SOLUTION

1

SE (CBCGS) EXAM, MAY 2018.

[Total marks : 80

SEM - III
Branch : CIVIL
Sub : ENGG. GEOLOGY Q.P. code :- 38826

1 a) Define the following terms: (M 1) each (5)

i) Volcanic rock : The igneous rocks formed on the surface of the earth by cooling & crystallisation of lava erupted from volcanoes.

ii) Cheveron fold : Its a type of fold with planar limbs whose crests and troughs are sharp and angular.

iii) Solifluction : It is a slow flowage type mass movement occurs in periglacial environment in saturated condition. Due to presence of enough water solifluction takes place even in very gentle slope.

iv) Juvenile Water : The water formed in the cracks or pores of rocks due to condensation of steam produced from hot molten magma below the surface of the earth. It is also known as magmatic water.

v) Disconformity : A Type of unconformity in which beds above and below are parallel but may have considerable topographic relief in the erosion surface.

1 (b) Answer the following — (1 mark each).

i) Differentiate Volcanic tuff and volcanic bomb —
The finest volcanic dust is blown away for greater distance and after consolidation volcanic tuff is formed. whereas solidified or semi solidified clots of Lava are also thrown out from the volcano called volcanic bomb.

ii) Plunge of a fold is the angle of inclination of axis of fold with horizontal plane.

iii) 2 Minerals showing pearly Lustre are Biotite and Muscovite.

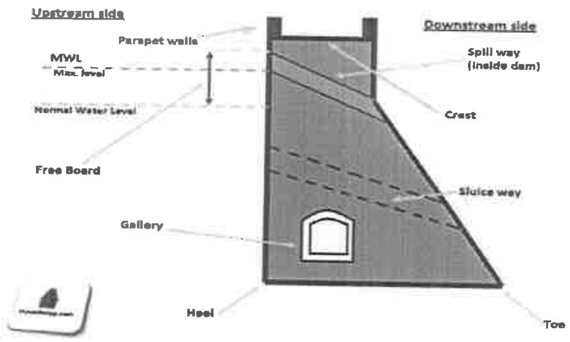
iv) Kyanite is the bluish coloured mineral with bladed form.

v) Asbestos.

(02)

1. (2 M Each)

c) i) Parts of gravity dam:



ii) Angular Unconformity:

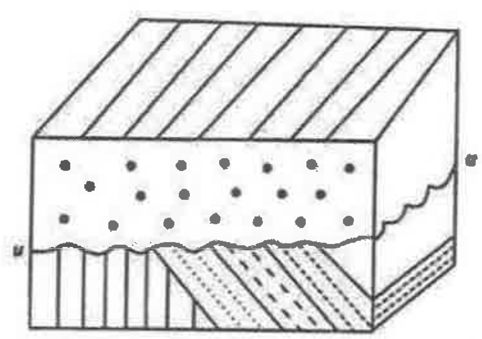
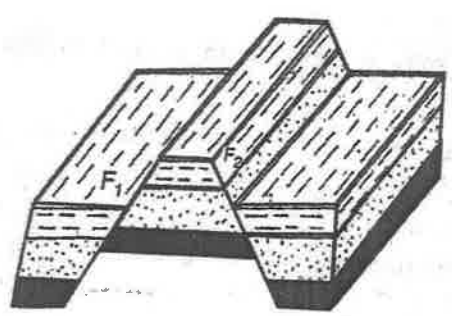
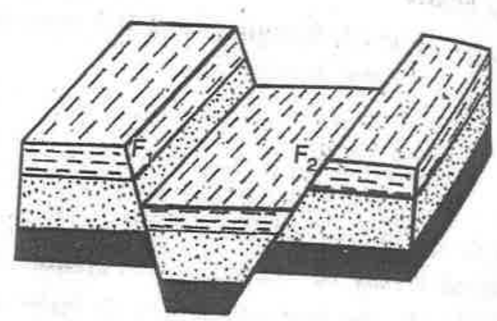


Fig. 4.37 *Angular unconformity*

iii) Horst and Graben:



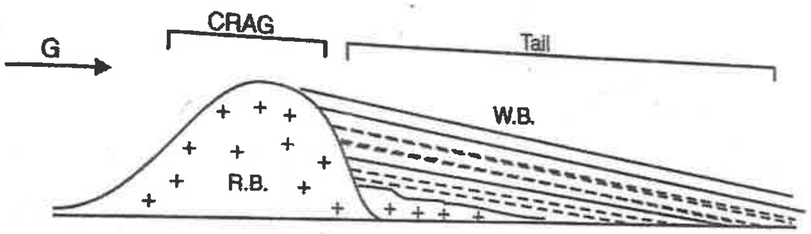
(a) Horst.



(b) Graben.

