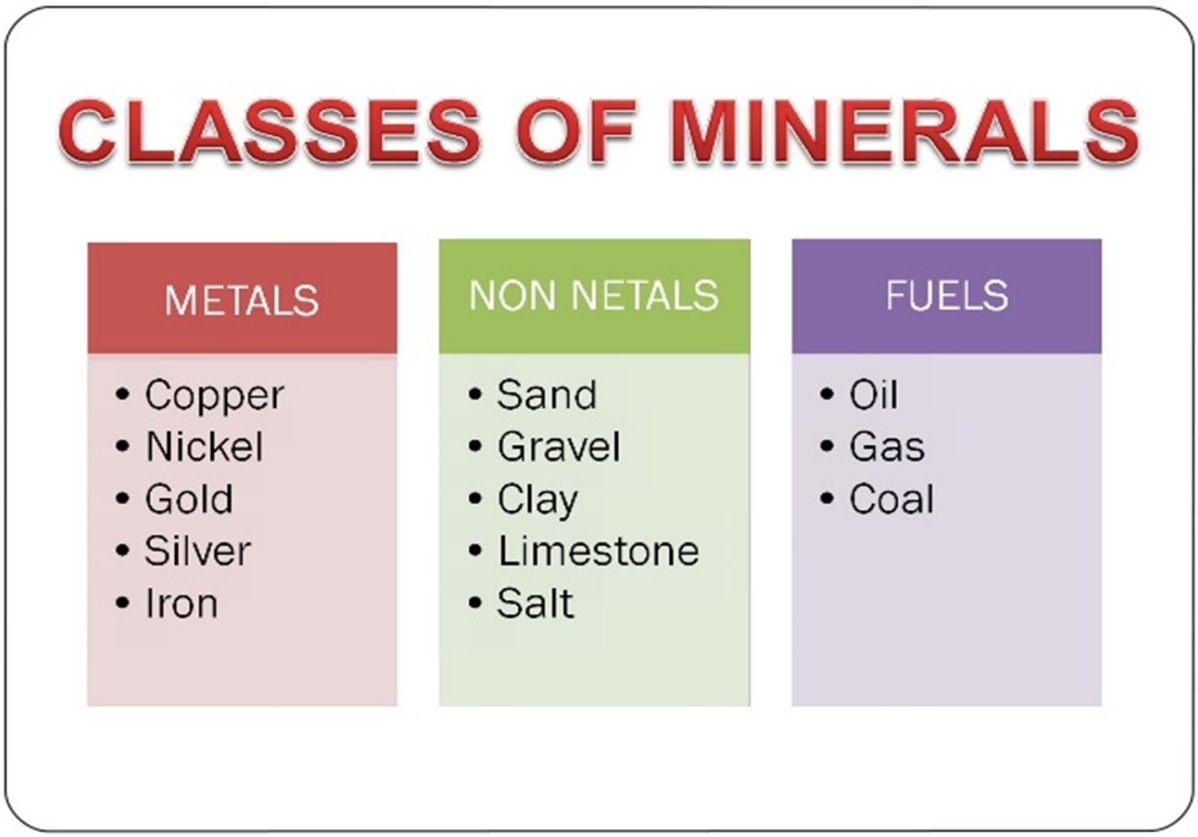
Mineral Resources

Natural resources play a vital role in supporting all activities of the life on earth. Without using any of natural resources, we cannot survive. Mineral resources are basic resources required by all societies. They are the basis for almost every product and material we use in our daily lives. They are the stuff from which a modern industrialized society is built. Essentially all are non-renewable on a human time scale. Have a limited amount of them. Have to exploit them in a sustainable fashion if we are not to run out.

Minerals are naturally occurring, inorganic, crystalline solids having a definite chemical composition and characteristic physical properties.

An ore is a mineral or combination of minerals from which a useful substance such as a metal can be extracted and used to manufacture a useful product.



Based on their properties, minerals are basically of two types.

1. Fuel Minerals: Oil, gas, coal
2. Non-metallic minerals: graphite, diamond, quartz, feldspar
3. Metallic Minerals: bauxite, chalcopyrite, hematite etc

India is the producer of 84 minerals the annual value of which is about Rs. 50,000 crores.

Types of Mineral Resources

1. **Fuel Minerals**
   i) Coal
   ii) Crude oil/petroleum
   iii) Natural gas

Fuels are used to produce energy required for all the activities in modern life.

2. **Metallic Resources**
   i) Iron ore(Hematite)-principal metallic ore in India
   ii) Lead and Zinc-batteries
   iii) Copper-Electrical
   iv) Bauxite-Aluminum
   v) Manganese and Chromite-Steel
   vi) Gold and Silver-electronics

3. **Non-metallic Resources**

i) Dolomite-$CaMg(CO_3)_2$-ingredients for glass, bricks and ceramics
ii) Lime stone-cement
iii) Mica
iv) Gypsum, plaster of paris, wall board
v) Quartz
vi) Diamond
vii) Other precious and semiprecious gem stone

Metallic minerals can be melted to obtain new products whereas non-metallic minerals do not yield new products on melting.

