



Minerals

For Prelims: Metallic Minerals, Non-Metallic Mineral, Non-ferrous metals, Ferrous metals

For Mains: Minerals and their different types, Economical Importance of the minerals, their extraction and uses

What are the Elements Found on Earth?

- The earth is composed of various kinds of elements. These elements are found in solid form in the outer layer of the earth and in hot and molten form in the interior. About **98 per cent** of the total crust of the earth is composed of eight elements.
 - **Oxygen, Silicon, Aluminum, Iron, Calcium, Sodium, Potassium and Magnesium.**
 - The rest is composed of **titanium, hydrogen, phosphorus, manganese, sulfur, carbon, nickel** and other elements.

What are Minerals?

- The elements in the earth's crust are rarely found exclusively but are usually combined with other elements to make various substances. These substances are recognized as minerals.
- Thus, a mineral is a naturally occurring **organic** and **inorganic substance**.
- It has an orderly atomic structure and a definite chemical composition and physical properties.
- A mineral is composed of two or more elements. But sometimes single element minerals like sulfur, copper, silver, gold, graphite etc. are also found.
- Though the number of elements making up the lithosphere are limited they are combined in many different ways to make up many varieties of minerals.
- There are at least **2,000 minerals** that have been named and identified in the earth crust; but almost all the commonly occurring ones are related to six major mineral groups that are known as major rock forming minerals.
- The basic source of all minerals is the **hot magma** in the interior of the earth.
- When magma cools, crystals of minerals appear, and a systematic series of minerals are formed in sequence to solidify so as to form rocks.
- Minerals such as **coal, petroleum** and **natural gas** are organic origin found in solid, liquid and gaseous forms respectively.

What are the Physical Characteristics of Minerals?

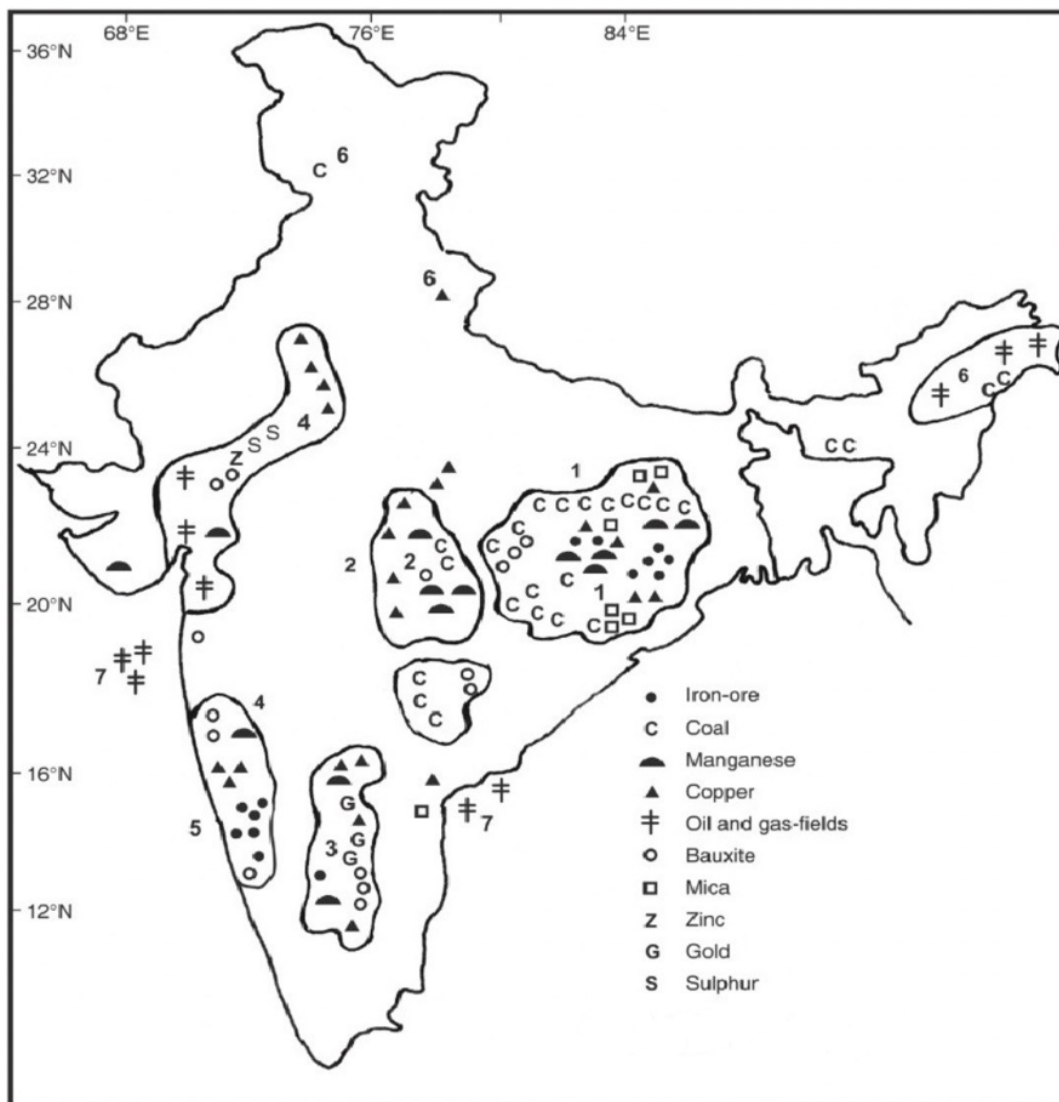
- **External crystal form:**
 - Determined by internal arrangement of the molecules: Cubes, Octahedrons, Hexagonal prisms, etc.
- **Cleavage:**
 - Tendency to break in given directions producing relatively plane surfaces
 - Result of internal arrangement of the molecules
 - May cleave in one or more directions and at any angle to each other
- **Fracture:**