03

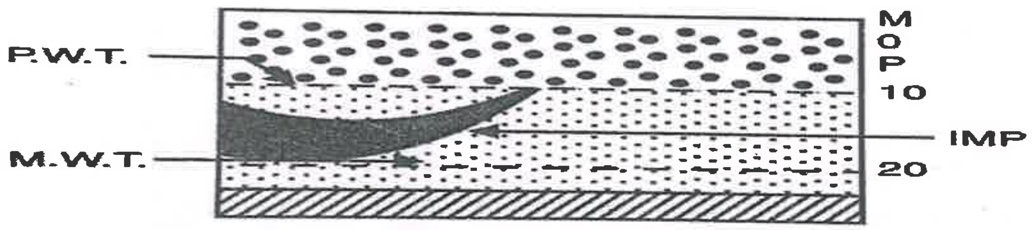
iv) Crag and Tail:



G = Glacier; R.B. = Resistant BED; W.B. = Weak Bed

Crag and Tail

v) Perched Water Table:



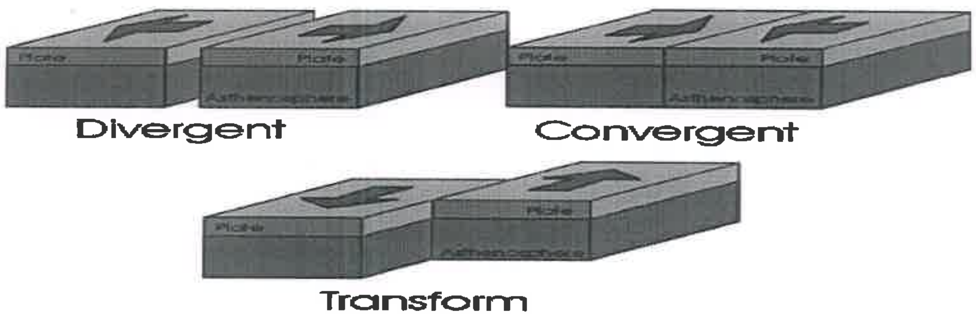
Perched Water-Table (P.W.T.)
MWT = Main water table.
IMP = Impervious zone

2)

[5M]

a) Explain theory of plate tectonics.

Plate tectonics, theory dealing with the dynamics of Earth's outer shell—the lithosphere—that revolutionized Earth sciences by providing a uniform context for understanding mountain-building processes, volcanoes, and earthquakes as well as the evolution of Earth's surface and reconstructing its past continents and oceans.



Main three types of plate boundaries are:

1. Transform boundaries (Conservative) occur where two lithospheric plates slide, or perhaps more accurately, grind past each other along transform faults, where plates are

04

neither created nor destroyed. The San Andreas Fault in California is an example of a transform boundary exhibiting dextral motion.

2. Divergent boundaries (Constructive) occur where two plates slide apart from each other. Active zones of Mid-ocean ridges (e.g., Mid-Atlantic Ridge and East Pacific Rise), and continent-to-continent rifting (such as Africa's East African Rift and Valley, Red Sea) are examples of divergent boundaries.

3. Convergent boundaries (Destructive) (or active margins) occur where two plates slide toward each other to form either a subduction zone (one plate moving underneath the other) or a continental collision.

b) [5 M]

Types of joints in igneous rocks: As magma undergoes cooling and solidifies or as lava gradually cools and becomes rigid, cracks or ruptures occur forming tension joints. These joints may be mural joints or sheet joints or columnar joints.

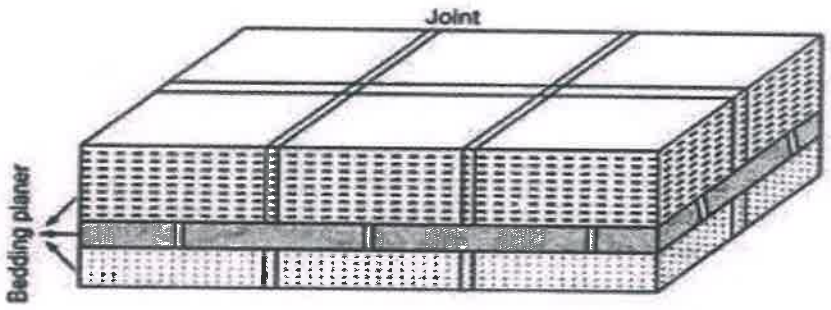


Fig. 17.45 Joints in rocks

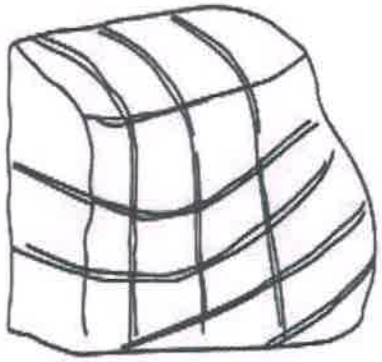


Fig. 17.46 Mural joints in granite

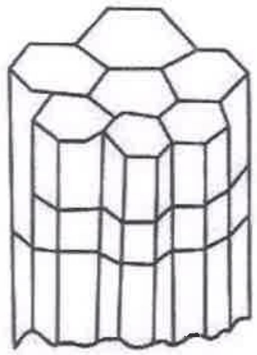


Fig. 17.48 Columnar joints in basalt

c) [5 M]

Controlling factors for landslide

A landslide, also known as a landslip [1]or Mudslide,[citation needed] is a form of mass wasting that includes a wide range of ground movements, such as rockfalls, deep failure of slopes, and shallow debris flows. Landslides can occur underwater, called a submarine landslide, coastal and onshore environments. Although the action of gravity is the primary driving force for a landslide to occur, there are other contributing factors affecting the original slope stability.

