* Mining Geology and Economic Geology

① Physical Geology :- constitution of earth's interior, earthquake and volcano, weathering.

• Physical Geology :-

it is a scientific discipline that is concerned with all aspects of the earth's structure, composition, physical properties, constituent rocks and minerals, and surficial features.

Accordingly physical geology is essentially a superdiscipline that overlaps such disciplines as geophysics, geochemistry, mineralogy, petrology, structural geology, and geomorphology.

Physical geology is important to study because we can study rocks and the fossils they contain to understand the evolution of our environment and the life within it. We can learn to minimize our risks from earthquakes, volcanoes, slope failures and damaging storms.

Physical geology :-

it concerned with

- Earth material as well as
- the processes that operate on those material either at or beneath the surface of the earth.

- **Earth material :-**
  - Elements
  - Minerals
  - Rocks
  - water
- **Processes :-**
  - Plate tectonics.
  - Volcanic eruptions
  - Earthquakes
  - Mountain building
  - Action of glaciers
  - oceans
  - Wind
  - weathering
  - Erosion.

• Constitution of earth interior :-

① It is not possible to know about that earth's interior by direct observation because of the huge size and the changing nature of its interior composition.

② It is an almost impossible distance for the humans to reach till the centre of the earth (the earths radius is 6,370 km).

③ Through mining and drilling operations we have been able to observe the earth's interior directly only upto a depth of few kilometers.

④ The rapid increase in temperature below the earth's surface is mainly responsible for setting a limit to direct observation inside the earth.

⑤ But still, through some direct and indirect sources, the scientists have a fair idea about how the earth's interior look like.

Sources of information about the interior of the earth.

① Direct Sources:-

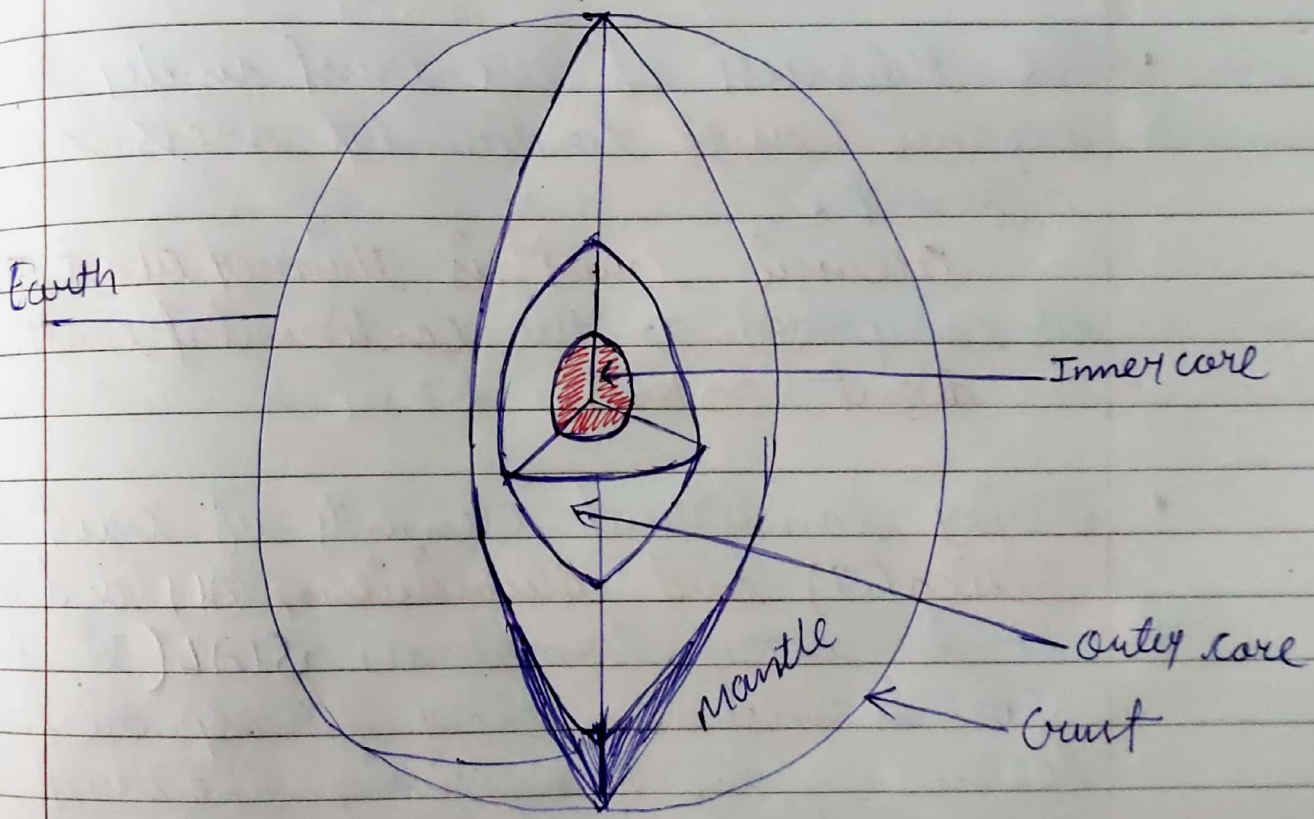
- Rocks from mining area.
- Volcanic eruptions