- Internal molecular arrangement is so complex
- There are no planes of molecules
- The crystal will break in an irregular manner, not along planes of cleavage
- **Luster:**
 - Appearance of a material without regard to color.
 - Each mineral has a distinctive luster like metallic, silky, glossy etc.
- **Color:**
 - Some minerals have characteristic color determined by their molecular structure: malachite, azurite, chalcopyrite etc. and some minerals are coloured by impurities. For example, because of impurities quartz may be white, green, red, yellow etc.
- **Streak:**
 - Color of the ground powder of any mineral.
 - It may be of the same color as the mineral or may differ
 - Malachite is green and gives a green streak, fluorite is purple or green but gives a white streak.
- **Transparency:**
 - **Transparent:** Light rays pass through so that objects can be seen plainly
 - **Translucent:** Light rays pass through but will get diffused so that objects cannot be seen
 - **Opaque:** Light will not pass at all.
- **Structure:**
 - Particular arrangement of the individual crystals:
 - Fine, medium or coarse grained.
 - Fibrous: Separable, divergent, radiating.
- **Hardness:**
 - Relative resistance being scratched.
- **Specific gravity:**
 - The ratio between the weight of a given object and the weight of an equal volume of water; object weighed in air and then weighed in water and divide weight in air by the difference of the two weights.

What is Mineral Belts in India?

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▪ **North-Eastern Peninsular Belt:**

- The **Chhota Nagpur Plateau** is renowned as India's mineral heartland.
- Iron, Coal, Manganese, Bauxite, Mica are the prominent minerals found in the region.
 - Chhota Nagpur (Jharkhand)
 - Odisha Plateau
 - West Bengal
 - Parts of Chhattisgarh

▪ **Central Belt:**

- **Manganese, bauxite, limestone, marble, coal, gems, mica, iron ore, and graphite** are all abundant here.
 - Chhattisgarh
 - Madhya Pradesh
 - Telangana
 - Andhra Pradesh
 - Maharashtra

▪ **The Southern Belt:**

- It contains ferrous mineral resources but no coal reserves other than lignite at Neyveli.
 - Karnataka plateau
 - Tamilnadu upland