(1) 5

1.Weathered materials
2.Sheared materials
3.Jointed or fissured materials
4.Adversely orientated discontinuities
5.Permeability contrasts
6.Material contrasts
7.Rainfall and snow fall
8.Earthquakes

[5 M]

d)

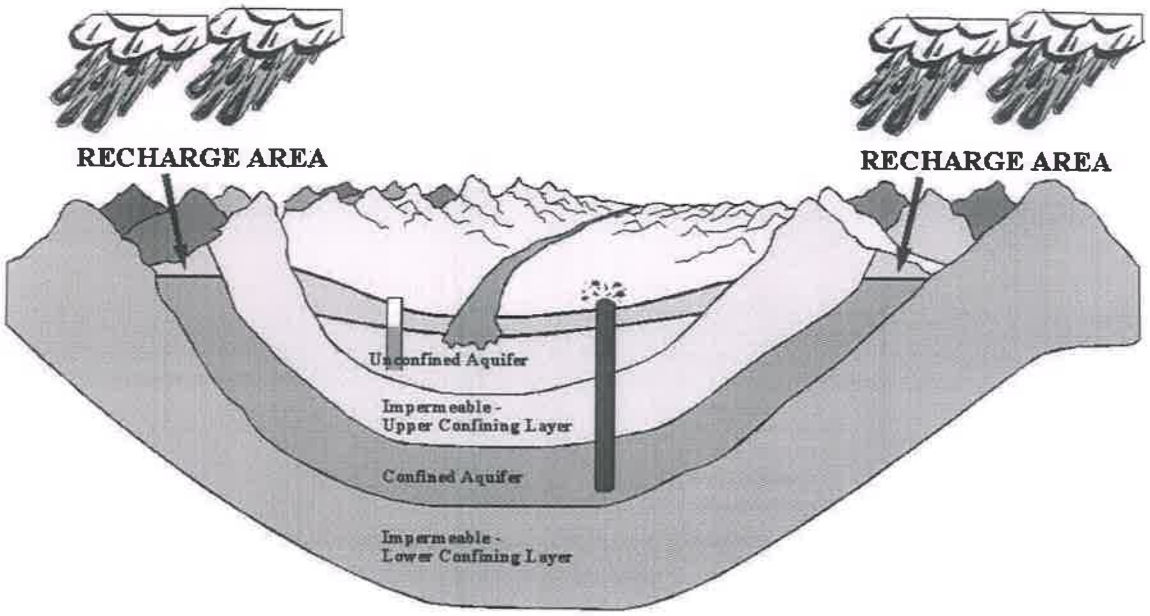
A rock formation which is porous and permeable is called aquifer

1. Unconfined Aquifer:

An aquifer which is not overlain by any confining layer but has a confining layer at its bottom is called unconfined aquifer. It is normally exposed to the atmosphere and its upper portion is partly saturated with water. The upper surface of saturation is called water table which is under atmospheric pressure therefore this aquifer is also called phreatic aquifer.

2. Confined aquifer

It is also called artesian aquifer. It is a type of aquifer overlain as well as underlain by confining layers. The water within the aquifer is therefore held under pressure. It is sometimes called pressure aquifer also. If the aquifer has high outcrop laterally than the ground surface there will be positive hydrostatic pressure to create conditions for a flowing well. Water from such well comes to the surface without pumping. The imaginary level upto which the water will rise is called piezometric surface.



06

3.

a) [10 M]

The earth is surrounded by an envelop of gases called the atmosphere. The movement of the atmosphere in a direction parallel to the earth surface is wind. i.e the air in motion is called wind whereas the vertical movement s of the atmosphere are termed as air currents.

Erosion by wind and developed features:

Wind erosion is generally caused by two erosion processes:

i) Deflation

ii) Abrasion.

Deflation:

Deflation is the process of simply removing the loose sand and dust sized particles from as area, by fast moving winds. Wind deflation can successfully operate in comparatively dry regions with little or no rainfall and where the mantle is unprotected due to absence of vegetation.

Such a removal of loose fine particles may at certain places leave a denuded surface consisting mostly of hard rocks or coarse materials like gravel and is called lag gravel. This gravel layer prevents further deflation.

Abrasion:

The wind loaded with such particles attains a considerable erosive power which helps a considerable erosive power which helps in eroding the rock surfaces by rubbing and grinding actions and produce many changes. This type of wind erosion is known as abrasion. 10 Vertical column of rocks are thus more readily worm out towards their lower portions and a result pedestal rocks are formed which wider tops have supported on comparatively narrower bases. Such type of rock formations is called Pedestal or Mushroom rocks.

Deposition of sediment by wind and the developed features:

The sediments get dropped and deposited forming what are known as Aeolian deposits. There are two types of Aeolian deposits;

a) Sand dunes

b) Loess

Sand dunes:

Sand dunes are huge heaps of sand formed by the natural deposition of wind blown sand sometimes of characteristics and recognizable shape. Such deposits are often found to migrate from one place to another due to change in the direction and velocity of wind.

