LEARNING MATERIALS

SEMESTER-6TH SEM.

BRANCH-MINING ENGG.

SUBJECT-MINE GEOLOGY-II(TH-2)

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MINE GEOLOGY -II

1.0 Stratigraphy :

Stratigraphy, also known as “Historical Geology” is the study of the stratified rocks that aims at unreaveling the geological history of the earth.

1.1 Describe the principles of stratigraphy.

Following are the principle of stratigraphy :

1. Law of superposition : It states that “an overlying bed or lamina is younger than that underling it, under normal conditions”.
2. Doctrine of uniformitarianism : “The study of the present is a key to the study of the past”.
3. The geological events of the past are mostly indicated by the rock units from their lithological and palaeontological characteristics. Rock units are distinguished from each other by their colour, texture, composition, fossil contents etc.
4. Facies : When a particular system (with reference to the geological time-scale) in a country is represented by different kinds of rocks in its different localities, it is said to possess different facies.
5. Homotaxis : The similarity of position of strata or system in a sequence not implying similarity of age is termed homotaxis. When geological formations are equivalent in age but situated wide apart in different districts, countries or continents, they are said to be homotaxial.
6. Rock units formed at different places exactly at the same time are known as synchronous-beds. In these beds the same species of the fossils are found.
7. Contemporaneous : Those rock units which are formed near about the same time, marked by the presence of the same genera of fossils, they are said to be contemporaneous.
8. Geological time : “Era” is the largest grouping of periods of geological time and each era covers many millions of years. The geological periods, are formed of epochs and the epochs are in turn sub-divided into ages.
9. Stratigraphic correlation : It is of three types like, lithostratigraphic, bio-stratigraphic and

chronostratigraphic correlation.

1.2 Describe the geological time scale.

(figures without brackets show the total duration of the group or system in millions of years, while those within brackets show the lapse of time from the beginning of the particular era or period to the present).

Group	System	Chief Fossils
Quaternary 1	Recent (.01) Plestocene 1(1)	Living animals. Man appears, Many mammals die off during glacial period.
Tertiary Or Kainozoic 65	Pliocene 7(8) Miocene 17(25) Oligocene 13(38) Eocene 27(65)	Mammals, mollusca and flowering plants dominant. Division largely based on proportion of living to extinct species of mollusca and the presence of mammal species.
Secondary Or Mesozoic 180	Creraceous 75(140) Jurassic 60(200) Triassic 40(240)	Giant reptiles and ammonites disappear at the end. Flowering plants become numerous. Ammonites abundant. First birds, flowering plants and sea urchins. Ammonites, retiles and amphibian abundant. Arid climate.
Primary Or Palaeozoic 370	Permian 50(290) Carboniferous 60(350) Devonian 60(410) Silurian 35(544) Ordovician 60(505) Cambrian 100(605)	Trilobites disappear at the end. Many non-flowering plants, first retiles appear. Abundance of Corals, Brachiopoda, first amphibians and lung-fishes. Graptolites disappear at the end, first fishes, probably first land plants. Abundance of Tiilobites, and Graptolites. Abundance of Trilobites.
Pre-Cambrian or Proterozoic Archaean or Azoic	Pre-Cambrian (2500) Archaean (3600)	Soft-bodied animals and plants. Lifeless.

1.3 Describe the stratigraphic sequence, lithology, distribution & economic mineral deposits of Iron Ore series, Cuddpah Super group, Vindhyan super group & Gondwana super group.

Iron ore series :

Introduction & Location :

1. It names from the occurrences of iron ore is north of Odisha & south of Jharkhand and it comes under archean of Odisha & Singbhum.
2. The iron ore occurs have & zone of occurrences: (a) Tamka Daitari, (b) Gorumahisani Badampahar (Maijurbhanj). (c) Joda Koria (Keonjhar).
3. It has horse shoe syncline occurrence.

Stratigraphy :

Intrusive ----------Newar Dolerite.

-----Soda Granite.

-----Choota Nagpur Granite (Singbhum Granite).

-----Dalma Lava.

-----Dhanjori Lava.

Iron ore series ----------Basic Lava.

-----Upper shale.

-----Blended Hematite Jasper / Blended Hematite Quarite.

----- Lower shale with lime stone.

-----Basal Conglerate.

Older metamorphic (base not)

Description of lithology :

Basal conglomerate : It is the lower sedimentary deposit formed due to unconformity.

Lower shale : It is succeed by basal conglomerate & having contain manage concentration.

BHJ / BHQ : It is succeed by lower shale. It is mother rock of iron ore, after the removal of jasper & Quarzite the hematite being concentrated.

Upper shale : It is being succeeded by lower shale. Having bauxite concentration.

Economic Importance :

Iron ore : (a) Tanka – Datari (Jajpur)

(b) Gorumahisani Badampahar (Mayurbari)

(c) Joda – koria (Keonjhar)

Chtomite : Found in Baula Nuasahi. Mother rock of Serpentine / Peridolite.

Bauxite : Found in Tensa area. From Bauxite rock, Aluminium is being concentrated.

Tyrophylite : It is the host rock of Quarzite. Found in Jaria, Jhangira of Keojhar dist.

Chin clay : It is the rock of Granite. It is the alternation product of Feldspar.

Cuddapah Super Group :

Introduction :

- The Cuddapah system take its name Cuddapah basin of A.P where it is best developed.
- The basin is more or less crescentic which concave side facing towards the East.
- It is about 300km in length and 140 km in width.
- The basin comprises over 6000mts thickness of sediment.
- Major rock types are quartzite sand, stone, shale, state, limestone and volcanoes.
- The eastern side of basin shown the higher degree of metamorphic and deformation compare to the western side.

Distribution :

The rocks belonging to the cuddapah system occur in different part of the peninsula and extra peninsula.

1. Kaladgi series of Cuddapah is southern side of Mumbai and Odisha.
2. Delhi system is devided in two types. (a) Alwar series. (b) Ajabgarh series.

(a) Alwar series : In mewar and Ajmer area the lower and middle parts of the bijawar series of Madhya Bharat, the Guwalior series around the Guwalior dity and Kalhan series of Singhbum.

