**— volcano is a mountain like structure form due to ejection of volcanic materials from beneath the earth.
It may come out from a fishers present in the volcanic area or the cracks are form due to heavy pressure of the throwing of magma.
The throw of the magma or lava or volcanic material are irregular as a result of which the regular dome shape structure may not form but instead truncated hill like structure is form.



Types of Volcano —

The type of volcano are based on the following factors

i) Interval of activity or Interval of eruption
ii) Mode of eruption
iii) Nature of eruption

i) On the basis of interval of eruption the volcano are classified as in to 3-type
(a) Active Volcano (b) Dormant volcano
(c) Extinct

(a) Active Volcano — The volcano which erupt continuously or intermitenty is called active volcano.

(b) Dormant Volcano — It is the type of volcano does not erupt for a long time but can erupt at any time or any moment such as 1 year, 5 year, 10 year etc.

c) Extinct volcano — It is the type of volcano which stops eruption for a very long time such as 50 years, a century etc.

ii) Mode of eruption :

On the basis of mode of eruption the volcano are classified as

(I) Central type

(II) Fissure type

(a) Central type – In this type of volcano hole is form as a results of which a pipe is formed this pipe is known as vent of the volcano through this vent volcanic materials are coming out the surface.

(b) Fissure type – In this type of volcano the volcanic material are coming through either a single fissure existed within the area or a no. of parallel fissure or a no. of close fissure which form a group of fissure may be paralles or may not be parallel.

iii) Nature of eruption –

On the basis of nature of eruption the volcano are classified as two types

(I) Explosive type (II) Quite type

(a) Explosive type – The name suggest that the eruption must be highely explosive. The material comes out as acidic also known as felsic. viscosity very high

(b) Quite type - The name suggest that the eruption is quite the materials comes out as basaltic in nature that is mafic. naturally viscosity is very low and the mostly liquid material are coming out due to less viscosity it spreads over earth surface at a long distance

* Topography (surface feature)-
The topography of the volcanic area depends on the material coming out along with eruption.
There are basically two types of material. (I) Pyroclastic (II) lava flows makes surface features of the area. The area is divided in to two structure
(I) Positive relief - The positive relief are those types of structure which form high landscape or domeshaped. Practically their elivated from the normal surface structure such as hills mountain cone etc. The following structure are prominent
(a) Cinder cone — The angle of inclination is normally 30° to 40° and very stiff. They are basically form due to ejection pyroclastic material.

(b) Lava Coue Basically lava cone form due to quite type of volcanic eruption

it is form due to heaping of lava at a particular place. It means lava flows are occurs continuously on a particular place creating a dome of lava

iii) Composite cone- Such cone is form due to eruption of both solid and liquid materials such as pysoclastic and lava. The pysoclastic material are heap at a place and the lava consolidate at a same place after cooling down. Geologist believe that pysoclastic material and lava flow take place alternatively.

iv) Shield Volcano- Such volcano are also result of lava flows but no pysoclastic material mixes. It differs from lava cone that's its top is round.

v) ____ relief — These are the depression or Basin shaped. The following are the main relief.

① Craeter → These are depression which are located at the top of the volcanic cone through which the volcanic material are coming out.

② Caldra — Practically caldra is formed after destruction of crater due to heavy volcanic eruption or also due to

repeated eruption. The central portion of the volcano destroy and its diameter is inlarge to a very large amount such structure is known as caldra.

(c) lava tunnel- If only lava is coming out through central conduit the lava will spread over the earth surface. Due to less surface temperature the lava become solid but the central portion may still be fluid such type of structure is known as lava tunnel.

(d) Cone in cone topography-
This is a special type of structure in which the previous cone which was formed due to previous eruption destroy when next eruption takes place as a result of which a new cone is form such structure is known as cone in cone topography.

Volcanic Materials —

The volcanic materials are those materials which are coming outs due to eruption of volcanic activity. There are 3- type.

i) Solid material known as pyroclastic materials
ii) Liquid material known as magma or lava flows
iii) Gasseous material

i) Solid material or pyroclastic material are classified on the basis of the diameter and the size.

(a) Volcanic blast — These are also known as bomb the diameter is more than 32 mm.

(b) Cinders — These are also known as lapilli. & the diameter is more than 4 mm but up to 32 mm

(c) Ash — More than 0.25 mm but up to 4 mm

(d) Fine Ash — up to 0.25 mm

The above are the classification of pyroclastic material but there are two more classification which are

(1) Tuff — A mixture of Ash & fine Ash is known as tuff since the Ash and the fine Ash can not be easily seperated.

(b) Agglomerate — It is purely solid material made of pyrodastic material when size of the pyroclastic

material is more than 20 mm then it is called Agglomerate.

ii) Liquid material – Lava is the only liquid material that coming out from the volcanic material.
These are two types

(I) Porus structure – In this case a no. of holes are form on the surface of the lava after consolidation. It is also known as sponge lava.