▪ **The South-Western Belt:**

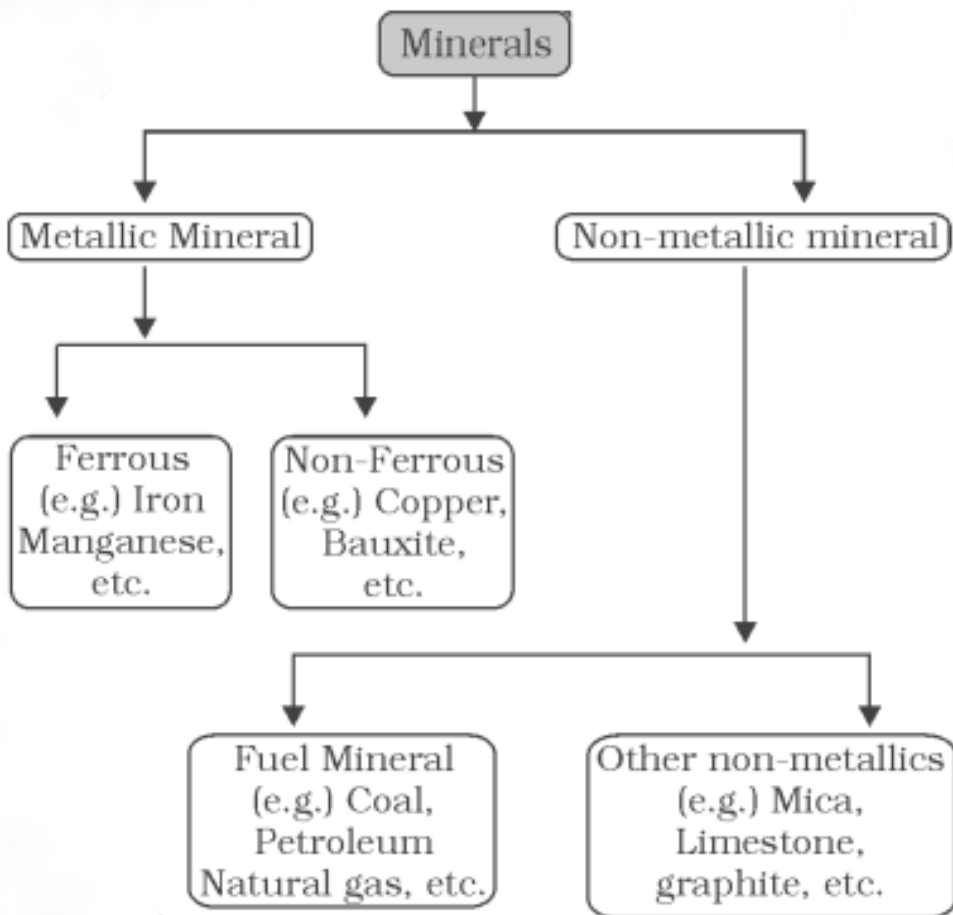
- Rich in iron ore, garnet and clay
 - Western Karnataka
 - Goa

▪ **The North-Western Belt:**

- Rich in non-ferrous metals such as **copper, lead, zinc, along with uranium, mica, beryllium and precious stones**
 - Aravalli, Rajasthan
 - Gujarat

What are the Different Types of Minerals?

- Minerals may be divided into two categories: metallic minerals and non-metallic minerals.



▪ **Metallic Minerals:**

- These minerals contain metal content. These minerals are extracted to obtain metals. Since they offer metals in their purest form, they are exceedingly precious. It can be subdivided into three types:

- **Ferrous metals:**

- Ferrous minerals such as **iron ore, manganese, chromite**, etc., provide a strong base for the development of metallurgical industries. Our country is well-placed in respect of ferrous minerals both in reserves and production.