② Indirect Sources:-

- By analyzing the rate of change of temp. and pressure from the surface towards the interior.
- Meteors, as they belong to the same type of materials Earth is made of.
- Gravitation, which is greater near poles & less at the equator.
- Gravity anomaly, which is the change in gravity value according to the mass of material, gives us information about the material in the earth's interior.
- Magnetic sources.

- Seismic waves :- The shadow zones of body waves (primary waves & secondary waves) gives us information about the state of materials in the interior.

- Structure of Earth's Interior is fundamentally divided into 3 layers



Crust :-

- It is the outermost solid part of the earth, normally about 8-40 kms thick.
- It is Brittle in nature
- Nearly 1% of the earth's volume & 0.5% of the earth's mass are made of the crust.
- The thickness of the crust under the oceanic and continental areas are different.
  Oceanic crust is thinner about 5 kms as compared to the continental crust about 30 kms.
- Major constituent elements of crust are Silica (Si) and Aluminium (Al) and thus, it is often termed as SIAL (sometimes SIAL is used to refer Lithosphere, which is the region comprising the crust & uppermost solid mantle, also).
- The mean density of the material in the crust is 3g/cm3.

Mantle :-

- the portion of the interior beyond the crust is called as the mantle.
- the mantle is about 2900kms in thickness.
- Nearly 84% of the earth's volume & 64% of the earth's mass is occupied by the mantle.
- Major constituent elements of mantle are Silicon (Si) and Magnesium (Mg) and hence it is also termed as SIMA.
- The density of the layer is heigher than the crust and varies from 3.3 - 5.4 g/cm^3.

Core :-

- it is the innermost layer surrounding the earth's centre.
- it is composed mainly of Iron (Fe) and Nickel (Ni) and hence it is also called as NIFE
- The core constitutes nearly 15% of earth's volume and 32.5% of earth's mass.

- The core is the densest layer of the earth with its density ranges between 9.5 - 14.5 g/cm³.
- The core consists of two sub layers
  ① Inner core
  ② outer core
- The inner core is in **Solid state** & The outer core is in **liquid state**

⊙ Temperature of the earth's interior :-

- In the beginning, this rate of increase of temperature is at an average rate of **1°C** for every **32 m** increase in depth
- while in the upper **100 kms**, the increase in temperature is at the rate of **12°C** per km and in the next **300 kms**, it is **20°C** per km. But going further depp, this rate reduces to mere **10°C** per km.
- The temp. at the centre is estimated to lie somewhere between **3000°C** & **5000°C**, may be that much higher due to the

chemical reaction under high pressure conditions.

⊙ Earthquake and Volcano :-

- An Earthquake is an intense shaking of earth's surface. the shaking is caused by movements in earth's outermost layer.

- A Volcano is an opening in a planet or moon's crust through which molten rock, hot gases, and other materials erupt.
  Volcanoes often form a hill or mountain as layers of rock and ash build up from repeated eruptions. Volcanoes are classified as active, dormant or extinct.

- Volcanoes and earthquakes occur due to movement of the earth's tectonic plates. they are both caused by the heat & energy releasing from the earth's core. earthquakes can trigger Volcanic eruptions through severe movement of tectonic plates

- Volcanoes are formed by release of gas & magma. Earthquakes are caused by movement along a fault. Volcanoes lead to the formation of new rock or Earthquakes simply causes waves which disturbs the rock.