(i) Pillow structure – Due to lengthy spread and obstruction on the surface of the earth and also due to obstruction the lava form of pillow after consolidation such form is known as pillow structure. This also called splitic lava.

iii) Gasious materials – Steam is coming out with the eruption this forms 90% of the gaseous material other gasses are CO_2, H_2S, SO_2, Nitrogen boric acid vapours, phosphorus and arsenic vapour.

EARTHQUAKE

Earthquake is a jerking motion on the surface of the earth it may be mid to severe.

Actually the jerking motion takes place on rocky sail of the earth crust.

Causes of Earthquake –

There are basically 3 causes of earthquake.

i) Surface cause
(ii) Volcanic cause
(iii) Tectonic cause

i) **Surface Cause** – Surface cause is any type of tremors or vibration of the surface of the earth. When a heavy vehicles is moving on the surface of the earth around the movement for a small distance there will be perceptible vibration on our body such vibration is also called earthquake

In mountaineous region there are landslides from the hill. The land slides give a severe impact on the surface of the foot hill due to impact there must be vibration to same distence from the foot hill such vibration are called earthquake, Due to landslide the action may be dangerous some time loss of ~~time~~ or life or loss of material

may involved.

Landslides are also take place in glaciers this is also cause of earthquake

The sea waters dasing the shore with heavy impact as a result of which mild to medium vibsation obsesved near the sea shore as result of which the road building near by sea shore sometime ~~gate~~ get crack this is kwaon as earthquake.

ii Volcanic Cause — The volcanic eruptions are severe cause of earthquake actually volcanic eruption are associated with the earthquake. When crates of the volcano is converted in to caldra, severe earthquake results.

Such earthquake are not spread a long distance but within the limit of the extention it means the shock wave is localised.

The followings are main region are earthquake associated with the volcanic eruption—

@ General eruption of the volcano which releases pyroclastic material, lava and gasses with heavy forces such material when coming out through the conduit transfes vibration around the conduit further when after coming out the

surface it coming the long distance when falls on the surface of great force definetly causing vibration on the earth surface such vibration is termed as ~~eq~~ earthquake.

(b) Due to volcanic eruption fault results within the earth hence there must be Gape filling phinomena within the earth during this procen heavy pressure are created. Such heavy pressure ultimately coming out to the surface such vibration is known as earthquake.

c) Collapse of the centre portion of the volcano that is conduit results due to repeated collapse the upper part of the rock must go down to fill the void during such process vibration results which is known as earthquake

iii) Tectonic Cause:- This is the very severe type of earthquake discussed this result due to geological disturbance within the earth crust.

Practically this occur in older fault area this an established fact this includes relative displacement of the parts of the earth crust and occurs in the places when there are

great fractures or cracks when such fracture or crack can not bear heavy pressure then rocks break downward as a result of which fault occurs during this phinomena heavy vibration derastation type comes up to the surface from above the faulted region. Such fault in causes shaking. Now earthquake shaken are sometime can not bear heavy vibration. progress of the vibration may be in horizontal, vertical or inclined direction.

Practically the rock in the fracture zone release a strain energy right up to the surface mainly a times such earthquake can not show visible effect. It is believed that the root cause of the such earthquake is too dip from the surface of the earth and hence visible effect to have not seen on the surface.

The following theory has put forward for mechanism of earthquake and it's known as elastic rebound theory. The theory states that all the materials of the earth are elastic in nature and being elastic it can accept a certain amount of stress after that it can not bear more stress as a result of which permanent

deformation and strain is produce. Ultimately rupture takes place such vibration is convested in to vibration and is known as earthquake.

Types of Earthquake —

Earthquake are classified on the basis of depth from the surface that is depth of origin.

The classification is practically given for tectonic earthquake.

(i) The earthquake is normal and shallow depth — When origin is at a distance of 0 to 54 km.

ii) Earthquake of medium depth — More than 40 and up to 240 km.

iii) Dic focus or plutonic earthquake when the depth is more than 240 km but up to 720 km.

Scale of Earthquake to measure intensity —

(i) Rossi and More
(ii) Mercali
(iii) Richter

There are 3 scale provided for knowing intensity of earthquake the scale depends on devastation, acceleration and combination of both.

Accordingly 3 scales are provided they are

(i) Rossi and Morel scale
(ii) Mercali scale
(iii) Richter scale

(i) Rossi and Morel scale

Intensity Number	Name of shock	Effect produce.
I	Micro Seismic	Recorded by delicate instruments Recorded by all seismograph
II	Extermly Feeble	Felt by experienced person.
III	Very Feeble	Felt by several person of rest.
IV	Feeble	Felt by person in motion, Affects windows and ceiling of house.
V	Moderate	Felt by every one, Greater disturbance on houses and produces ringing of bells.
VI	Fairly Strong	General awakening of persons from sleep and rising of bells clocks stop. Trees oscillate.
VII	Strong	Overthrows movable objects causes removal of plasters but no general damage on buildings.

