# 1. Introduction to Minerals

A **mineral** is defined as a natural substance of either organic or inorganic origin, characterized by definite chemical and physical properties. The availability of these resources provides the necessary base for industrial development in a country.

### I. Classification of Minerals

On the basis of their chemical and physical properties, minerals are broadly grouped into two main categories: **Metallic** and **Non-Metallic**.

- **Metallic Minerals:** These are the sources of metals and are further subdivided into:
  - **Ferrous:** Minerals containing iron, such as iron ore and manganese.
  - **Non-Ferrous:** Minerals that do not contain iron, such as copper and bauxite.

- **Non-Metallic Minerals:** These are classified based on their origin:
  - **Organic Origin:** Also known as **mineral fuels** or fossil fuels, derived from buried animal and plant life (e.g., coal and petroleum).
  - **Inorganic Origin:** Includes minerals like mica, limestone, and graphite.

### II. Key Characteristics of Minerals

1. **Uneven Distribution:** Minerals are not spread uniformly over the earth's surface.

2. **Inverse Quality-Quantity Relationship:** There is an inverse relationship between the quality and quantity of minerals; high-quality minerals are generally available in smaller quantities than low-quality ones.

3. **Exhaustibility:** All minerals are exhaustible. They take millions of years to develop geologically and cannot be replenished immediately once used.

# 2. Distribution of Minerals in India

The majority of India's metallic minerals are found in the **peninsular plateau region** within old crystalline rocks. Most of the country's major mineral resources occur to the **east of a line linking Mangaluru and Kanpur**.

### I. Major Mineral Belts in India

Minerals are generally concentrated in three broad belts:

1. **The North-Eastern Plateau Region:**
   - **Coverage:** Chhotanagpur (Jharkhand), Odisha Plateau, West Bengal, and parts of Chhattisgarh.
   - **Minerals:** This is a rich belt containing iron ore, coal, manganese, bauxite, and mica.

2. **The South-Western Plateau Region:**
   - **Coverage:** Karnataka, Goa, and contiguous uplands of Tamil Nadu and Kerala.
   - **Minerals:** Rich in ferrous metals and bauxite. It contains high-grade iron ore, manganese, and limestone.
   - **Note:** This belt lacks diversified mineral deposits compared to the North-Eastern belt and specifically lacks coal, except for **Neyveli lignite**.

3. **The North-Western Region:**
   - **Coverage:** Extends along the **Aravali range** in Rajasthan and parts of Gujarat.
   - **Minerals:** Associated with the **Dharwar system of rocks**. Key minerals include copper and zinc. Rajasthan is rich in building stones (sandstone, granite, marble) and gypsum. Gujarat is known for its petroleum deposits, and both states are rich sources of salt.

*The Himalayan belt is another emerging zone where copper, lead, zinc, cobalt, and tungsten are known to occur.*

# 3. Detailed Study of Metallic Minerals

### I. Ferrous Minerals

These provide a strong base for the development of metallurgical industries.

- **Iron Ore:**
  - India has the **largest reserve of iron ore in Asia**.
  - **Types:** The two main types found are **haematite** and **magnetite**.
  - **Distribution:** About 95 per cent of reserves are in Odisha, Jharkhand, Chhattisgarh, Karnataka, Goa, Telangana, Andhra Pradesh, and Tamil Nadu.
  - **Key Mines:** Gurumahisani and Badampahar (Odisha); Noamundi and Gua (Jharkhand); Bailadila (Chhattisgarh); and Kudremukh (Karnataka).

- **Manganese:**
  - Primarily used for **smelting iron ore** and manufacturing ferro-alloys.
  - **Geology:** Mainly associated with the Dharwar system.
  - **Leading Producers:** Madhya Pradesh and Odisha. Major mines include Balaghat (MP) and Bonai (Odisha).

### II. Non-Ferrous Minerals

India is generally poorly endowed with these, except for bauxite.

- **Bauxite:**
  - The ore used to manufacture **aluminium**.
  - **Geology:** Found in tertiary deposits associated with laterite rocks.
  - **Leading Producer: Odisha** (Kalahandi and Sambalpur districts). Other producers include Lohardaga (Jharkhand) and Bhavanagar (Gujarat).

- **Copper:**
  - Indispensable for the electrical industry due to its malleability and ductility.
  - **Distribution:** Occurs in Singhbhum (Jharkhand), Balaghat (MP), and Jhunjhunu/Alwar (Rajasthan).



# 4. Non-Metallic Minerals

- **Mica:**
  - Used extensively in **electrical and electronic industries** because it can be split into thin, tough, flexible sheets.
  - **Distribution:** Produced in Jharkhand, Andhra Pradesh, Telangana, and Rajasthan.
  - **Key Belts:** A 150-km belt in lower Hazaribagh (Jharkhand) and the Nellore district (Andhra Pradesh), which produces the best quality mica.