The active dunes can be divided into three types:

a) Barchans or Crescent shaped dunes

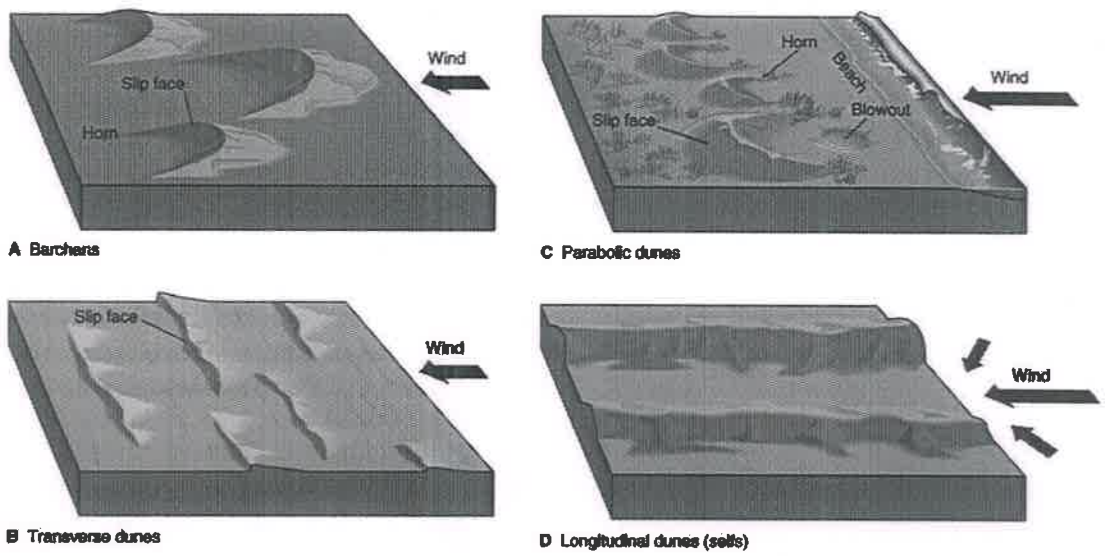
b) Transverse dunes

c) Longitudinal dunes

Loess:

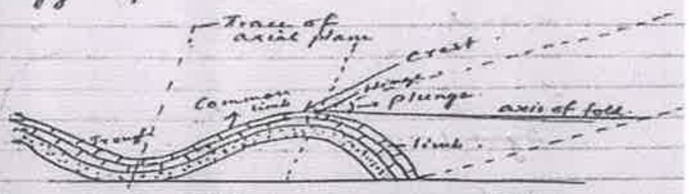
The finest particles of dust travelling in suspension with the wind are transported to a considerable distance. When dropped down under favourable conditions these have been found to accumulate in the different constituents the form of paper-thin laminae, which have aggregated together to form a massive deposit known as Loess.

Engineering considerations:
In general no site is selected for any type of important work on the moving dunes because such dunes are always a source of trouble to an engineer. It has been experienced that sometimes the moving dunes damage certain important works. But if an engineer is compelled to select such a site, special methods should be adopted to check the motion of the moving dunes.



3 **b) Terminology of fold** [5 M]

3. b) Terminology of Fold



Folds are the undulations or curvature.
A no of Terms are used to describe a fold.

Crest and trough → highest point of uparched fold is crest and ~~that~~ lowest pt of downarched fold is Trough.
Limbs — Sides of the fold. The middle side of two adjacent folds is Common limb.

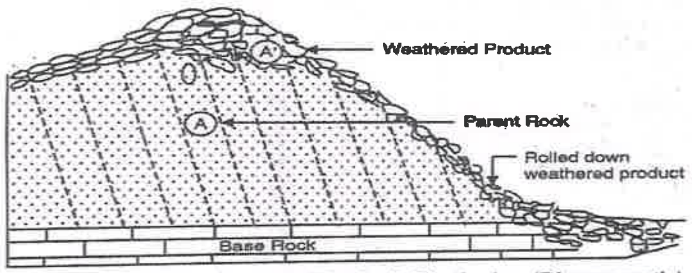
Hinge → The pt. of maximum curvature.
Axis of fold → line of intersection of axial plane & bedding plane OR line parallel to hinge line
Axial plane → An imaginary plane that passes through all the points of maximum curvature

Plunge — The angle of inclination of axis of fold with horizontal plane.

c) [5 M]

Mechanical (Physical) Weathering

It is a **natural process** of in-situ disintegration of rocks into smaller **fragments** and particles through essentially physical processes **without** a change in their composition. A single rock block on a hill **slope** or a **plain**, for instance, may be disintegrated gradually into numerous small irregular fragments **through frost action** that in turn may break up naturally into fragments and particles of still smaller dimensions. These loose fragments and particles may rest temporarily **on the surface** if it is **a plain. On slopes,** however, the end product fragments and particles may **roll down** under the **influence of gravity** and get **accum**ulated at the base as heaps of unsorted **debris.** All these fragments and particles, however, **have** the **same chemical composition** as the parent rock. (Fig 3.1)



Explanation of Mechanical (Physical) Weathering (Diagrammatic)

Fig 3.1.

Mechanical weathering is one of the very **common geological** processes of **slow natural rock** disintegration in all parts of the world. **Temperature** variations and **organic activity** are two important factors that bring about this change **under specific conditions.**

Temperature variations are held responsible for extensive mechanical weathering of rocks **exposed** on the surface. These manifest in two different ways : **frost action in cold humid** regions and thermal effects (**insolation**) in **hot arid** regions. An outline of these processes is as follows :

09

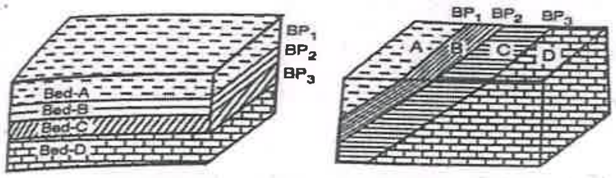
[10 M]

4.