(b) Ajabgarh series : In mewar and Ajmer area as made up of bottles Echists, Phycites, case sehisls and case gneumes.

Lithology :

The rocks of the system are devoid of fossils and include quartzites, indurated sandstones, slates, shales and lime stones with some banded jaspers.

Contemporaneus volcanic activity prevailed on a large scale during the lower half of the system, the records of which are left in a series of bedded traps and tuff-beds.

Classification :

Cuddapah system is devided into two main group.

The upper Cuddapah comprising (i) kistna series and (ii) Nallamalai series.

The lower Cuddapah comprising (i) cheyair series and (ii) papaghni series.

Mineral Economics :

- In AP deposits of take and occur at the contact of vempall limestone and intrusive sills.
- Cobatt and copper are deposited are mainted with the block states of the delhi system in Rajasthan.
- The alwar qyarizotes are found on Rajasthan.

Vindhyan super group :

The Vindhyan system lies uncomfortably on the Cuddapah rocks and constitutes an unmetamorphosed column of calcareous, arenaceous and argillaceous sediments. The

Vindhyan rocks are developed characteristically in the Sone valley and in certain parts of Rajasthan, Madhya Pradesh and Andhra Pradesh. The Vindhyan rocks do not show any sign of metamorphism. They retain their horizontally.

The lower part of the system is made up of calcareous and argillaceous sediments deposited under a marine environment. The upper part is made up principally of arenaceous rocks of Estuarine of Fluviatite origin. These rocks said to be devoid of fossils except a few doubtful organic remains found in Suket shales of Lower Vindhyan rocks in Rajasthan.

Mineral Economics :

Diamond : the upper Vindhyan are commercial very important for their enclosing diamond bearing strata. The conglometrs form which MP diamonds of historical fame have been devided e.g. Para diamond mine in MP. Waga karun in AP.

Pyrite : At Amjhor in Bijaygarh shale of kohinore series.

Lime stone : Lime stone of Vindhyan system are of virtue of their composition most suitable for cement manufacture and are supporting many of the cement factories.

Building and Decorated stone : building and decorated stone have been utilized in the construction places pants and buildings at Delhi and different parts of Rajasthan and UP.

Equivalent of Vindhyan group : Kurnool group found in AP. Indrabal group found in Basta district of Chhatishgarh and Kalahanok and Karaput dist of Orissa.

Stratigraphy sequence :

The stratigraphic succession of the Vindhyan system is as follows :

The lower vindhyan rocks have received various names according to the localities, where they are best developed. For example :

(a) Bhima series : Vindhyan rocks developed in the valley of Bhima, in Gulbarga and Bljapur district.

(b) Kurnool system : Vindhyan rocks developed in kurnool and adjacent areas.

(c) In Rajasthan the lower Vindhyan rocks are represented by Jorohan limeston and breccia, the Suket shales, the Nimbhera shales and limestones. These together constitute the Malani series.

The upper Vindhyan rocks, developed in the Godavari valley are known as Sullvai series.

Gondwana super group :

It is named after the Gond kingdom of where first studied in 1872 by HB mediats. It consists of a last thickness of sediment of the order of 20-30 thousand foot river take basin is perin insurance of India. The deposition of sediment is started. This period includes south America, Antarctica and India to united together to form streach of land is known as Gondwana land.

Distribution :

1. Stone- Damodar- Narmada valley on WB. Jharkhand, Bihar and MP.
2. Mahanadi Valley in Odisha (Tir & TB) and Chatishgarh.
3. Gudabari valley in Maharastra and A.P.

Important features :

1. The deposition of Gondwana sediments commenced under glacial climate conditions.
2. Then there prevailed a warm and humid climate during the rest of the UP. Carboniferous and the whole of the Permian.
3. Throughout Triassic there prevailed a dry and arid climatic conditions.
4. During Jurassic again the country appears to have witnessed a more or less warm and humid climate.
5. Each individual cycle commenced with the deposition of coarse sand.

Classification :

(a) The two fold classification have been proposed by C.S Fox, M.S. Krishnan etc. in which they

have divided the Gondwana rocks on the basis of floral characteristics into Lower Gondwana rocks characterized by Glossopteris flora and the Upper Gondwana sediments marked by the advent of the Ptilophyllum flora.

(b) The three fold classification has been proposed by Feistmantel, Vredenburg, D.N. Wadia etc. on the basis of prevailing climatic conditions and faunal characteristics of the Gondwana era.

Mineral Economics :

Coal : Gondwana rocks particularly the lower Gondwana have so for been the most important source of coal supply for this country.

The deposits are extensive and of very high quality coal.

Cooking and steam coals are abundant in Barakar series.

The reserves of workable seams are stamated to be around 25000 million tons of which 6000 million tons are thought to be of good quality coal.

Good quality fire clays and sand stones are also available.

2.0 Fossil fuels.

2.1 Coal.

Coal can be defined as vegetal matters that has been subjected a variety of geological process and by that has undergone a number of changes is its physical properties and as well as chemical composition changes involves darkening in colour increasing in hardness and volatile matter like O_2, CO_2, N_2, H_2 and increase of carbon contents.

2.1.1 Describe the different ranks of coal.

Coal are named by different manner like :

1. Peat : Peat is the first stage in the formation of coal. It light brown to dark brown in colour. It is light, porous and fibrous.

It contains : Moisture – 85%.

Volatile matter – 10.5%.

Fixed carbon – 4.6%.

Peat burns with long smoking yellow flame and doesn't give much heat. Peat occurs in deltas of Ganga and in aluminum of Jelum in Kashmir.

2. Lignite : It is second stage of coal formation its colour is brown due to high amount of moisture. It is characterized by development crafts. The lignite burns freely with long smoking flame having heating power.

In air dried lignite contains :

Moisture – 20%. Volatile matter – 5%. Oxygen – 20%.

Hydrogen – 5%. Nitrogen – 17%. Sulpher – 2%. Carbon – 65-75%.

Sub-Bituminous : It is the intermediate long lignite and Bituminous coal.

Moisture content – 10-25%. Carbon percentage – 65-75%.