VIII	Very Strong	Fall on chimneys and cracks in the walls of buildings.
IX	Extreme Strong	Partial or complete distruction of buildings
X	Shock of Extreme Intensity	General destruction of building and ground, produces landslides in mountaineous region

ii. Mercali Scale — The scales depends on accelesation produced on vibration

Intensity	Accelesation produced	Name of the shock	Effect Produced
I	less than 1cm/sec^2	Instrumental	Recorded by seismograph only.
II	Over 1cm/sec^2	Vesy Feeble	Received by sensitive pesson only
III	Over 2.5 cm/sec^2	Feeble	Received by pesson at rest
IV	Over 5 cm/sec^2	Madesate	Received by pesson in motion.
V	Over 10cm/sec^2	Fairly Strong	Wakes pesson rings bells
VI	Over 25 cm/sec^2	Strong	produces cracks in the walls
VII	Over 50 cm/sec^2	Vesy Strong	Sliget damage to buildings
VIII	Over 100 cm/sec^2	destruction	throws chimney

IX	Over 200 cm/sec²	Ruins	Over throws building
X	Over 500 cm/sec²	Dissaster	General destruction of building
XI	Over 750 cm/sec²	Extreme dissaster	Few buildings are left stands causes fissures in the ground
XII	Over 980 cm/sec²	Catestrophy	Total destruction of buildings and ground object thrown up

iii) Richter Scale –

The intensity of earthquake approximately proportional to the acceleration produced. Observing this phenomena C.F. richter proposed a new scale to measure degree of intensity of earthquake.

The scale have 12 division who is denotes magnitude of the earthquake intensity as indicate in the mercali scale. In this scale practically mercali scale is combined in a no. of group excepting I, XII & XI.

Intensity	Acceleration
I	1
II, III	3.5 to 4.2
IV, V	4.3 to 4.8
VI	4.9 to 5.4
VII	5.5 to 6.1
VIII, IX	6.2 to 6.9
X	7 to 7.3
XI	7.4 to 8.1
XII	> 8.1

Mercalli scale is previously divided into up to 10 scale ~~tell~~ latter on two scale XI & XII introduced

WEATHERING AND EROSION

Weathering — Weathering is a geological process in which mechanical disintegration and decomposition takes place hence sum total of disintegration and decomposition is known as weathering.

Geologically weathering involves process of breaking of rocks in to smaller past and decomposition of the rock.

Erosion — Removal of weathered rock from one place to another place is called erosion.

Erosion makes the rock denudation. It denudes the rock over which it was existed.

In some phenomena the proces of weathering and erosion are not Indapendent.

It indicates that erosion can have been without weathering and further weathered rock, all the time need not or can not exeded it means transportation has not effected.

Agents which are the causes of erosion-

i) River water also known as fluvial.
ii) Wind erosion
iii) Marine erosion (sea water erosion)
iv) Glacier erosion (ice erosion)

Process involved in weathering -

There are two process involved in weathering.

(i) Mechanical disintegration also known as mechanical breaking.
(ii) Chemical decomposition

Factors affecting weathering -

There are 3-factors normally which affects weathering.

(i) Physical factor (ii) Chemical factor
(iii) Biological factor

(Actually factors affecting weathering decides classification)

i) Physical factors - The physical factors are those factor which are affect on the rock masses from surface environment condition. Which are as follows.

(i) Frost (ice) action - Water is converted into ice when temp. falls to 0°C this water if present within the crack of the rock and converted into ice then there must be temp. difference and disintegration takes place. This that

of disintegration is also known as frost action. This happens practically in high altitude or in hilly place.

(i) Action of gravity — Due to action of gravity the new surface is exposed by the removal of upper part many a times upper part gets decomposed and the decomposed part is removed exposing fresh surface such type of weathering is visible due to downward movement of the loose particle this is clearly visible in mountaineous region

(ii) Action of Water — This is the very prominent type of weathering. The weathering takes place in very great magnitude.

(iv) Action of wind — This takes place normal in desart area but it is also found in plane area also where residential area exist the wind first of all denudes the surface of the earth and the remove particles are colloid with one another at an altitude from the surface of the earth

2.) Chemical factor —

○ Water - water is a very good solvent it also has got disintegration and decomposition process simultaneously.

It can dissolve many material chemical composition of the material with the water is called hydration.

Removal of soluble material with water is known as leaching. Basically any salt available with the rock mass became solution with the water and removed.