a) Structures of sedimentary rocks

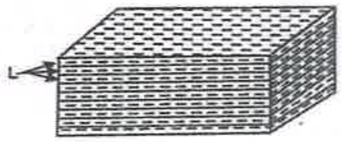
Stratification

By stratification is understood a **layered arrangement in a sedimentary rock.** This may be developed very prominently and can be seen from a distance of miles or in other cases may have to be ascertained **after close examination** of the rock. The different layers, also called beds or strata may be similar or dissimilar in colour, composition, grains size and texture. Planes of weakness - **the bedding planes** separate the beds from each other. The thickness of each layer in a sedimentary formation may show great variation: from **a few centimeters** to **many meters.** In lateral extension, the layered structure may show continuity for several meters to **hundreds of kilometers.** Further, the layers may be **horizontal** or slightly inclined when they are undisturbed after their formation; in other cases they be steeply inclined, folded or bent and broken or overturned if affected by tectonic forces after their original deposition.



Stratification, Beds and Bedding

Fig. 13.2.



L = Laminae

Lamination

Fig. 13.3.

Lamination

This is also a layered structure similar to stratification as found in the sedimentary rocks. In lamination, however, the individual layers **are quite thin** (generally less than 1 cm. in thickness). Lamination is a characteristic structure of fine-grained sedimentary rocks like clays and shales. The individual layers are called **laminae** and are distinguished commonly on the basis of difference in colour.

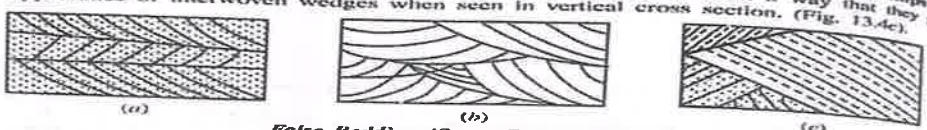
Cross Bedding

It is a sedimentary structure in which various layers lying **one above another** are **not parallel** but bear an irregular or inclined relationship to each other. Such a structure often results from deposition having taken place in a shallow-water environment. In such environment the stream suffers repeated changes in **direction of flow** or the currents produced in the body of the water. The structure is sometimes referred as **false bedding** or **current bedding**. Following are common types of false bedding :

(a) **Tabular.** A type of cross bedding in which the **top and bottom** surfaces of the deposit are **essentially parallel**, indicating its deposition in the same main channel, but the intervening layers are inclined differently with respect to each other. (Fig. 13.4*a*)

(b) **Lenticular.** A type of cross-bedding in which all the layers show an extreme irregularity in their shape and disposition; each individual layer may be **intersected** by many others lying at different angles. (Fig. 13.4*b*)

(c) **Wedge shaped.** In this case, the cross-bedding structure is highly **complex**: the individual layers exist in well defined sets of parallel layers but these sets bear **angular relationships** to each other. These layered sets are sometimes mutually inclined in such a way that they give the appearance of interwoven wedges when seen in vertical cross section. (Fig. 13.4c).



(*a*) (*b*) (*c*)

False Bedding (Some Common Types)

Fig. 13.4.

Graded Bedding

In some stratified rocks the component sediments in each layer appear to be characteristically sorted and arranged according to **their grain size**, the **coarsest** being placed at the bottom and the **finest at the top**. Such an individual layer is said to be graded. When a sequence of rocks is made of such graded layers, the structure is called **graded bedding**. Normally such perfectly graded beds are the result of sedimentation in bodies of standing water where factor of **gravitative settling** from a mixed load is the predominant process. In many cases, however, the exact cause of graded bedding is far from simple and may be attributed to such unrelated processes as **subaqeous** landslides and submarine **earthquakes.**

Mud Cracks

These are common structural features of many fine-grained sedimentary rocks. The structure consists of **polygonal** or **irregular cracks** spread along the **surface** of an exposed sedimentary layer. Their development is explained by an analogy of development of similar cracks on the surface of **drying mud** in shallow environments even at present. Once these cracks are covered under further layers of mud, **they get preserved** in the body of the deposits. They come to light once again when the overlying layers are eroded with the passage of time.

Rain Prints

These are irregular, small **crater-shaped** depressions seen on fine-grained dried sediments. Like mud cracks, their formation can also be explained on the analogy of present day process: rain falling forcefully on fine-grained compacted clays often makes **crater like depressions.** These may get dried up and subsequently **preserved** under another layer of mud. The imprints become a part of the deposit.

Ripple Marks

These are also quite common types of sedimentary structures of mechanical origin found in deposits made in **shallow water environment.** They are defined as **symmetrical** or asymmetrical **wave-like** undulations or irregularity in a layer. Ripple marks generally result from interplay of

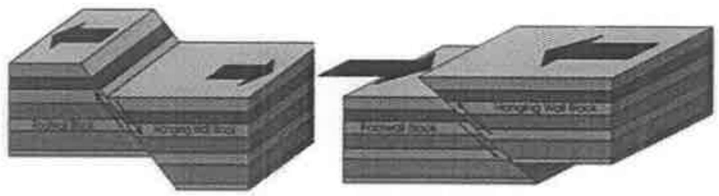
b) Types of fault

[05M]

Faults are planar or gently curved fracture in the rocks of the Earth's crust, where compressional or tensional forces cause relative displacement of the rocks on the opposite sides of the fracture.
When rocks slip past each other in faulting, the upper or overlying block along the fault plane is called the hanging wall or headwall; the block below is called the footwall.
Types:

Normal dip-slip faults: are produced by vertical compression as the Earth's crust lengthens. The hanging wall slides down relative to the footwall.