Weathering :-

Weathering is the breaking down or dissolving of rocks & minerals on earths surface. once a rock has been broken down, a process called erosion, transports the bits of rock and mineral away. water, acids, salts, plants, animals and changes in temperature are all agents of ~~xxxx~~ weathering and erosion.

There are 3 types of weathering :-

1. physical (Freeze-thaw or onion skin)
2. chemical
3. biological

Weathering affect climate :-

- As atmosphere carbon dioxide concentration increase, the climate gets warmer.
- The warmer climate speedup chemical weathering, which consumes carbondioxide from the atmosphere and mitigates the greenhouse effect thus leading a climate cooling.

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① Geological time Scale petrology Definition & Scope, Main Classes of rock forming Minerals.

Age Million years	Era	Period	Epoch
	CENOZOIC	Quaternary	Recent 1
			pleistocene 2
2		Tertiary	pliocene 3
12			miocene 4
26			oligocene 5
37			Eocene 6
53			Paleocene 7
65			
136	MESOZOIC	Cretaceous	
190		Jurassic	
230		Triassic	
280	PALAEOZOIC	Permian	
345		Carboniferous	
395		Devonian	
430		Silurian	
500		ordovician	
570		Cambrian	
2500	PRE-CAMBRIAN	proterozoic	—
		Archaeozoic	Vindhyan

Geological time Scale :-

The time spend on earth history is about 3000 million years. On the basis of unconformity the geological time sub divided into smaller unit on this basis a standered geological time scale had been prepared which is used universal for the co-relation of rock formation

Sub-division of geological time Scale :-

1. Erq - Canozoic, Mesozoic, Paleozoic, precambrian
2. Period
3. Epoch - Recent, Pleistocene, pliocene, miocene, oligocene, Eocene, Paleocene, Vindhyan

* Petrology and its scope :-

Petrology is the study of rocks - Igneous, Metamorphic and Sedimentary or the processes that form and transform them. Mineralogy is the study of the chemistry, crystal structure and physical properties of the mineral constituents of rocks.

petrology plays an important role in ascertaining the physical and chemical properties and composition of rock or the different conditions that influence their formation.

* Difference between geology and petrology :-

- Geology is the scientific study of the structure and composition of earth
- petrology is a branch of geology that is concerned with the structure, composition and distribution of rock.

* Types of petrology :-

① Igneous petrology :-
it is concerned with the identification, classification, origin, evolution, and processes of formation and crystallization of the igneous rock

② Metamorphic petrology :-
It covers the chemical and physical work done in natural system in response to changing physical conditions.

③ Sedimentary petrology :-
Sedimentary petrology is the study of their occurrence, composition, texture, and other overall characteristics.

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② Igneous, sedimentary & metamorphic rock- origin, characteristics, classification, uses and mining importance.

- Igneous Rock :-
Igneous rock are formed from melted deep inside the earth.

- Sedimentary rock :-
Sedimentary rocks are formed from layers of sand, silt, dead plants & animal skeletons.

- **Metamorphic rock :-**

Metamorphic rocks formed from other rocks that are changed by heat and pressure underground.

* Characteristics of Rocks :-

- **Igneous Rock :-**

(a) the igneous form of rocks does not include any fossil deposits

(b) Most igneous forms include more then one mineral deposit.

(c) They can be either glassy or coarse.

(d) These usually do not react with acids.

(e) The mineral deposits are available in the form of patches with different sizes.

- **Sedimentary Rock :-**

(a) These rocks are generally not crystalline in nature.

(b) They are soft and have many layers as they are formed due to the deposition of sediments.

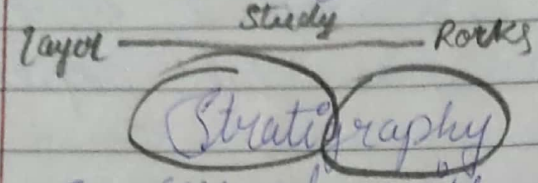
(c) These rocks may have the presence of the remains of plant animals in between various layers.

- **Metamorphic Rock :-**

(a) Metamorphic rocks were once igneous or sedimentary rocks, but have been changed (metamorphosed) as a result of intense heat and/or pressure within the earth's Crust.

(b) They are crystalline and often have a "squashed" (foliated or banded) texture.