3. Bituminous : 70% of coal in India occurs as Bituminous coal. It is brittle, dence, dark in colour. Bituminous coal break parallel to be beds presence of vertical joints produce blocks of coal.

It contains : Carbon – 85-90%. Oxygen – 2-7%. Hydrogen – 4-5%. Volatile – 15-45%.

It burns with smoking flame but produce greater heat than lignite.

Semi-Anthracite : It is intermediate of Bituminous anthracite coal contain 90-93% of carbon.

4. Anthracite : It is the coal of highest rank contains 93-98% of fire carbon. It does not occurs in India. It is hard iron block colour. Sub metallic lustier and does not give sell finger, breaks,

with concoidal. Fracture difficult to burn but when burn of produces short and hot flame blue flame without smoke. They are used for steam raise house hold purpose in metallurgical process.

2.1.2 Describe different grades of coal like A, B, C, D.

SL. NO	CLASS	GRADE	SPECIFICATION
1	Cooking coal	Steel-1 Steel-2 Washery-1 Washery-2 Washery-3 Washery-4	Ash content not exceeding 15%. Ash content not exceeding 15-18%. Ash content not exceeding 18-21%. Ash content not exceeding 21-24%. Ash content not exceeding 24-28%. Ash content not exceeding 28-35%.
2	Semi cooking, Weakly cooking coal	Semi cooking 1 Semi cooking 2	Ash + moisture content 19%. Ash + moisture content 19-29%.
3	Non cooking Coal produce in all states other than A.P., Assam, Arunachal, Meghalaya	Non cooking-A Non cooking-B Non cooking-C Non cooking-D Non cooking-E Non cooking-F Non cooking-G	Heat value exceeding 6200 kcal/kg. Heat value exceeding between 5600-6200 kcal/kg. Heat value exceeding between 4940-5600 kcal/kg. Heat value exceeding between 4200-4940 kcal/kg. Heat value exceeding between 3360-4200 kcal/kg. Heat value exceeding between 2400-3360 kcal/kg. Heat value exceeding between 1300-2400 kcal/kg.
4	Non cooking Coal production in A.P., Assam, Meghalaya & Meghalaya	Not gradeing	

2.1.3 Describe the various theories accounting for the origin of coal.

Origin : Through it is universal agreed the old variety of coal originated vegetal matter which has been subjected to a variety of geological processes bringing about marked changes in the physical & chemical composition.

The changes are revealed by the gradual darkening in colour increase in compactness, hardness & carbon content & decrease the moisture & volatiles.

Two views have been advanced to the origin of coal

(a) Growth in situ theory. (b) Drift theory.

(A) Growth in situ theory : This theory states that the coal vegetation was fossilized practically on the site of growth either due to tectonic movement or due to same other reasons.

Evidence in support of this theory :

1. A vast amount of plant material is accumulated in Situ is the present day swamps.
2. Many fossilized be tree trunks found standing in erect positions with their rode. Firmly fixed in the under day that lies beneath the coal seams.
3. A comparatively pure state of coal seam indicate that the material accumulated without getting mixed with adventitious material & had not been transported along with sediments.

(B) Drift theory : The drift theory however strongly held by some geologist, which states that coal seam have been formed as a result of drifting & subsequent accumulation of the plant bodies away from their place of growth.

Evidence in support of this theory :

1. No under days, representing the soil at the root are associated with the coal.
2. Stems with roots in upright position are not found.
3. Beds of coal are observed to branch out which in the characteristics only of drift matter.
4. Coal seams occur in association with sedimentary rock and it self behave like a stratified sedimentary rocks.
5. Presence of channel sands indicates crios-cross movement of water through swamps.

2.1.4 Describe various important lower gondwana Coalfields of India.

1. The greatest period of coal formation in India is the Permian. The important coal bearing formations are collectively known as Damudas & being to the lower Gondwana system.
2. The lower Gondwana coals account for more than 98% of the annual production of coal, which are generally of Bituminous rank. The Gondwana coals are largely confined to the river valleys like to Damodar, Mohanadi, Godavari etc.
3. The workable coal seams are confined to the Damudar group of the lower Gondwana, where in they occure in two main horizons

(a) The measure breaker measure of lower Permian age and (b) The Raniganj measures of the upper Permian age.

4. Barakar coals posses low moisture, low volatile high fixed carbon high ash, low sulpher and low phosphorous content.
5. In comparison to this the Raniganj coals contain high moisture, high volatile, medium fixed carbon, medium ash, low sulpher & low phosphorous contents.
6. Among the important lower Gondwana coal fields in India
   (i) Raniganj coal fields of West Bengal.
   (ii) The Jharia Giridih and Bokaro coal fields of Jharkhand.
   (iii) The Talchar coal fields of Odisha.
   (iv) The umaria, Sohagpur, Mahapani, Korba & pinch valley coal fields of Madhya Pradesh.
   (v) The Songrolli coal fields of Hydrabad.

2.2 Petroleum :

Petroleum is the term which means “rock-oil”. This is one of the important mineral fuels, and is a complex mixture of hydrocarbon compounds with minor amounts of impurities, nitrogen, sulphur and oxygen. The liquid petroleum is called crude oil, petroleum gas is called natural gas and the semi solid to solid forms of petroleum are commonly known as asphalt, tar, pitch, bitumen etc.

2.2.1 Describe the organic & inorganic theories accounting for the origin of petroleum.

Organic Theory :

(a) This has been put forwarded by Engler. His theory is based on the fact that by destructive distillation of fish blubber, a product similar to natural petroleum could be obtained.

(b) Vegetable origin theory: On the basis of certain facts as deposits of petroleum found in close association with sedimentary deposits containing diatoms, seaweed, peat, lignite, coal, oil shale of known vegetable origin, this theory has been propounded.

(c) Animal origin theory: Since 95% of the oil fields occur in marine sediments it is assumed that oil was formed from marine organisms buried in sediments. It has been suggested that bacterial action plays the most effective role in the conversion of organic material into oil. It is now commonly presumed that the primitive forms of life like sediments in the sea bed, were the primary source material for petroleum.