Reverse dip-slip faults: The hanging wall moves up and over the footwall. Thrust faults are reverse faults that dip less than 45°.
Strike Slip fault

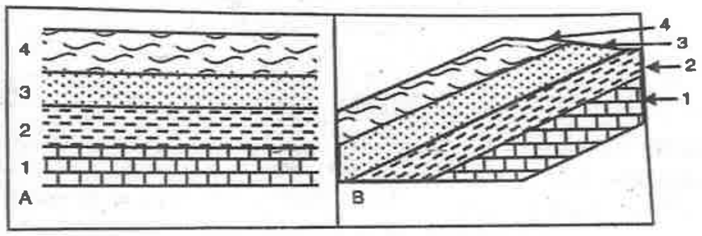


Normal fault Reverse fault

c)

[5M]

Order of Superposition. It implies that if rocks (particularly sedimentary rocks) are allowed to be formed **without an interruption** and have not undergone any structural deformation subsequent to their formation, the **oldest** of them would occur at the **base** of the sequence whereas the **youngest** will occupy the **top**. In such a multi layer sequence every upper, successive layer will be younger than the next, lower one. (Fig. 16.1)



A. Horizontal B. Simply Tilted
Order of Superposition

Deccan volcanism, representing a tremendous outburst of volcanic activity, marks an important episode in Indian geological history, affecting nearly two-thirds of peninsular India. The Deccan volcanic province is one of the most important and largest flood basalt provinces of the world. Primary volcanic structures like vesicles and cooling joints are conspicuous in this volcanic succession and are used to divide individual flows into three well-defined zones namely the lower colonnade zone, entablature zone, and the upper colonnade zone.

Economic importance:
1.Bauxite deposit
2.as a material of construction
3. House for precious and semiprecious mineral (geodes)

11

4. Black cotton soil
5. Serve as aquifer (vesicular basalt)

5
a)

[10 M]

22.3. METHODS OF GEOLOGICAL INVESTIGATIONS

These may be divided into two **main groups**: the surface investigations and the subsurface investigations.

A. Surface Investigations

These include **preparation** of topographic maps (if these are not already available) using the normal mapping techniques. In fact all field surveys begin with the preparation (or availability) of **topographic** maps showing elevation contours relative to some datum.

Aerial **surveys** and preparation of photogeological maps are the latest methods of surface investigations. The **entire area** involving an engineering study is **photographed** using sophisticated cameras and controls from low flying aeroplanes. These maps are then interpreted to provide sufficiently accurate geological details of the area surveyed. **Photogeology** is now a branch of geology in its own right and is fast acquiring an important place. Its scope is enlarged by **mapping of vast areas of the globe through satellites.** Imageries obtained from satellite surveys and aerial surveys, when interpreted properly, provide useful details regarding rock outcrops on the surface with possibilities of estimating their **subsurface configuration.**

Hydrogeological surveys to obtain hydrogeological details of the area are also conducted partly on the surface with a view of recording following details that are of immense help in the later studies :

(*i*) **Drainage pattern** of the area and discharge;
(*ii*) **Location** and **discharge** details of springs and other leakage points;
(*iii*) **Location of wells** and measurements of water levels after intervals to note aberrations in behaviour with time;
(*iv*) **Precipitation** and evaporation details.

All **surface** surveys, however, carefully carried out, can give only **superficial details.** These could broadly be classed as preliminary surveys and have necessarily to be followed by well planned **subsurface investigations** which would provide fairly accurate idea about the subsurface geological conditions at the **most critical locations.**

B. Subsurface Explorations

These are accomplished by following two broad methods: **direct** subsurface explorations and **indirect** subsurface investigations. The **direct methods** involve examination of **rocks** or **materials** of the underground by **digging of drill holes,** trial pits, adits, shafts, galleries and exploratory tunnels. In such explorations either the underground areas are reached for **direct** examination and testing or samples are obtained which are examined and tested in the laboratory. The **indirect** methods of subsurface explorations are used **extensively** and involve application of geophysical techniques for obtaining fairly accurate idea of subsurface geology.

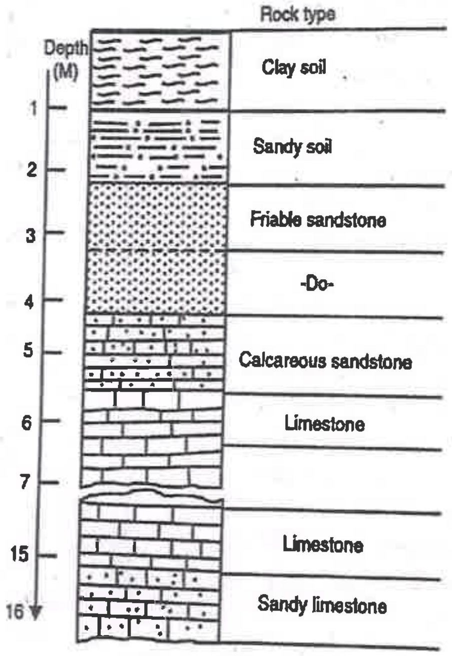
Only an outline of principles of two groups of methods would be possible here. The subject is exhaustive and falls in the specialisation of field geologists and **geophysicists.**

Drilling of Boreholes (Direct method)

A borehole into the surface of the earth is drilled upto a required, predetermined **depth** using a suitable technique. In the simplest case, **soil and rock samples** are obtained from the ground below as the drilling progresses. These samples are arranged sequentially in special boxes, the core boxes, and properly labelled or **logged.** Subsequently, samples from each **core box** are examined thoroughly for their important geological characteristics. These observations are summarized in the form of a chart which is commonly called a **Core Log.** A cursory glance on a core log would reveal the nature of rocks present upto a given depth in a given area. When core logs from a few locations from the same area are studied **collectively** and interpreted properly, very important structural features of rocks like dip and strike, repetition and omission of strata and thickness of each layer could also be found quite easily.