(4) Stratigraphy Defination and scope:-



Stratigraphy is scientific discipline concerned with the description of rock successions and their interpretation in terms of a general time scale. It provides a basis for historical geology, and its principles and methods have found application in such fields as petroleum geology & archaeology.

* Stratigraphic correlation :-

Stratigraphic correlation is the process of establishing which sedimentary strata are the same age at distant geographical areas by means of their stratigraphic relationship.

* Importance :-

it is critical to understanding earth history because stratigraphic correlation is one of the principle method by which the succession & synchrony of geological event are established.

Stratigraphic units of India :-

Era	Periods	Stratigraphic unit India
Quaternary	Recent	Recent alluvium
	Pleistocene	Karewas of Kashmir, old alluvium
Tertiary	Mio-pliocene	Siwalik group
	oligocene	Murre group
	Eocene	Ranikot, Laki formations
Mesozoic	Cretaceous	Cretaceous of trichinopoly, deccan traps
	Jurassic Triassic	Gondwana Supergroup
Palaeozoic	permian carboniferous	Spiti shales, Zewy group, Kiota limestone Kuling group
	Devonian Silurian ordovician Cambrian	Missing in peninsular india & present in himalayan region
Precambrian	proterozoic Archaeozoic	Cuddapah & Vindhyan Supergroup Archaean, dharwar & Aravali group

* Dharwar Supergroup:-

The archean rock of South India are described as dharwar Supergroup. They are best development in Karnataka and adjoining states.

The Sediments of the Dharwar Supergroup were deposited over a basement of the fundamental gneiss complex.

Lithology:-

The chief rock type of dharwar Supergroup are Gneiss and Granite they cover the major part of South India.

Classification:-

On the Bans of difference in Chemical Character in 1951 W.F. Smeeth divided the dharwar Super group into two group.

1. Hornblenditic division.
2. Chloritic division.

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Division	Rock formation
Igneous Intrusions	Closepet granite Peninsular gneiss Champion gneiss
	Unconformity
upper Dharwars	Form igneous quartzite, limestone conglomerate.
	unconformity
Middle Dharwars	Quartzite and conglomerate
	unconformity
Lower Dharwars	Metamorphosed acid lava Metamorphosed basic lava
	Base not known