Inorganic Theory :

(a) Brethelot's alkaline carbide theory: According to him CO_2 might react with alkaline metals contained in the interior of the earth at high tempreture with the formation of alkaline carbides. These on contact with water liberate acetylene which through subsequent processes of polymerization and condensation forms petroleum.

(b) Mendeleef"s carbide theory: It is believed that iron carbides within the earth on cantact with percolating water form acetylene, which escapes through fissures to the overlying porous rocks and there condenses. This theory is based on laboratory experiment, but the presence of iron carbide within the earth has not been established definitely.

(c) Oissan"s volcanic theory: He suggests that volcanic explosions may be caused by the action of water on sub-terranean carbides, and may lead to the formation of petroleum.

(d) Cosmic theory: Taking into account the presence of small quantities of hydrocarbons occasionally in meteorites, Sokolov considers petroleum to be an original product resulting from the combination of carbon and hydrogen in the cosmic mass during the consolidation of the earth.

2.2.2 Define oil pool & oil trap.

Oil pool : Oil is lighter than water, the oil tends to float on top of the water. If the sandstone unit was formed under marine water, it already contains salt water in its pore-spaces. The oil slowly moves up around the sand grains until it reaches the top of the sandstone unit. Gases that have been produced are lighter than the oil and tend to move to the top of the oil accumulation. The greater the porosity, the greater the amount of oil that a reservoir rock can contain and the larger the pore space the greater the amount of oil is called oil pool.

Oil trap : Petroleum mostly occurs under the impermeable cap rock of a reservoir. The barrier which helps in the accumulation of petroleum is called an oil trap.

Oil traps are classified into the following three types :

(i) Structural trap : These are caused by folding or rupture and displacement of the rock units. They include closed anticlines, domes, monoclines, terraces, synclines, faults, fissures, salt domes, igneous intrusion etc. the process of strata deformation may be compressional, gravitational, intrusional or rejuvenated uplifting.

(ii) Stratigraphic traps: These are formed by conditions of sedimentation in which lateral and vertical variations in thickness, texure and porosity of beds result. They include unconformities (angular unconformities are more effective), ancient shore line sands, shoe string sands, sandstone lenses and bars etc.

(iii) Combination structural stratigraphic traps: Here are included these reservoirs where structural, stratigraphic and lithological features are significant in controlling the accumulation, migration and retention of oil and gas. They include both deformational as well as erosional features, for example bald headed structure, traps with buried hills etc.

2.2.3 Describe process of accumulation of oil.

1. The oil originates in a source bed and marine shale. Once a black mud rich in organic compound is thought to be a common source rock.

2. The oil then migrates to permeable reservoir rocks and to do this, it may travel for long distances both vertically or horizontally. The source beds tend to lack of the permeability necessary for profitable extraction of the oil.

3. A non permeable layer must occur above the reservoir bed.

4. A favorable structure must be exist.

Uses :

1. The chief use of petroleum are as fuel particularly in transport operations.
2. The petro-chemical derivatives of petroleum have a wide range of used in agricultural, industrial & medical industries.
3. It is also used for the purpose of generation of heat & power.

2.2.4 Describe different important oil fields in India.

In India, deposits of petroleum and natural gas are associated with the belt of tertiary-rocks in Assam, Gujarat as well as in the offshore regions of Bombay High and in the Cauvery and Godavari deltaic areas.

Assam :

(i) Digboi oil fields: Where the Tipam sandstones of Miopliocene age is the oil bearing formation.

(ii) Nahorkatiya oil field: In the Brahmputra valley, where the oil bearing formation is the Barail series of Oligocene age.

Besides the above the other important oil fields of Assam are Moran oil fields, Rudrasagar oil field, Duliajan oil field and Lakwa oil field.

Gujarat :

(i) Comaby basin: Where the main oil bearing sand is of oligocene age. Here a m,ajority of the wells are only gas producers.

The other oil fields if importance are Kalol oil field, Nawagam and Sanand oil field.

(ii) Ankleshwar oil field: This is the most important oil field discovered so far in Gujarat. The producing sands are of Eocene age.

Mumbai high: About 115 miles of Mumbai, in the Arabian sea, a huge oil deposit has been strick in limestone rocks of Miocene age. This has proved to be the richest oil deposit in the country. The deposit is estimated to be around 4 billion tones.

Andhra Pradesh: In the off shore regions of Tamil Nadu and Andhra Pradesh, a number of oil deposits have been discovered by ONGC, recently. Among them the deposits of Nagapatinam is the most important one, from the commercial view point.

3.0 Prospecting & exploration.

3.1 Define prospecting.

Prospecting means looking for ores minerals of value of importance. Prospecting is a sum total of systemic process under taken in a sequential manner to discover new ore deposit.

3.2 Differentiate between prospecting & exploration.

Prospecting	Exploration
Prospecting is a sum total of systemic process under taken in a sequential manner to discover new ore deposit.	Exploration is a incorporates set of operation take drilling, trenching keeping sampling assaying, core, ranger, estimated of determining the availability of the ore deposite.

3.3 Enumerate & describe various criteria for geological exploration.

Geochemical prospecting : This method aims of plotting on suitable map such dispersion pattern of farce metal in sample of soil ground water or vegetation (usually leaves) collected of suitable interval from the area to be prospected aromatizes are indicated by a marked in the concentration of farce metal from the back ground valve. It deals with examination with the earth crush consist of not only rock but also water & gases.

It is divided into two primary and secondary processes. Primary process are connected with magnetism. Metamorphism. Secondary process are associated with superegos agent of rock degradation of water.

On primary geochemical prospecting important to dated difference in the distributor of element in the earth crust. Dispersion is influenced both mechanical as well as chemical process, primary cone of mineral is due to pressure and temperature condition.

Element under normal differentiation separate group oxy phallic, chalo phyllic (sulpher) phylllic side rophyllic (iron) and phylllic.

3.4 Describe various methods of Geophysical prospecting.

Geophysical exploration : It take the help of natural physical parameters of earth side like gravity magnetism or natural electric field. Artificial physical field is created by electrical radioactivity.