RQD

The **core** samples recovered from **drilling** are interpreted and tested for many **desired** physical and engineering **properties** of rocks. In one case the percentage of **solid continuous** cores recovered **during drilling** to the total depth of penetration is expressed as **Rock Quality Designation (RQD)** which is very commonly used for describing the quality of rocks underneath. A 100% RQD denotes excellent **unjointed massive rock,** and a less than 10% RQD obviously indicates a weak or fractured zone.



A Typical Core Log

Fig. 22.1.

The main classes of RQD are :

- **Poor (25 – 50)**
- **Fair (50 – 75)**
- **Good (75 – 90) and**
- **Excellent (90 – 100).**

In practice, the RQD is determined as follows :

(*i*) The cores recovered from a bore hole are arranged sequentially in a core box;

(*ii*) The sound cores having a minimum length of 100 mm each and free from natural fractures etc. are identified. Their length is summed up. Say it is 'A'.

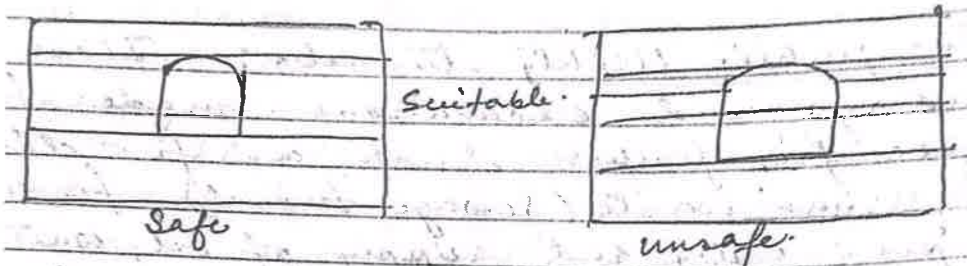
13

b) Side selection of tunnel [5M]

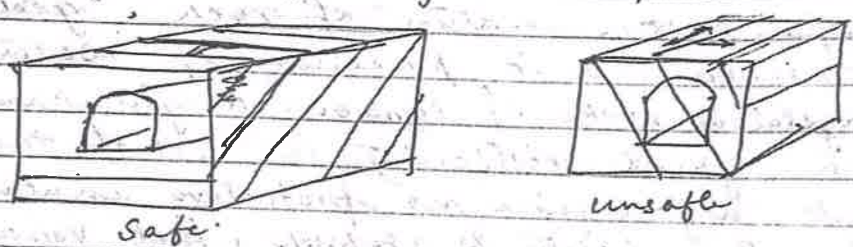
Geological Conditions suitable for tunnelling.

The convenience and cost of tunnelling operation as well as the safety and Stability depend on nature of rock, geological structures and position of water Table. Crystallin rocks of igneous origin can be excavated with great difficulty i.e. cost of tunnelling is high but they require no protective inner lining for their safety & stability. ~~But~~ Volcanic rocks are hard & tough but at the same time contains joints and vesicles, so tunnelling through ~~those~~ such rock is hazardous. Tunnels through massive sandstone beds are sufficiently stable. Amongst metamorphic rocks, the compact & massive gneisses and granulites are stable & do not require lining. The common structural features present are joints, fault planes, Shear zones, vesicles etc make the area unsuitable for Tunnelling.

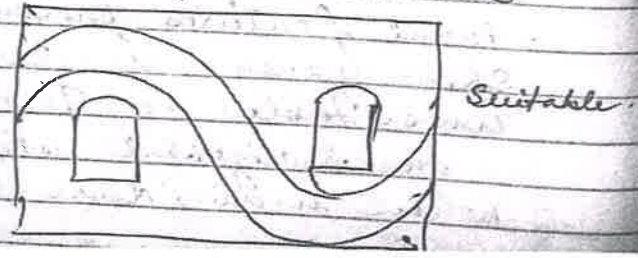
In horizontal strata of sedimentary rocks when individual layers are very thick the Situation is favourable because the layers overlying the tunnel act as natural beam.

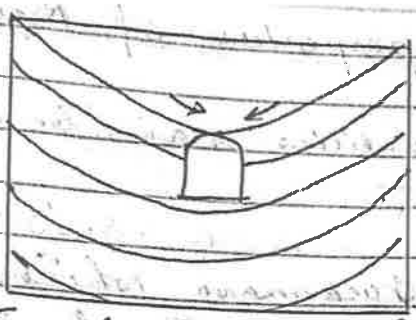


In case of moderately inclined strata The tunnel axis should be parallel to the dip direction, the layers offer a uniformly distributed load on the excavation But across the dip the not Suitable