The metals or of the metals, hydroxide of the metal when attac' to water and hydroxide is easily transported.

Some restriction are their such as pure water normally react with lime stone but if the water contain soluble CO_2 then it becomes very good solvent

ii) CO_2 → The reaction of rock mass with CO_2 is known as carbonation it forms carbonet of the metal normally.

Actually when CO_2 comes in contact with water a mide carbonic acid is form such carbonic acid works as a very good solvent.

(iii) Oxygen → The combination of oxygen with any rock mass is called oxidation In general rock mass at the surface when reacts with oxygen forms Oxide of the metal existed within

the rock mass.

In general chemical action takes place near the surface of the earth or a shallow depth from the surface.

3) Biological factors —

i) Animals and insects forms heaps of earth such heap of earth can easily be removed and can be treated as transportation.

Trees and plants also disintegrates the earth due to pentration of roots inside the earth ~~feet~~ further the animals and plants also produce some toxic materials. Such toxic material are the cause of erosion on the surface of the earth.

On the basis of above facts the biological weathering are divided in to two parts.

① Biophysical process –

Erosion cause due to plant material are called biophysical procers this also include action by insects or earth-worm

ii) **Biochemical process** — Sometimes bacteria are forms such bacteria when reacts with rock Mass decomposes rock mass.

After death of some animal it gives out toxic substance such toxic

substance when reacts with earth surface causes decomposition.

All the above factors clearly indicates the two process involved in weathering any one process may involve are both the process may involve.

WIND EROSION — Wind erosion means erosion created by flow of air or velocity of air.

The Wind erosion involves 3 process —

(i) Deflation → Deflare (Blowout)
(ii) Abrasion
(iii) Attrition

(i) **Deflation** → The deflation means blowing away of rock particles or small fragments of rock by wind force. The word deflation is derived from latin word it means to blow away

The deflation causes removal of loose particle specialy in coastal region. Particle of the beach sand are dried during low tides and the wind carries dried sand or particles in land from the coastal region.

These are thus excavating action of wind on the ground. The

excavating action is limited. The maximum excavation is up to the waters table level. There after deflation stops.

Steps to be taken to deflation -

Deflation is dangerous condition specially for the farm land. This can be stoped by plantation, since the following factors affects the deflation.

i) Absence of vegitation
ii) Absence of moisture
iii) Loose rock particle
iv) High velocity air

Hence vegitation is only way to Stopped ~~veg~~ deflation.

2. Abrasion - Some times flow of wind strikes against of standing masses normally rock mass and mechanical disintegration result. practically the wind strikes from all directions to the standing rock mass depending on the flow of wind as a result of which a round mass can be form.

The loose particles that are blown away from a very good eroiding agent this particles strikes against hard rock mass and makes a great deal of erosion with the rock mass. causing Erosion.

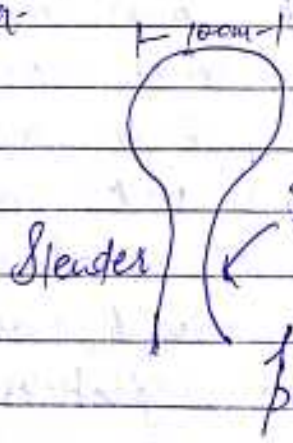
In this way due to wind erosion

Specially abrasion the standing mass becomes groved polished or reduced in size the effect of wind abrasion is found in the following causes

(i) When blown out particle is very hard.
(ii) The standing rock mass or bed rock is soft.
(iii) Velocity of wind is very great.

It is not easy to controll abrasion this is a natural phenomenon One of the prominent structure producing by wind abrasion is bedestal rock.

The blown out particle can not go very high as a result of which the lower part of the up standing rock mass are geting reduced this is known as slender. In other words top part is les reduced or bottom part is more reduced due to abrasion.



5. Attrition — The blown particle themselves are also striking with each other practically there are impact among the particles above the earth surface this process is known as attrition.

The rock particles not only abrad the rocks but they themselves involve in abrasion by colloiding against each other. This is because of the fact that the appearance of the sand are found round specially the desert sands are in general round in shape

Describe Geological Action of Wind:

i) Transportation— The transportation of loose particles affected by velocity of wind The wind action is prominent in desert region it also sometimes felt in semi dry region which are devoid (absent) of vegitation and no abstracte life of standing rock mass are form. The wind take away particles formed due to abrasion in far distance but the particles are not carried very high. This is called transportation

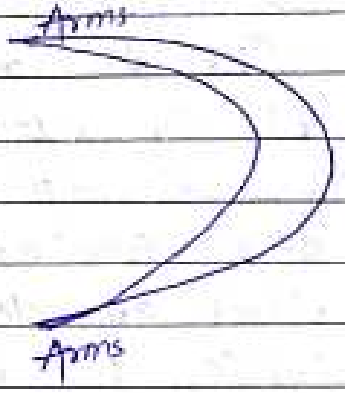
ii) Deposition→ If the forward movement of the wind is arrested by up standing mass or the velocity of wind is reduced and deposition is takes place.