There are major type of geophysical exploration method such as

(a) Gravity Method, (b) Magnetic Method, (c) Seismic Method,

(d) Geothermal Method, (e) Radiometric Method (f) Electrical Method.

Gravity Method :

1. It represented a set of geophysical method which makes use of the natural gravity field of the earth. Density is the physical prospers which helps in gravity method.
2. In gravity method the nature of distribution of gravity on the surface is analyzed. The gravity influenced positively by heavier longer & shallow depth ore bodies.

3. If the gravity field deviates from the normal value then bodies can be present below the surface.
4. The geophysical unit of gravity is villigals & cotors.
5. The different kinds of gravity methods are gravity prospecting gravity logging air born gravity & sea burn gravimetric.
6. It fonds application for exploration of ore deposit oil & natural gas regional geological structure sub surface geology solving engineering problems etc.

Magnetic Method :

1. It makes use of the natural magnetic field of the earth.
2. The physical properties with operates upon his method is based on the fact.
3. The magnetic method is based on the fact that magnetic bodies present in the earth sub surface continue to the magnetic field of the earth.
4. When the magnetic field of the earth is measured on the surface bodies processing magnetic moment different form those of surrounding rock contribute.
5. Magnetic instrument use are magnetic meter tension magnetometer & fluxgate magnetometer.
6. Unit Gamma & Orestar.
7. It is used for locating iron nickel, tin chromites.

Seismic Method :

1. The elastic property, difference in rocks the controlling properties.
2. It is based on the principled that sub surface rock formation bear different elastic properties.
3. The velocity of propagation of seismic ways through them changes with change in lithology.
4. In seismic method artificial explosion are made in ground.
5. The waves this practice travel through the sub surface layer critical refraction.

6. With the help of geophones fixed suitable intervals on the ground, the different seismic way reaching the surface are recorded & from the time of the arrival time distance curve are constructed.
7. These graph known as hodographs seismic waves are of 4 types, (a) Primary wave, (b) Secondary wave, (c) Long wave, (d) Reflected wave.

Radiometric Method :

1. The controlling parameter is the natural radioactivity of rock & ore.
2. The normal radioactivity is different types of rocks.
3. If rock contains radioactive are bodies such area will show very high radioactivity given rise to anomalies.
4. Igneous body have relatively more radioactivity than basic & ultra basic roads.
5. There are two types of natural radiometric method employed in the field. These are (a) Gamma method and (b) An Emanation method.

Gamma method : In which the intensity of gamma rays from rocks or ores in a area is measured.

A Emanation method :

1. In this method the concentration of radioactive emanation of solid & air are measure.
2. The instrument used as Geiger miller counter or scintillation counter or Gamma ray spectrometer.
3. Unit : Milicurie or Microcurie
4. It is used in exploration of uranium theorirare earth metal like Berrilium. Lithium, Tanteium, Neobium.
5. In the exploration of oil & natural gas the radioactive tracer techniques is utilize to measure velocity of ground water direction of flow & salt water instruction.

Geothermal Method :

1. Here the controlling factors thermal conductivity.

2. The temperature distribution on the surface of the earth is occurred in three sources.
   (a) Insulation : in coming solar radiation.
   (b) Heat conveyed from the intercoring earth by conduction & convention.
   (c) Due to radioactive mineral.
3. The reodual value of temperature distribution on the earth surface can be interrupted in forms of sub surface geology.
4. The instrument used as thermister thermometer, platinum thermometer, radiometer and crystal defector.
5. It used in deep structural ore deposite and ground water.

Electrical Method :

It is based on the fact that the sub surface formation & ore deposite contain different electrical properties. The different methods are as follows :

(a) Electrical resistivity method : Electrical resistivity is of sub surface formation varies from one another.

(b) Werrer : Unit – ohm x meter, Instrument used is electrical resistivity meter.

(c) Electromagnetic Method :

- The alternative emf is established ground using an artificial source.
- The electromagnetic field unduces feddy current is the conducting ore body.
- The different method includes (a) Sargram, (b) Enslin, (c) Turam, (d) Sundberg.

(d) Self potential : It uses the natural method electric field of the earth sulphide one like pyrite, pyrchilite, chaleophrite. The instrument used a pair of non pollarisable electrodes & potentiometer. Unit is Millivolt.

(e) Induced pollarisation : Based on the study of secondary electro chemical process that takes place on the sub surface due to flow of electric current. When direct electric current is passed in the ground the current is ionic electrolyte & electric solid minerals. Thus at the

electrolyte conducting particle boundary the change is transformed from ion to the particle. Thus (+ve) ion change pole of at the particle boundary when the current is stopped the accumulated charge is the material give rise to reodual voltage which decrease with time. Unit is Millivolt. It is used in exploration of sulphide & ground water.

3.5 Explain Geochemical prospecting.

It deals with the examination of the earth crust consisting not only of rocks but also water gases. Geochemical processes are divided into primary & secondary processes. Primary processes are connected with magnetism and metamorphism. Secondary processes are associated with super gane agent rock degradation as well as magnetic water. In primary geochemical prospecting it is important to detect difference in the distribution of elements in the crust. Dispersion in influence by both mechanical as well as chemical. Primary concentration of ore minerals is due pressure & temperature condition. Element under normal condition magnetic differentiation separate out as group like oxy phyllic, chalcophyllic, lethophyllic, sidenophyllic, atmophyllic, which plug a significant path lock for emplacement and concentration of economic mineral deposit.

3.6 Differentiate between biogeochemical & geobotanical prospecting.

Biogeochemical Prospecting: Roots, barks, leafs, concentrate, elements from the ground uniform of nutrient elements like as CO, Zn, Ca, K, P, Fe, Mg, Mn, etc are important for the growth of plants to be surveyed to be assayed using various chemical and weight chemical method. First this plant parts are dry in the sun burnt under errabic condition. Then the ash is finaly powdered & leached with hydrochloric & hydrogen sulphide. The organic part are washed a ray leaving behind elements residue. Then this residue are analysed or assyed using weight chemical & instrumental techniques. The concentration of a particular element in the plant parts we give the picture about the concentration the element below.