- **Iron Ore:**

- India is endowed with fairly abundant resources of iron ore. The two main types of ore found in our country are hematite and magnetite.
- The **iron ore mines** occur in close proximity to the coal fields in the **northeastern plateau region**.
- About 95 per cent of total reserves of iron ore is located in the **States of Odisha, Jharkhand, Chhattisgarh, Karnataka, Goa, Telangana, Andhra Pradesh and Tamil Nadu**.
- In Odisha, iron ore occurs in a series of hill ranges in **Sundergarh, Mayurbhanj and Jhar**.

- **Jharkhand** has some of the oldest iron ore mines and most of the iron and steel plants are located around them.
- Most of the important mines such as **Noamundi** and **Gua** are located in **Poorbi and Pashchimi Singhbhum districts**.
- This belt further extends to **Durg, Dantewara and Bailadila**.
- **In Karnataka**, iron ore deposits occur in **Sandur-Hospet area of Ballari district, Baba Budan hills and Kudremukh in Chikkamagaluru district and parts of Shivamogga, Chitradurg and Tumakuru districts**.
- The districts of **Chandrapur, Bhandara and Ratnagiri** in **Maharashtra**, **Karimnagar** and **Warangal** district of **Telangana**, **Kurnool, Cuddapah** and **Anantapur districts of Andhra Pradesh**, **Salem and Nilgiris** districts of **Tamil Nadu** are other iron mining regions.
- **Goa** has also emerged as an important producer of **iron ore**.

- **Manganese:**

- **Manganese** is an important **raw material** for **smelting iron ore** and also used for manufacturing **ferro alloys**. Manganese deposits are found in almost all geological formations. However, it is mainly associated with **Dharwar system**.
- **Odisha** is the leading producer of **Manganese**. Major mines in Odisha are located in the central part of the **iron ore belt of India**, particularly in **Bonai, Kendujhar, Sundergarh, Gangpur, Koraput, Kalahandi and Bolangir**.

- **Non-ferrous metals:**

- India is poorly endowed with non-ferrous metallic minerals except bauxite. Include metals like copper, lead, zinc, tin, aluminum etc.

- **Bauxite:**

- It is ore, which is used in manufacturing **aluminum**.
- **Bauxite** is found mainly in tertiary deposits and is associated with laterite rocks occurring extensively either on the **plateau** or hill ranges of peninsular India and also in the coastal tracts of the country.
- **Odisha** happens to be the largest producer of Bauxite. **Kalahandi** and **Sambalpur** are the leading producers. The other two areas which have been increasing their production are **Bolangir** and **Koraput**.
- The **patlands of Lohardaga** in **Jharkhand** have rich deposits.
- **Gujarat, Chhattisgarh, Madhya Pradesh** and **Maharashtra** are other major producers.
- **Chhattisgarh** has bauxite deposits in **Amarkantak plateau**.

- **Copper:**

- **Copper** is an indispensable metal in the **electrical industry** for making **wires, electric motors, transformers and generators**.
- The **Copper deposits** mainly occur in **Singhbhum district in Jharkhand, Balaghat district in Madhya Pradesh** and **Jhunjhunu and Alwar districts in Rajasthan**.
- Minor producers of **copper** are **Agnigundala** in **Guntur District, Andhra Pradesh, Chitradurg** and **Hasan districts, Karnataka** and **South Arcot district, Tamil Nadu**.

- **Non- Metallic Minerals:**

- Among the **non-metallic minerals** produced in India, **mica** is the important one. The other minerals extracted for local consumption are **limestone, dolomite** and **phosphate**.
- Minerals that don't contain metals are referred to as non-metallic minerals. To create coatings and insulating materials, they are utilized in a variety of sectors.
- India is poorly endowed with non-ferrous metallic minerals except **bauxite**.
- **Mica:**
 - **Mica** is mainly used in the electrical and electronic industries.
 - It can be split into very thin sheets which are tough and flexible.

- **Mica** in India is produced in **Jharkhand, Andhra Pradesh, Telangana Rajasthan, Tamil Nadu, West Bengal** and **Madhya Pradesh**.
- In **Jharkhand**, high quality mica is obtained in a belt extending over a distance of about **150 km** in length and about **22 km**, in width in lower **Hazaribagh plateau**.
- **Sulfur, phosphates** and **nitrates** are examples of **non-metallic minerals**.
- They are employed in the creation of **fertilizer and cement**.
- **Cement** is a mixture of **non-metallic minerals**.