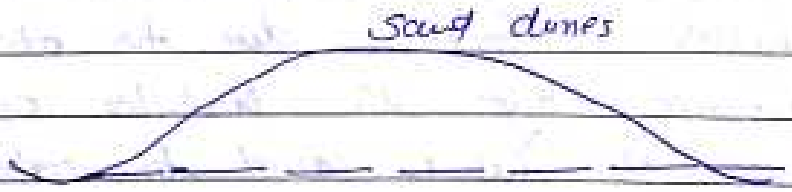
Many a times such deposition is temporary and further transportation of the previously deposited materials are taken place. This is known as swept away The wind deposites are termed as aeolian deposite.

The word come from ~~the~~ greek literature 'Aeolus' means Greek God of Wind.

The sand deposite formed in the desert are known as sand dune.

Other structure of the deposition is known Barkhan the words come from Turkey. Barkhan is a concave shaped from one side and another side is convex but the arms are slightly tapperred.





Geological action of river waters :-

River waters flows along the gradient of the earth surface. The following geological action are involved

(i) Erosion
(ii) Transportation
(iii) Deposition

① Erosion — The river erosions are mainly carried in core process.

(i) Hydraulic action
(ii) Abrasion
(iii) Attrition
(iv) Corrosion

i) Hydraulic action — The forces are ~~in~~ inherent within the flowing water of the river. A running water is a very good agent for mechanical erosion. It can loose the big rock mass in to smaller parts along with other particles.

ii) Abrasion — This is also known as corrasion it means striking of the river water with the bed rock or side rock but practically when river water flows some distance it carries rock fragment such rock fragment continuously striking with the rock and side of the river causing abrasion. This is known as load or west.

The result is that the rocks are getting eroded and the product of the abrasion are further carried away by the flow of water. Fresh abrasions are all the time taking place. Since, flow of water is continuous. Practically the rock waste becomes tools for destruction. Due to abrasion pot holes

are formed in the rivers bed (Pot holes are rounded or less rounded structure of the hollow in the vertical shaft).

(iii) Attrition — The attrition is the mechanical wear of the rock masses practically transported rocks fragment during transportation this rock fragment continuously colloiding with the bed rock and side of the rives due to this phenomenon the rock mass are reduced in this size forming pebbles. It means the big boulders are converted in to sand due to attrition such sand so form is normally thrown away towards is bank of the river.

iv) Corrosion → It is also known as solution. The corrosion means chemical action of ~~of~~ rivers waters with the rock mass. The dissolving power of river water differs from place to place. The dissolving power increases when some alkaline matters are added by the factory waste or added by some other means many a time CO_2 gas are also added due to factory wastes. The CO_2 gas when reacts with waters, it forms carbonic acid. Such Carbonic acid becomes solvent for the rock mass available.

2. Transportation — Water is a very good transporting media. The product of the erosion is definetly carried by river water to other process.

River water is not only carried it own loads but it also carries material added by the human being or by the materials forms due to landslides wind-borne are also carried by river water.

The transportation by rivers waters is done in two ways

(i) Mechanical process

(ii) By solution

(i) Mechanical process- Mechanical transport are depends on the following three factors-

i) Velocity of water

ii) Nature of river current.

iii) Density of rock materials carried.

(ii) Transportation of solution only depends on velocity of water current.

3. Deposition - Practically the deposition of material carried by river water depends on change in gradient or curve made by the direction of the river deposition takes placed at the bending position or where the gradient are normally less in those case the depth of river become less.

In general the river deposition

takes place in the sea. But before entering the sea it throws away its depusite close to the sea on the land forming land.

MINERALOGY

Def^{n}: Menerology is the science which deals with classification and properties of minerals availble at the surface of the earth specially who is form crust of the earth.

Minerals — Minerals are in-orgnic substance which are found in nature. It is heavy definite chemical composition. The composition vaeries within certain fixed limits. The composition consist of metals, non-metals and its oxides, carbonate, nitrat etc.

It has well defined interal atomic structure the form of the mineral may be crystaline or amorphous in nature.

Classification of minerals —

From geological point of view the Mineral is classified in to two types —

(i) Rock forming minerals

(ii) Minerals which has got some economic

value and marketability.