Geobotanical Prospecting : Plants depend for their growth on geological CO_2 moisture and mineral nutrients. Certain elements are essential & important for its growth & development

where as some elements are toxic to plant growth the different morphological modification are visible.

For Cu, osmium humble is a indicator of Cu mineralization in below. A crocephylus Roberto, polycarpea, spira styles, poly, carpea, corymboso are indicator of Cu.

For CO, Critotoria cobalticola & silence cobalticola.

For Pb & Zn, Plantgo lanceolate, lobilla inflate, sorghustram Neutrons (grass)

For Mo, Molitus alba, trifolium repens, lotus carniculates.

4.0 Economic Geology.

4.1 Define ore & gangue.

Ore : An ore is a term applied to that part of a metalliferous mineral deposit, which can be used for profitable extraction of one or more metals. The economic minerals of an ore is called ore minerals.

Gangue : The term is used to indicate the useless material associated with ore minerals. The usual gangue minerals are quartz and other forms of silica, calcite, dolomite, siderite, barite, feldspars, garnet, chlorite, fluorite, apatite, pyrite etc. and sometimes the gangue material is the country rock itself in which the ore minerals occur.

4.2 Define tenor & grade.

Tenor : The metal content of an ore is called the tenor of the ore. It is generally expressed in percentage of the metal. It say pays for the extraction cost of the ore.

Grade : Signifies the commercial classification of an ore where by the physical and chemical parameters are taken into account beside its qualitative aspect.

4.3 Describe the mineralogy, mode of occurrence, distribution & use of iron ore deposits in India.

Mineralogy : The chief economic iron ore minerals are :

Magnetite	Fe_3O_4	(containing 72.4% of iron)
Hematite	Fe_2O_3	(Fe=70%)
Limonite	$2Fe_2O_3, 3H_2O$	(Fe=59.8%)
Goethite	Fe_2O_3, H_2O	(Fe=62.9%)
(Spathic ore)		
Siderite	$FeCO_3$	(Fe=48.2%)
Pyrite	FeS_2	(Fe=46.2%)

Chamosite and thuringite are examples of iron silicate minerals.

Mode of occurrence : Iron ore deposite occur as magma tic deposits, as bedded deposits, as residual concentration deposits or sometimes as nodules and concretions in shales associated with coal-seams.

Distribution in India :

1. The biggest iron ore field of India is situated in the Singhbhum district of Bihar and the adjoining districts of Keonjhar, Sundergarh and Mayurbhanj of Odisha. The important mining centres of Odisha and Bihar are Barbil, Gua, Bonai, Joda, Kiriburu, Suleipat, Gorumahisani, Noamundi, Barajamda etc.
2. Madhya Pradesh: In the Bailadila hill ranges.
3. Maharashtra: Ratnagiri district.
4. Goa: Bicholim- Pale in Goa.
5. Karnataka: Bananudan hills in Chikmagalur district, and in Sandur, Bellary, Hospet districts as well as Shimoga and Chitaldrug districts. Important one is that of Kudermukh.
6. Andhra Pradesh: Cuddapah, Kurnool, Chitnoor, Nellore, Anantapur, Warangal and Adilabad districts.
7. Tamilnadu: Salem district, and Tiruchirapalli district.
8. West Bengal: Deposit of lateritic ores mostly occur in West Bengal.

9. Assam: Iron stone clay are found as nodules and thin beds in the coal measures of Eocene age and in the Tipam series of Miocene age.

Use of Iron :

1. Smelting for steel.
2. Srenge iron.
3. Rail, coaches, wagons, ships.
4. Heavy machineries.
5. Koaol breezes & buldings dums.
6. Weapons and reaitors.
7. High speed steel.
8. Utensils & forming equipments.
9. Coal iron, Pig iron, wrought iron.

4.4 Describe the mineralogy, mode of occurrence & description of Chromites deposits in India & its uses.

Mineralogy: It is an important alloying element in the manufacture of steel Chromite is the only ore-mineral of chromium.

Chromite – FeO, Cr_2O_3, Cr_2O_3 = 68.0% and Cr = 46.66%.

Mode of occurrence: Chromite deposits occur as lenses, masses, veins and disseminated grains in host rocks. The deposits are regarded as the early or late magma tic segregation or injection product.

Distribution in India: The largest shromite deposit in the country is located in the Sukinda ultrabasic belt of Cuttack and Dhenkanal district of Odisha, and also in the Keonjhar district of the state. The belt extends over a distance of about 20km, the width of the belt is about 2km. the ore bodies are lenticular in shape and occur as lenses and patches within the lateritised ultrabasic rocks.

The other important deposits occur in:

(i) Andhra Pradesh: Kistna district (Kondapalle)

(ii) Bihar: Singhbhum district.

(iii) Karnataka: Chitaldrug, Hassan and Shimoga districts.

(iv) Tamil Nadu: Salem districts (Sittampundi).

Economic uses:

1. In the metallurgical industries in the production of various non ferrous alloys of chromium and also in the form of ferro chrome for manufacturing chrome steel.
2. In refractory industries, due to its high resistance against corrosion, high temperature and sudden temperature changes and its chemically neutral character.
3. In chemical industries, for the manufacture of chromium compounds like chromates and bi-chromates and chrome acid etc.

4.5 Describe the mineralogy, mode of occurrence & distribution of copper deposits in India & uses of this metal.

Mineralogy: It is the most important non-ferrous metal and was the earliest metal used by man. In nature copper occurs in four principle formes, sulphides, carbonates, oxides and as native copper. Of these the bulk of cooper is obtained from the sulphide ores. To be economically exploited a cooper ore should contain at least 2.5% of copper. In modern times ores with 1% of copper are also used.

Mode of occurrence: Copper deposits may occur as.

(a) Disseminated ore bodies: Where the copper minerals are generally dispersed in a large volume of rock. They are generally of low grade. The porphyry copper deposits of USA are of this type.

(b) Massive, irregular or lenticular ore bodies, which are formed by the process of replacement.

(c) Vein deposits or lodes: In which the copper hearing solutions percolating along shear zones and rock fractures deposit copper mineral with changes of temperature and pressure forming fissure veins, copper deposits of Singhbhum.