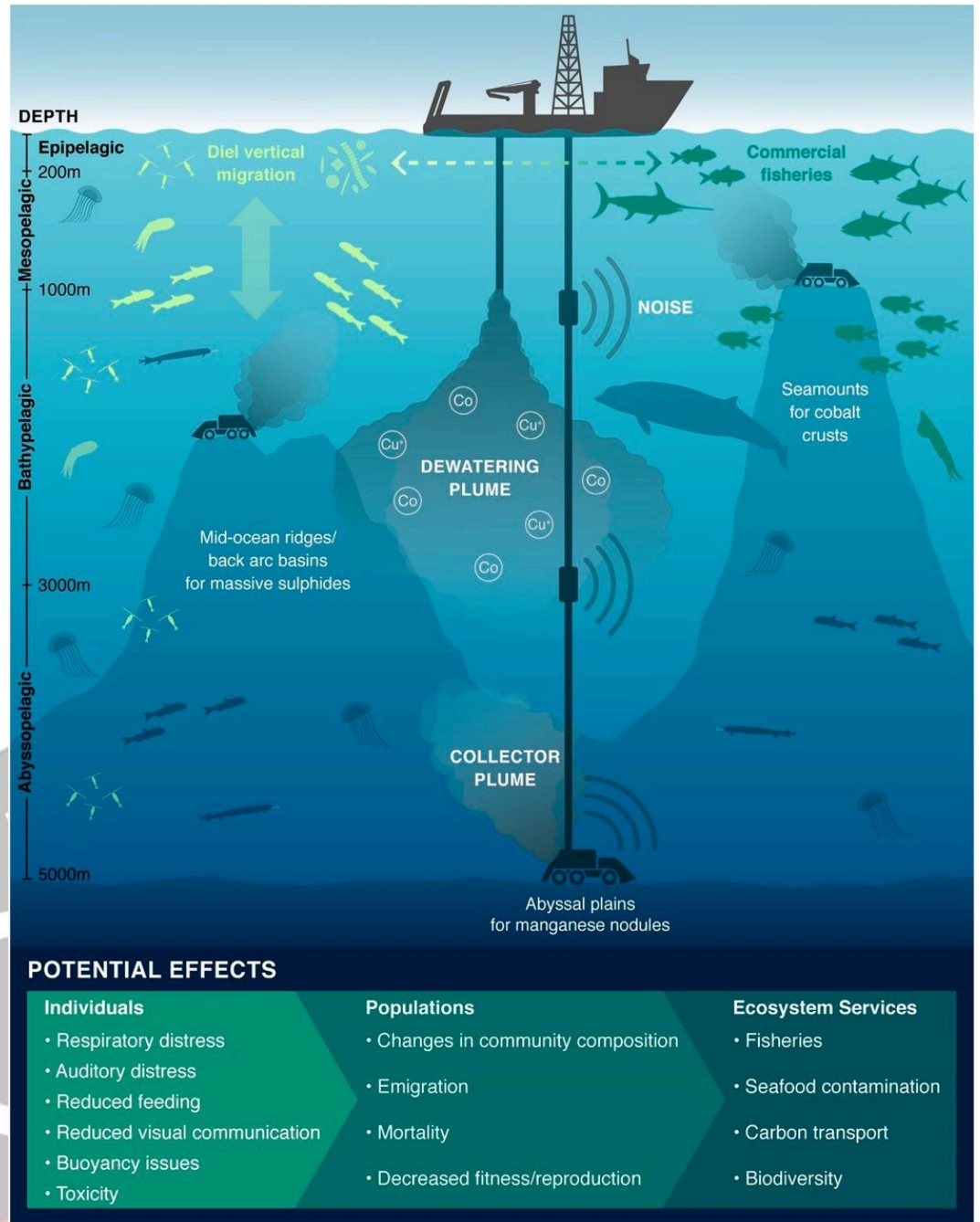
▪ **Energy Resources:**

- Mineral fuels are essential for generation of power, required by **agriculture, industry, transport** and other sectors of the economy.
- **Mineral fuels** like **coal, petroleum and natural gas (known as fossil fuels), nuclear energy minerals**, are the conventional sources of energy.
- These conventional sources are exhaustible resources.
- **Coal:**
 - Coal is one of the important minerals which is mainly used in the generation of **thermal power** and **smelting of iron ore**.
 - Coal occurs in rock sequences mainly of two geological ages, namely **Gondwana and tertiary deposits**.
 - About **80 per cent** of the coal deposits in India is of **bituminous type** and is of **non-coking grade**.
 - The most important **Gondwana coal** fields of India are located in **Damodar Valley**.
 - They lie in **Jharkhand-Bengal coal belt**.
 - Important coal fields in this region are **Raniganj, Jharia, Bokaro, Giridih, Karanpura**.
 - **Jharia** is the **largest coal field** followed by **Raniganj**.
 - The other river valleys associated with **coal** are **Godavari, Mahanadi and Sone**.
 - **Tertiary coals** occur in **Assam, Arunachal Pradesh, Meghalaya** and **Nagaland**.
 - Besides, the **brown coal** or **lignite** occur in the **coastal areas** of **Tamil Nadu, Puducherry, Gujarat** and **Jammu and Kashmir**.
- **Petroleum:**
 - **Crude petroleum** consists of **hydrocarbons of liquid and gaseous states** varying in **chemical composition, color** and **specific gravity**.
 - It is an **essential source of energy** for all **internal combustion engines** in **automobiles, railways** and **aircraft**.
 - Its numerous by-products are processed in **petrochemical industries**, such as **fertilizer, synthetic rubber, synthetic fiber, medicines, Vaseline, lubricants, wax, soap** and **cosmetics**.
 - **Crude petroleum** occurs in **sedimentary rocks** of the **tertiary period**.
 - In **Assam, Digboi, Naharkatiya** and **Moran** are important oil producing areas.