The marketability of minerals depends on its used by the society

1) Rock forming mineral — The rock forming minerals are those minerals which are responsible for the formation of earth crust but it has no or very little economic value.

for e.g. - The mineral quartz (SiO_2) is an important ingradient for the formation of rock known as granite. for the similar region the other mineral such as calcium carbonate ($CaCO_3$) also form some part of the earth crust though it contain calcium but extraction of calcium from calcium carbonate is very costly, or low costly or no costly or no possible to extract hence it forms rock forming minerals

2) Mineral of economic value -

This is such mineral who is produce metals and useful to the society such as haematite is a rock forming mineral from which we can extract iron similarly galena (PbS) is a rock forming mineral from which we can extract lead therefore such rock forming mineral has very good market value.

Some geologist classified

minerals on the basis of the deposition of magma or conversion of magma at the surface of the earth accordingly these are two classification.

(i) Primary Mineral
(ii) Secondary mineral

(i) Primary Mineral- Primary minerals are those minerals which are formed due to consolidation of magma due to the effect of surface environment.

(ii) Secondary Mineral- After coming at the surface from beneath the earth the magma is subjected to various chemical reaction or physical effect it means after consolidation of magma. The mineral which are form by this process is known as secondary mineral.

From economic value and naming of the rock, the mineral rock is classified in to two types

(i) Essential mineral
(ii) Fuser mineral

(i) Essential Mineral- Some rock contain mineral which have effect on the naming of the rock such as silicate it contain (SiO_2) silicon dioxide.

ii) Accessory Mineral- It means it addition to the esscential mineral it contain some other mineral but in less proportion for e.g. silicon dioxide is essential in rock granite and zircon is the accessory hence the name is granite.

The most scientific classification is based on the chemical composition of the mineral this is the modern classification and propose by Dana.

According to him minerals are classified as-

① Which are found as native element without composition of many other materal such as gold, diamond etc. Practically it does not react with environment, many a times copper may also found as native element.

ii) Sulphide- It means the mineral is associated with Sulpher such as galena, iron pysites.

(iii) Halides- Which reacts with halogen groups the principal mineral is rock salt.

iv) Oxides- When minerals reacts with oxygen such as silicon dioxide similarly other minerals are also found such as calcite, ~~Feldspher~~ Felspar.

Some of the hydrocarbon compounds

and organic salts are also take part in classification of mineral.

PROPERTIES OF Minerals

Properties of minerals divided practically in to two types division —

(i) Physical properties (ii) Chemical properties

2015 10 marks

(i) Physical properties — The following are the physical properties

i) colour — Actually each mineral has gots its own colour but in nature many a times minerals are mixed or contaminated to with other minerals hence its colour divested from its parent body. The dark colours dominets or contrast colour available

(ii) Streak — Streak is a dips cut marks on the hard surface when any mineral of a particular colour is made to cut on the hard surface, the colour may change this is called streak. This is very characteristics properties of the mineral and widely remarkable. Actually the colour of a powder of a mineral is known as streak. Therefore streak is determined

by the producing of a mark with the mineral on the unglazed surface.

iii) Specific gravity — Each and every mineral has its own specific gravity on this basis any mineral can be decided whether it is ~~heavier~~ heavier or lighter then any other substance. (It is the ratio of weight of the mineral to equal volume of water).

iv) Hardness — In general all most all the minerals are hard but intensity of hardness varies. The hardness decided on the basis of how any mineral can give any streak or mark on any other surface. hence the hardness is the comparison between two surface. It has been observed that glass made scraches on the iron plate hence from the point of view of hardness in mineralogy glass is hardness then iron.

Geologically the resistance given by any surface is called its hardness.

v) Cleavage — Cleavage is the properties of the minerals due to which breaks along a particular direction.

Actually cleavage is tendency to break down due to this tendency

cracks are form hence such cracks are known as cleavage cracks

(vi) Fracture – It is a properties by virtue of which any mineral can breaks in to two or more parts. The difference between cleavage and fracture is that if the mineral does not have any cleavage then also it may breaks in to a no. of piece when high impact is given on the mineral surface but due to presence of cleavage plane it will break the cleavage plane and forming more small pieces. It is the nature of the surface itself.

(vii) Lustre – lustre is the properties of any minerals due to its reflects in all direction Practically it gives shiny effects. The degree of shine varies from mineral to mineral.

Accordingly it has been characterised by following 5 variation–

(i) Splending (ii) shining (iii) glistering
(iv) glimering (v) Dull

(viii) Special properties – some of the minerals soil and also gives mark on the piece of paper such as graphite. Some of the minerals has soapy feelings such as talc powder.

(ix) Form and structure – Though form and structure does not include strictly in the study

of properties of mineral but it is included due to its behavior.

The minerals are of two types crystalline and amorphous (non-crystal).

2.) Chemical properties of minerals –

The minerals which found at the surface or underneath the surface is either element or compound and in general all inorganic substance.

It has atoms and molecules as the case may be–

It has definite chemical formula and symbol.