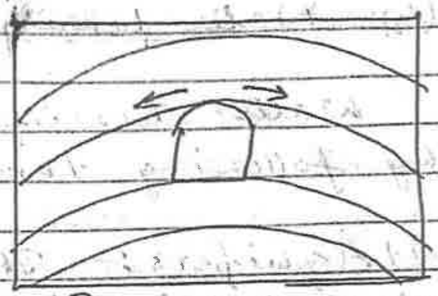


Folds represent the deformation of rocks under the influence of ~~Tect~~ Tectonic forces. ~~the~~ In folded region the tunnel alignment should be parallel to the fold axis and the excavation should run along the same bed throughout the length of the tunnel

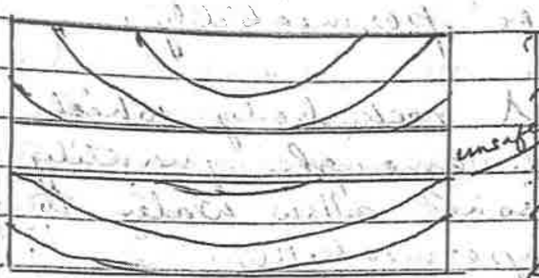




Tunnel along axis of Syncline



Tunnel along axis of anticline



Tunnel across axis of syncline

Tunnel across axis of anticline

Folding of rocks.

Tunnel in Fault zone, shear zone, jointed zone is very hazardous.

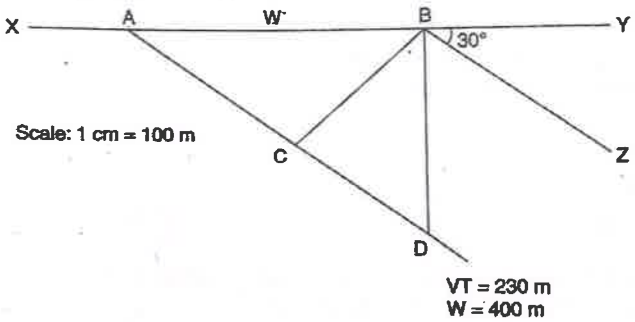
Tunnel allignment parallel to the axis of the fold is desirable because similar formation with similar physical properties are encountered along the course of the Tunnel. Ofcourse Tunnelling along limbs only is desirable and not along crests & troughs. Because along crests the rock masses may be in highly fractured condition so there may be frequent fall of rocks from the roof. Also Tunnelling through Trough may create undesirable ground water problem. Tunnel across the fold axis is unsafe due to diff rockfor^{n}.

10

[5M]

c)

~~Example~~: On a horizontal tunnel a bed of sandstone dips 30° eastwards. Its true thickness is 200 m. Determine its vertical thickness and width of outcrop in the tunnel..



6. a) (any five) [4 M Each]

1. Central type eruption.

This type of Volcanoes are represented by a cone crowned by a bowl-like depression called the crater and a vent, connecting the crater with the magma-chamber, through which the eruption products reach the surface.

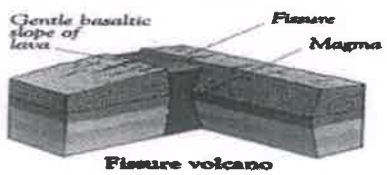
2. Fissure type eruption.

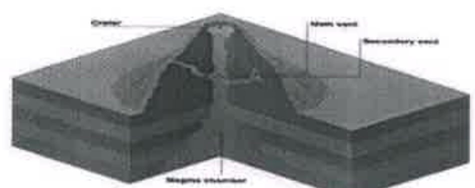
Sometimes volcanic eruptions take place along a fissure or a group of parallel or closed fissures. Usually volcanic cones are not produced through fissure-eruptions. Lava, flowing out of fissures, spreads out over extensive areas forming lava sheets.

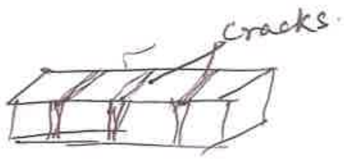
Fissure - eruptions are characterized by quiet welling out of molten lava. The Deccan Traps in India are made up principally of basaltic lava-flows, which were erupted mostly through fissures and covered a major portion of the Deccan-plateau.

Fissure eruption

Central vent eruption



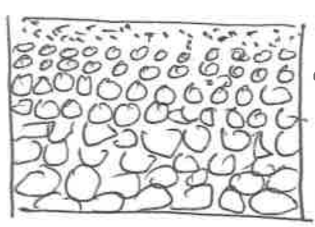


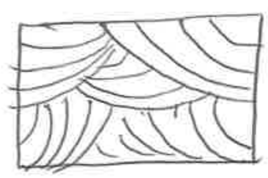


6. b) Concordant type of igneous intrusion flows along the bedding plane. Ex – Lacolith, Lopolith, phacolith and Sill.
Whereas the igneous intrusion which flows across the bedding plane called discordant body. Example, Dyke, Batholith.
Diagrams can be drawn.

c) Cross bedding: Sedimentary rocks are normally deposited as horizontal layers. Even when folded or tilted by faulting the original horizontal layering is obvious. Upon closer observation we may see very fine layers that are at an angle to the main bedding. These tilted layers continued within Larger layers are termed as Cross bedding.

Graded bedding:





Cross bedding

In some stratified rocks the component Sediments in each layers appears to be characteristically sorted and arranged according to their grain size. Ther coarsest being placed at the bottom and the finest at the top. Such an individual layer is said to be graded. When the sequence of rocks is made of such graded layers, the structure is called graded bedding.

d) Isoclinal & overturned fold.

Isoclinal fold

Overturned fold.