# 5. Energy Resources

Energy is required for all sectors of the economy, including agriculture, industry, and transport.

**I. Conventional Energy Sources (Exhaustible)**
These rely on exhaustible raw materials.

- **Coal:**
  - Used for thermal power and iron ore smelting.
  - **Geological Ages:** Occurs in Gondwana and Tertiary deposits.
  - **Gondwana Coal:** Accounts for **80 per cent** of deposits; it is bituminous and non-coking. The most important fields are in the **Damodar Valley** (Jharkhand-Bengal belt). **Jharia** is the largest coal field.
  - **Tertiary Coal:** Found in Assam, Arunachal Pradesh, Meghalaya, and Nagaland.
  - **Lignite:** Brown coal found in coastal Tamil Nadu, Gujarat, and J&K.

- **Petroleum:**
  - Referred to as **"Liquid Gold"**.
  - **Geology:** Occurs in sedimentary rocks of the tertiary period.
  - **History:** Systematic exploration began after the **ONGC** was set up in 1956.
  - **Fields:** Digboi (Assam) was the first; others include Ankaleshwar (Gujarat) and **Mumbai High** (off-shore).
  - **Refineries:** Divided into **field-based** (e.g., Digboi) and **market-based** (e.g., Barauni).

- **Natural Gas:**
  - Released when crude oil is brought to the surface.
  - **Uses:** Domestic/industrial fuel, power sector, and transport fuel (CNG).
  - **Infrastructure:** The **HVJ Pipeline** (Hazira-Vijaipur-Jagdishpur) is a major link connecting gas fields to markets.

- **Nuclear Energy:**
  - Minerals used: **Uranium** (found in Dharwar rocks, Singhbhum, and parts of Rajasthan) and **Thorium** (obtained from monazite in Kerala and Tamil Nadu beach sands).
  - **Timeline:** Atomic Energy Commission established in 1948; Bhabha Atomic Research Centre renamed in 1967.
  - **Projects:** Tarapur (Maharashtra), Rawatbhata (Rajasthan), Kalpakkam (Tamil Nadu), Narora (UP), Kaiga (Karnataka), and Kakarapara (Gujarat).

**II. Non-Conventional Energy Sources (Sustainable)**

These are renewable, equitably distributed, and environment-friendly.

- **Solar Energy:** Tapped via photovoltaics or solar thermal technology. Western India (Gujarat/Rajasthan) has the highest potential.

- **Wind Energy:** Pollution-free and inexhaustible. Kinetic energy is converted via turbines. Rajasthan, Gujarat, and Maharashtra have favourable conditions.

- **Tidal and Wave Energy:** Oceans are store-houses of energy; large waves occur along India's west coast, but this potential remains largely unutilised.

- **Geothermal Energy:** Tapping heat from magma or hot springs. A plant is commissioned at **Manikaran** in Himachal Pradesh.

- **Bio-energy:** Derived from biological products like agricultural and municipal waste. It reduces pressure on fuelwood and

environmental pollution (e.g., the Okhla project in Delhi).


## 6. Mining Methods

The profitability and method of mining depend on physical factors (size/grade of deposit) and economic factors (demand, technology, capital).

1. **Surface Mining (Open-cast/Strip Mining):** The easiest and cheapest method for minerals close to the surface. It has low overhead costs and rapid output.
2. **Underground Mining (Shaft Method):** Used when ore lies deep below the surface. It involves sinking vertical shafts and building underground galleries. It is **risky** due to potential poisonous gases, fires, floods, and cave-ins.

## 7. Conservation of Mineral Resources

Sustainable development requires the protection of resources for future generations.

- **Strategies for Conservation:**
  - Developing **alternative energy sources** (solar, wind, etc.) to replace exhaustible ones.
  - **Recycling metals** using scrap, which is vital for minerals where India has meagre reserves (e.g., copper, lead, zinc).
  - Using **substitutes** for scarce metals.
  - Reducing the export of strategic and scarce minerals to extend the life of existing reserves.

**Summary Table for CUET Preparation**

| Mineral/Resource | Primary Use | Leading States/Regions |
|---|---|---|
| **Iron Ore** | Steel manufacture | Odisha, Jharkhand, Chhattisgarh |
| **Manganese** | Smelting/Ferro-alloys | Madhya Pradesh, Odisha |
| **Bauxite** | Aluminium production | Odisha (Kalahandi/Sambalpur) |
| **Copper** | Electrical industry | Jharkhand, MP, Rajasthan |
| **Mica** | Electronics/Electrical | Andhra Pradesh (Nellore), Rajasthan |
| **Coal** | Thermal power/Smelting | Damodar Valley (Jharia/Raniganj) |
| **Petroleum** | Energy/Petrochemicals | Mumbai High, Gujarat, Assam |
| **Solar/Wind** | Renewable electricity | Gujarat, Rajasthan |
| **Nuclear** | Clean power | Tarapur, Kalpakkam, Narora |