The ~~chemical properties~~ proportion of different elements are fixed.

The chemical properties and sometimes physical properties of any mineral changes due to impurity present with the mineral.

Some of the mineral body exhibit polymorphism hence mineral can not be study from its chemical composition only but presence of different impurities of different type is responsible for polymorphism. According structure differs such as $CaCO_3$ crystallise in two forms such as

(I) Triangular division

(II) Hexagonal division

The different mineral may show

same type of structure this is known as isomorphism. In this case the substance are different but the crystalline structure are same such as the mineral albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$) are different mineral or substance but have same structure.

In addition to the above properties each minerals has its own fusibility which further depends on temp. condition. Hence chemical reaction many a times depends on solubility and fusibility.

ISOSTASY (Equal balance)

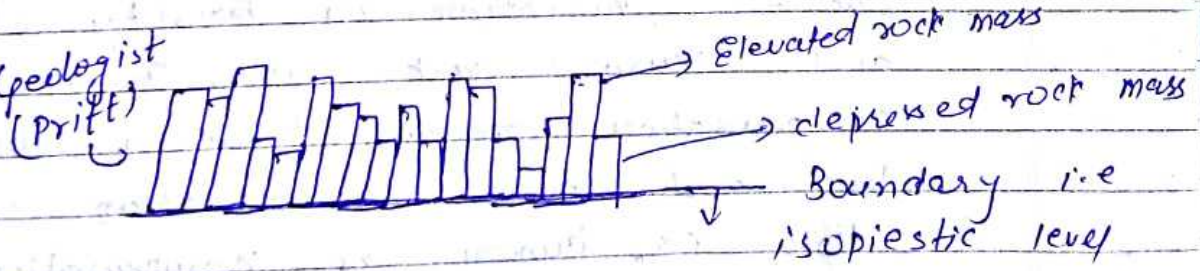
Isostasy → Isostasy is a Greek word it means equal balance, the surface of the earth contain igneous, sedimentary and some times metamorphic rocks hence they are the constituent of different rocks having different density to become in isostatic position they are must be some equilibrium between denser rock and lighter rock which is known as isostatic adjustment.

In geology isostasy means existance of equilibrium in between denser and lighter rock body i.e. balancing between elevated rock mass dressed basin.

Geologist Dutton suggest that elevated rock mass are formed due to low density rock and depressed basin are formed due to high density rock such phenomenon is called isostesy in other words ~~equal poise~~ equipoise i.e equal in position.

Isopiestic :- To create equal balance on the surface of the earth by elevated rock mass and depressed rock mass they are must be equal pressure due to this phenomenon such existing equal pressure is known as isopiestic

Isopiestic level :- A level is though to be existed when equal pressure ..... in to play i.e when isopiestic state reaches this is known as isopiestic level.



The height depends on the density of the rock for balancing low density rock raises much than high density rock.

Three theories put forward for explaining phenomenon of isostasy.

① Pritt theory or (Prat theory). ② Airy theory
③ Combined pritt and Airy theory.

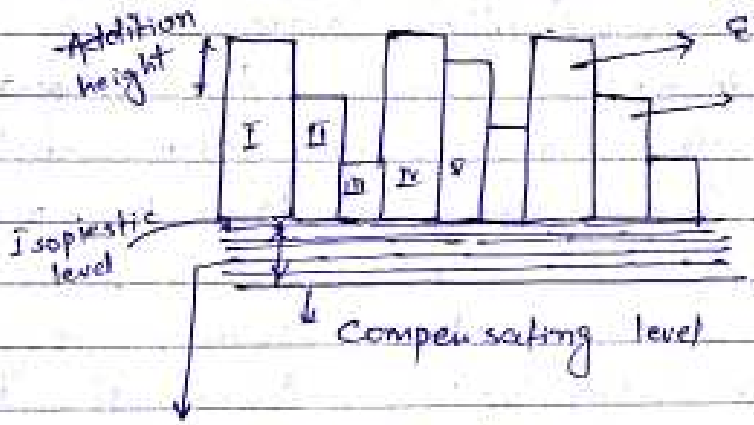
② Pritt theory → Pritt theory suggest that the elevated rock of mass must have some addition height to its adjust these adjusted by density of rock of the adjusent depression. It mean depressed rock have more density as compare to the elevated rock mass.

Further Pritt suggested that the bottom boundary line of all the rock mass are same otherwise there would have been great disturbance and the top of the elevated and depressed rock mass in this manner density of the rock is responsible for formation of the mountain and plone.

Pritt theory does not have limit within the isopiestic level but the assume that they are must be some depth of compensation for balancing to takes place due to variation in density of ligules and densor rock mass. There is compensation zone between upper isppiestic level and lower compensation level the depth is known as compensation depth. This is very importent theory and all other theories are based on pritt theory.