 - The major oilfields of **Gujarat** are **Ankaleshwar, Kalol, Mehsana, Nawagam, Kosamba and Lunej**.
 - **Mumbai High**, which lies 160 km off Mumbai was discovered in **1973** and production commenced in **1976**.
 - **Oil and natural gas** have been found in **Krishna-Godavari and Kaveri basin on the east coast**.
 - **There are two types of refineries in India:**
 - **Field-based**
 - **Market-based**
 - **Digboi** is an example of field based and **Barauni** is an example of market-based refinery.
- **Natural Gas:**
 - **Natural Gas** is found with **petroleum deposits** and is released when crude oil is brought to the surface.
 - It can be used as a **domestic** and **industrial fuel**.
 - It is used as fuel in the power sector to generate electricity for heating purposes in industries as raw material in chemical, petrochemical and fertilizer industries.
 - **Natural gas** is also emerging as a preferred transport fuel (**CNG**) and **cooking**

fuel (PNG) in homes.

- India's major gas reserves are found in the **Mumbai High** and allied fields along the west coast which are supplemented by finds in the **Cambay basin**.
- Along the East Coast, new reserves of natural gas have been discovered in the **Krishna-Godavari basin**.

▪ **Oceanic Minerals:**



- Polymetallic nodules and polymetallic massive sulphides are the two mineral resources of primary interest in the Indian Ocean.
- Massive sulphide deposits of manganese, copper, iron, zinc, silver, and gold, as well as nodules of nickel, cobalt, and iron, are present in significant numbers on the sea bottom.
- The Indian Ocean's coastal sediments are rich in titanium, zirconium, tin, zinc, and copper.
- Rare earth elements exist, even though commercial extraction is not always feasible.

UPSC Civil Services Previous Year Questions (PYQ)

Mains

Q. Critically evaluate the various resources of the oceans which can be harnessed to meet the resource crisis in the world. **(150 words)**

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