(d) Deposits following stratigraphic beds, as is the case with the deposits of Khetri (Rajasthan).

Distribution in India :

1. In Andhra Pradesh, the most important copper deposits are the Agnigundla deposits.
2. In Bihar, in the Singhbhum district, a copper bearing belt of about 80 miles long occurs. Here the copper ores occur as veins in the country rock consisting of mica achists, quartz-schists, chlorite-schists, biotite-schists, granite and granite-gneisses.
3. In Madhya Pradesh, the important deposit is the Malan Jhakhand copper deposit, where copper ores occurs in the form of veins within dolomitic limestone.
4. The Khetri copper deposit of Rajasthan is one of the important copper deposit in the country. This belt has 3 richly mineralized sections - Madhian, Kolihan and Akhwali.
5. Other important copper deposits of the country are as follws

(a) Himachal Pradesh: Kangra, Kulu valley.

(b) Mysore: Chittaldrug, Hassan, Bellary districts.

(c) West Bengal: Darjeeling, Jalpaiguri districts.

(d) Sikkim: Rangpo and Dickchu deposits which are found to occur in association with the metamorphic rocks belonging to the Daling series.

Economic Series: The metal is of great industrial importance, because of its high electric conductivity, high ductility and malleability. Thus it is mostly used in electrical manufactures. Besides, the copper alloys are used in buildings, automobiles, air planes, naval ships, house hold utensils as well as in metallurgy and paints.

4.6 Describe the mineralogy, mode of occurrence, distribution of lead & zinc deposits in India & the uses of these metals.

Mineralogy: The two metals lead and zinc rarely occurs in native state, they generally occur in combination with other elements. The ore minerals of lead and zinc are usually found to occur in association with each other. The following are the important minerals of lead and zinc:

Lead	Zinc
Galena-PbS-Pb 86.6%	Sphalerite or zinc blende – ZnS, Zn – 67%.
Cerussite-$PbCO_3$-Pb 77.5%	Smithsonite or Eng. Calamine – $ZnCo_3$, Zn- 52%.
Anglesite-$PbSO_4$, Pb 68.3%	Hemimorphite or Americanname
	Calamine Zincite- ZnO – $2ZnO_2SiO_2H_2O$, Zn– 54.2%

Mode of occurrence: Most of the lead ore mines of the world are also zinc ore producers and nearly all zinc ore deposits carry lead ore. Both lead and zinc ore bodies usually occur as veins and massive or tabular lodes, and as disseminations, mostly in limestone or dolomites. Majority of these ores occur as cavity fillings and replacements formed by low temperature hydrothermal solutions.

Distribution in India: The most important lead zinc deposits of economic value in India is the Zawar deposit of Udaipur district of Rajasthan. India's reserve of these ores is meager compared to her needs.

In the Zawar area, the Mochia Marga, Barai Magra and Zawar Mala hills contain most extensive deposits.

The ore minerals consist of argentiferous galena associated with sphalerite and chalcopyrite. The ore contains 1.5 to 2% of lead and 4.5 to 5% zinc.

Other important occurrences in the country are as follows:

(a) Lead copper ore deposits in Agnigundla area of Guntur district of Andhra Pradesh.

(b) Lead zinc copper belt of 3 km long in Ambamata Devi area of Gujarat and Rajasthan.

(c) Sargipalli area in the district of Sundergarh (Odisha).

Economic uses:

(i) Lead is used in the construction of accumulators, for lead piping and sheeting cable covers, as pigments in glass making, in medicine etc.

(ii) Zinc is used for coating, galvanizing iron and steel products, in the manufacture of pigments and alloys with other metals, in the manufacture of batteries and electric appliances. Besides they are widely used in textile industry, timber preservation etc.

5.0 Sampling.

5.1 Define sampling, outline the method of preparation of samples for assay.

Sampling: Sampling is the process by which physical & chemical characteristics of mine or one ore curtained with the accuracy.

- It is the process of collecting a small portion of a whole such that consistency of that represent that of whole.
- In case of metallic ore this consistency is the metal content or the assay value which in case of coal not curves the properties determined Proximinate & ultimate analysis such as fixed carbon volatile matter ash calshing index calorific value.
- In case of iron ore & manganese ores the consistence cover not only the content of the metal in the ore but also the content of other impurities such as Silica, Alimina, Sulpher, and Phosphorous.
- The physical nature of ore is sometime necessary to be determine and the sampling process adopted should be able to give this information.
- Samples are generally collected at regular interval in order to avoidable in the location of sampling point preside regular distribution of the sampling point are the entire ore body become necessary to establish the generally geological character of the deposit. The interval of sampling is ignored by the regular by the regular of the deposit. As well as the accuracy of sampling desired in regular deposit a few sample may give the desire accuracy while in irregular accuracy. While in irregular deposit a much larger umber may be needed. It is obvious that the accuracy tend the lead. When the number or sample is so larger as cover the whole. But the cost of sampling increase with the number of samples.

Outline the method of preparation of samples for assay.

Coining & quartering :First take the sample and crush it to about 12-15m size sample is divided into four heaps. First mix the two opposite quadrant sample. After fixing again it is divided into four parts. The two opposite diagonal parts are mixed. The process is repeated till the sample left is about 100gms. Then it is taken for chemical analysis. This process is called coining and quartering.

5.2 Describe the different methods of sampling as outlined by Bureau of Indian Standards. (BIS).

The different methods of sampling are as follows:

1. Grab sampling:

- It is the random collection of broken chips from the expose surface of an out crop from the mine working or from stock material.
- The material from the stock can be obtained by a small hand shovel.
- Grab sample is generally obtained during the preliminary survey.
- The grade of the deposit can't be relied upon from the assay valve of such sample.

2. Chip Samples:

- Chip samples closely resemble grab sampling accept that the sample is collected from a fresh rock surface.
- The surface of an ore body is first clean by a wire brush and then a chip or fragment is broken by a hammer.
- This is also used in preliminary survey.

3. Channel or Groove Sampling:

- It is collected from groove cut systematically across the exposure of the ore body.
- It is used in sampling of frenches, pits, drifts, winzes, raises, shafts.
- The purpose of cutting a groove or channel is to ensure that uniform quantity of material is

drawn the entire ore body.