The weight of rock mass which are extending from the surface and weight of the rock mass of the depth of the surface are same which prove isostasy and pritt theory.

Further seesic study reveals that the density of the rock mass below ocean flow are more as compare to the density the rock mass at the surface these further proves pritt theory it means isopiestic level must have existed some where below ocean flow.



Important

Airy Theory →

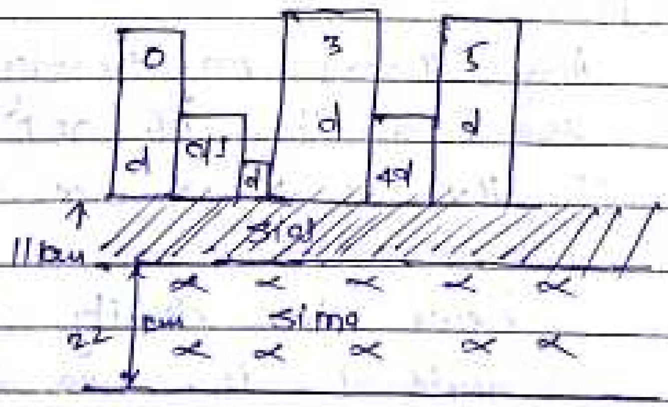
Airy theory on isostacy considered that the density of rock increases with depth of the earth surface it is well known fact.

Hence the density of crustal rock, considered is save throwout the surface of the earth.

Further the Earth surface contents, hills, mountains, ocean flow etc. In general ocean flow eroded Sial portion of the Earth crust some times it may touch out the Sima portion.

At the surface of the earth the volume of features such as plane, mountain high raised etc. have different volume normally mountaineous region contain more volume as the density of the crystal rock considered same throughout the surface of the earth hence mass of different structure will be different and more volume must have more mass further more mass gives more downward force to connected accordingly goes some more distance downward as compare to the plane or high raise.

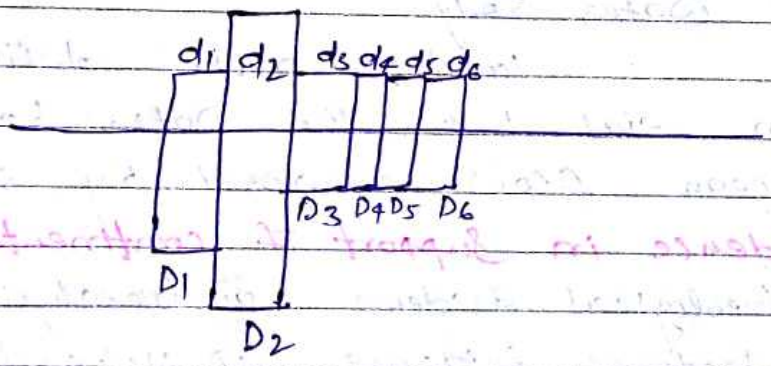
The above theory suggest that due to penetrating force of the different features there is a balance at the earth surface which is known as isostacy.



Combination of Airy and pratt theory →
This theory is also known as Herskman's theory In this theory the density of Crystal rock is considered different i.e lower portion of the crystal rock is having more density as

compare to the upper portion hence due to more density the denser goes down and lighter rock does not much force to go down the surface is more or less having same elevation except some very high mountain.

The theory assumes that due to different penetration the balancing can easily be occured it means the height of each and every rock is more below the earth crust and very less above the surface of the earth.



$d_1 d_2 \ldots\ldots d_6$ stands for density of different rocks similarly. $D_1 D_2 \ldots\ldots D_6$ stands for density of corresponds rock at the lower part.

$D_1 > d_1$ and so on

the adjoining fig shows penetration of different rock the main object of the fig. that the crystal rock no III to VI is having more or less same elevation at the surface though penetration below earth crust differs a little bit depending on the density of the lower portion. but the crystal rock no I & II shows more elevation these are fee

feature of mountain the important thing to note that their is no disturbance at the surface or above the crust hence balancing must have occur this is called Isostacy

Continental drift theory →

The earth is divided in to two parts
(a) land mass
(b) Water body

land mass definetly composed in sial but the water body specially ocean flow composed by sima.

Evidence in Support of continental drift theory-
(I) Geological Evidence (II) Geophysical Evidence
(III) Tectonic Evidence (IV) Metereological Evidence- -Weather and climate

(I) Geological evidence-

Boundary of the Atlantic ocean of the same rock mass i.e both the boundary matching each other.

Some fossils available on both the boundries may be flora, fauna similar Lithology (types of rock)
Similar Stratigraphy in relation to age

(2) **Geophysical evidence-** Different survey carried on both side of the boundry of atlantic ocean shows similar magnetic and