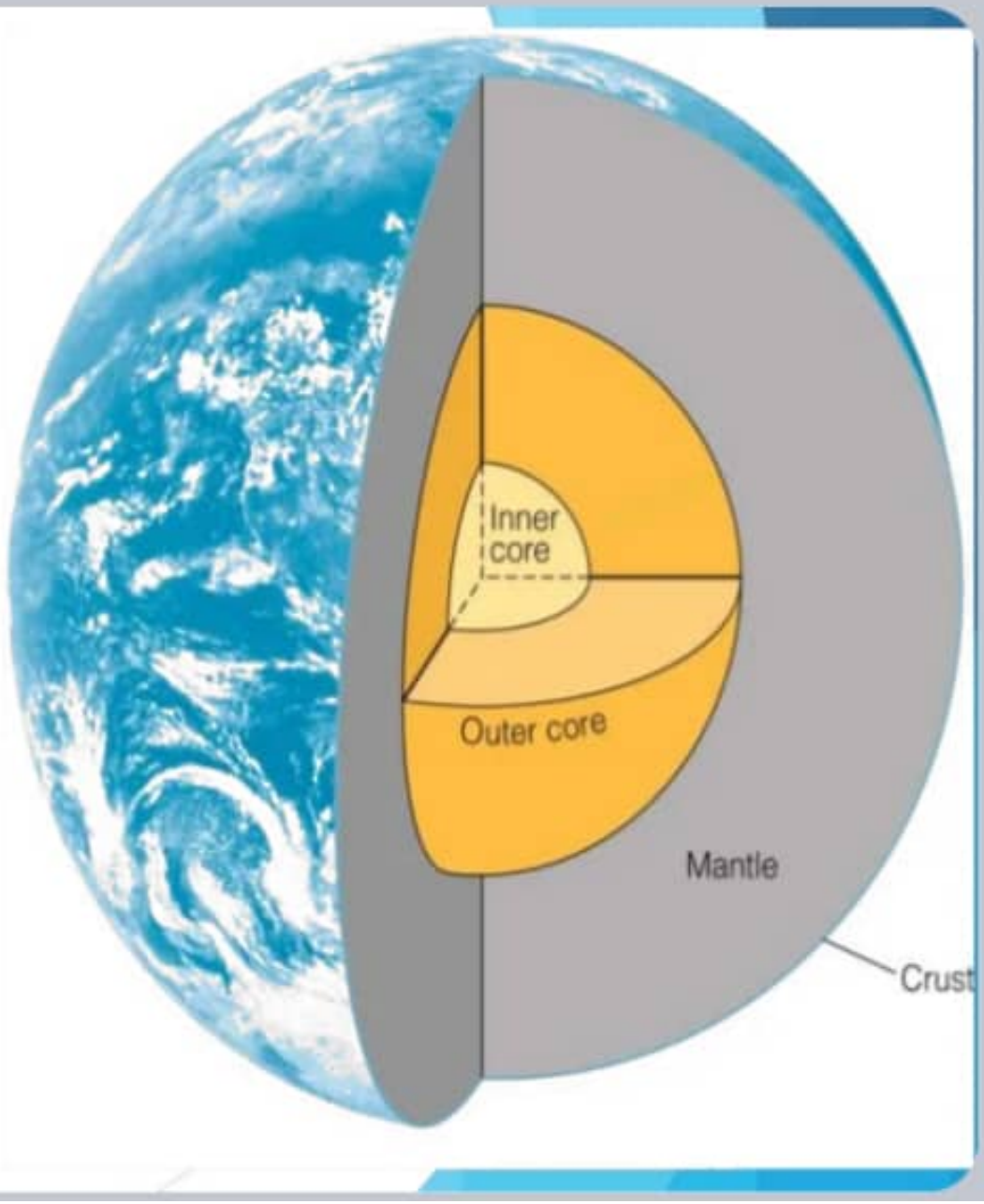
Earth's Interior

- Compositional Layers
  - **Crust** (~3-70 km thick)

  -Very thin outer rocky shell of Earth

    Continental crust - thicker and less dense

    Oceanic crust - thinner and more dense
  - **Mantle** (~2900 km thick)
    - Hot solid that flows slowly over time;
    - Fe-, Mg-, Si-rich minerals
  - **Core** (~3400 km radius)
    - Outer core - metallic liquid; mostly iron
    - Inner core - metallic solid; mostly iron



⊙ Mohs Scale of hardness.

The Mohs scale of hardness is a qualitative ordinal scale, from 1 to 10 characterizing scratch resistance of various minerals through the ability of hard material to scratch softer material. And it is developed in 1822 by Friedrich Mohs.

:- Mohs scale of hardness :-

* Name *	* Scale Number *	* common object (Scratch) *
Talc	1	
Gypsum	2	← Fingernail (2.5)
Calcite	3	← Penny (copper) [3.5]
Fluorite	4	
Apatite	5	← Knife (5.5)
Orthoclase	6	← Steel Nail (6.5)
Quartz	7	
Topaz	8	← Masonry Drill Bit (8.5)
Corundum	9	
Diamond	10	

Economic Geology:-

Economic geology is a discipline of science that focuses on earth materials that can be used for economic or industrial development purposes. often, much of the purpose of study is to identify new ore deposits for excavation, as well as understanding how ore deposits are generated and localized within earth's crust.

Origin of coal:-

It is generally accepted that most coals formed from plants that grew in and adjacent to swamps in warm, humid regions. material derived from these plants accumulated in low-lying areas that remained wet most of the time and was converted to peat through the activity of micro-organisms.

Coal measures were laid down in the carboniferous period, around 300 million years ago. trees and other plants material died, fell to the ground, and gradually were compressed. under immense pressure, the decomposing

Vegetation was converted first into peat & then into coal. the latter is not a unique product and in fact exists in various forms with properties that depend upon the age of the deposit and the stresses imposed by temperature and pressure.

Geological processes that took place over millennia converted peat first into lignite, then into Sub-bituminous coal, then bituminous coal finally into anthracite, which is the hardest form of coal with the least content of Volatiles.

* Approximate % of Carbon & hydrogen in the above ranks of coal (pure coal basis)

	Carbon %	Hydrogen %
• Anthracites coal	93-95	3.8-2.8
• Carbonaceous coal	91-93	4.25-3.8
• Bituminous coal	80-91	5.6-4.25
• Sub-Bituminous coal	75-80	5.6-5.1
• Lignites	60-75	5.7-5.0