- A channel of 10cm with and 2.5cm depth is cut.
- After cutting a groove across the ore body parallel to the true with samplers drawn by further deepening the groove by means of a chisel to a uniform depth.
- When the ore body consists of a alternate bend if reached and liner and each type is separately sample.

4. Bore Hole Sampling:

- It is carried out by drilling bore & hole in the leased hole area.
- It is the most modern method of examination of mineralization under neat the surface of the earth.
- The horizontal extension and the vertical persistency of ore body is easily de-marketed by bore hole sampling.
- Drill holes are place at suitable intervals preferably on a grid pattern to determined on easy valve of the ore.
- Bore hole cores are taken out and preserved in core box.

5. Bulk Sampling:

- A few tones of the ore either from the French pit channel or from run of mine ore taken out all are collected to determined ore for its physical properties and its accumulative to beneficiation techniques by pilot plant foot.
- For iron ores the bulk sample is taken to examine the ratio of fines to total mass of core mines.

6. Car and Wagon Sampling:

- It is obtained by taking a predetermined on quantity of run off mine from each car load or wagon load.
- It is done to determine the quality of ore dispatched to the mill of beneficiation.

Salting of Samples:

The term means adding salt and may be defined as the act performed to enrich or impoverish the samples taken for the test purpose either intentional or accidentally.

Intentional Salting:

Salting with a purpose or aim:

(a) Before collection of samples: Interested parties have successfully increased the grade of the samples by

(i) Pouring or dropping gold chloride & silver nitrate over the ore face.

(ii) Injecting a salting or suspension of metallic salt in to the cracks. Gold chloride, silver nitrate, silver chloride or silver cyanide.

(iii) By shooting finely divided metal at the ore face by a shot gun, pistol or stick of dynamic gold fillings placer gold or silver precipitates.

This is expansive because large quantities of metal is to beaded & may not fetch result as the addition is done to the ore surface before sample is collected & likely to be removed by brushing, washing & cutting before the sample is collected.

(b) After collection of sample:

(i) Gold contained cigarette ash, pipe ashes or tobacco juice may be dropped in to the sample sock (by opening the mouth of the sock) which shows high value.

(ii) Solution or suspension of salt of gold & silver may be injected into the sock by hypodermic needy & this will subsequently shows high values.

(iii) Sample addition of cigarette ash may impoverish the metal content in the sample.

(c) during preparation of samples for assay:

(i) Artificial enrichment can be made by Gold contained in cigarette ash etc.

(ii) Impoverishment can be done by adding with the connivance of obliging persons in charge of preparation of samples.

(d) During Assaying:

With the connivance of the obliging assayer materials may be added to enrich or

impoverish the or else the assayer may be asked desired by interested parties.

As several hands are involves in sampling preparation of samples & assaying it is not possible to prevent salting even it is watched day & night. But still then salting is prevented in different stages.

Prevention of Salting:

(i) Salting of samples face can be prevented by clearing the sample face with a wire brush & then with a jett of clean water, removing outer portion of the channel or shifting the site of sampling from that already marked.

(ii) Prevention of salting prior to assaying can be done by keeping properly & security. The sampling sack should be sealed & locked in leather mail pouch which prevents injection & this is put into a truck or locked room & should be kept under a thrust worthy person who should not permit others to handle the sample nor he should be under alcohol giving opportunity to others for salting.

Accidental Salting:

Non intentional salting is made by the Geologist when he takes samples from a dirty contaminated exposure or when he uses an unclean previously used sack for keeping the sample.

These type of salting can be prevented by being conscious of the effect of salting. Salting can ruin a sample & waste all the hand labour in exploratory work. High & low values in salting will lead to the failure of the exploratory project.

Quality Control:

Instead of prevention salting some engineers prefers to detect any salting in the following manner.

(i) Dumpy samples: A piece of rock or any other material devoid of metal is crushed & kept as dumpy samples which can be salted & salting is detected.

(ii) Duplicate: If no salting has been done up to quartering then duplicate samples of different weight are kept along with original. It becomes different to add materials exactly. So that the original & duplicate of different weight will give the same assay value.

(iii) Re sample: The channel may be resembled & the assay value is determined & it should be same as original sample if not salted.

(iv) Planning: Planning the sample reveals the presence of any gold fitting or other extraneous material. Washing samples before assay may remove soluble salts & finally divided metal but it may wash the legitimate value.

(v) Recording: Recording the nature of ore. High-grade and low-grade are characteristics by their texture, mineralogy, colour & general appearance. An assay result widely in consistent with the description of record will immediately suggest re-examination of the channel & resulting of samples.

(vi) Comparison: Comparison with past production record, high or low assay value than on record suggest re-examination.

Chief Fossil:

1. Living animal may appear many mammals if during glacial period.
2. Mammal mollusks and flowering points dominant division largely and the presence of mammal species.
3. Giant replies and ammonites disappear at the end flower plant becomes numerous. Ammonites abundant first birds in flowering plants & sea urchins. Ammonites reptiles and amphibole abundant acid climate.
4. Trilobites disappear at the end many non flowering plants first reptile appear. Abundance of carol Boride polo first ambhi & lung fish raplotic disappear at the end. First fishes probably first land fish plant abundance of trilobites and graptolilos abundance of trilobites.
5. Soft bodies animal & plants.

6. Life less: The entire life span of earth on cable geological time if has been broadly divided into some major division known as eras.

Describe the method of preparation of sample for assay.

- The samples obtained from the grooves one first crushed separately to convenient size of 12 to 15mm.
- They are then reduced by a method of coming and quartering to about a kilogram, half quantity of which again by further crushing coning and quartering is sent for analysis.
- The core samples are spit into two halves by means of core spiitter so that one is the mirror image of the other.
- The one half portion is crushed, coned and quartered for the preparation of the sample for assay.
- The other half is generally kept for cross check and the preparation of thin sides to be of thin side to be tested under the microscope.
- Its always not necessary to do so and in that event the whole mineral portion of the core is crushed for the preparation of the sample.
-