The main uses of minerals are as follows:

- (i) Development of industrial plants and machinery.
- (ii) Energy Source: coal, lignite, uranium.
- (iii) Construction, housing, settlements.: Iron,
- (iv) Defence equipment-weapons, armaments.
- (v) Transportation means.; Rail, Vehicle
- (vi) Communication- telephone wires, cables, electronic devices.
- (vii) Medicinal system- Ayurvedic/Allopathic System: Ag, Au,Zn
- (viii) Formation of alloys for various purposes (e.g., Bronze, Brass).
- (ix) Agriculture: fertilizers, seed dressings and fungicides (e.g.
- zineb containing zinc, Maneb-containing manganese etc.).
- (x) Jewelry: Gold, silver, platinum, diamond.

<u>Availability of different minerals in India</u>

- (a) Energy generating minerals: Coal and lignite: West Bengal, Jharkhand, Orissa, M.P., A.P.
- Uranium (Pitchblende or Uranite ore): Jharkhand, Andhra Pradesh (Nellore, Nalgonda), Meghalaya, Rajasthan (Ajmer).
- (b) Other commercially used minerals Aluminium (Bauxite ore): Jharkhand, West Bengal, Maharashtra, M.P., Tamilnadu.
- Iron (haematite and magnetite ore): Jharkhand, Orissa, M.P., A.P., Tamilnadu, Karnataka, Maharashtra and Goa.
- Copper (Copper Pyrites): Rajasthan (Khetri), Bihar, Jharkhand, Karnataka, M.P., West Bengal, Andhra Pradesh and Uttarnchal.

Iron ore: India possesses over 20% of world's total reserves of iron. Iron ore of very good quality is obtained from principal areas in Orissa and Singbhum district of Bihar. Besides there iron ore is obtained from Durg in Madhya Pradesh, Saleem in Tamil Nadu, some parts of Karnatak etc.

Bauxite: Important bauxite deposits occur in Bihar, Goa, Gujrat, Jammu and Kashmir, Karnataka, Madhya Pradesh, Odisha and Tamil Nadu

Mica: India is the largest producer of mica in the world and the largest supply comes from Bihar. In Bihar, most of the areas are Gaya and Hazirabag. Another important area is Nellore in Andhra Pradesh, some parts of Rajastan etc.

Coal: India is one of the principal producers of coal in the world. Bihar and West Bengal produce the largest quantity of good quality coal. Besides this, coal is found in Odisha, Madhya Pradesh, and Andhra Pradesh.

Petroleum: It is also called mineral oil or crude oil. It is dark, thick liquid found at a great depth under the rocks of the sea bed. We get petrol, diesel, kerosene oil, wax, Vaseline and tar when petroleum is refined. Petroleum is known as black gold. Petroleum is found at Digboi of Assam, Bombay high off the sea shore of Bombay.

Manganese: Manganese is used in the manufacture of steel. It is also used in chemicals and glass industries. India is the largest producer of manganese in the world.

Copper: It is a valuable metal. Being a good conductor of electricity, it is used for making electric wires and electric and electrical appliances.

How do we exploit mineral resources?

Surface mining: Shallow overburden removed and discarded with other material not wanted or processed (**spoil**). It is now the most common form of mining in the U.S. It is becoming even more popular (for example, in coal mining) because it is relatively inexpensive. Can be done in **open-pits** or **quarries**, by **dredging** (in water), and by **strip mining** (either area, where flat, or contour, where hilly).

Subsurface mining: Relatively deep vertical, inclined, or horizontal shafts dug underground. Disturbs much less (~10%) land than surface techniques and produces less waste material. However, it is a much more expensive and dangerous (mine collapse and inhalation diseases) technique, while also being much less efficient.

Environmental Impacts of Extracting and Using Mineral Resources

Depending on the particular resource, method of extraction, processing technology, and mode of use exploiting mineral resources can cause a large amount of land disturbance, air and water pollution, erosion, and use of energy. But we need these things to have a modern technological society.

A. Mining pollution

Mining typically results in surface disruption, loss of habitats, and water pollution. Underground mines can collapse and waste materials may pollute surrounding streams and the air. Acid (sulfuric) mine drainage often a problem if sulfate or sulfide minerals being extracted. Toxic metals (Pb, Hg, As, Cd) can be leached from their source by the action of acidic waters.

Initial processing of the ore (**milling**) often leads to large amounts of waste (**gangue**) rock being separated. Placed in open **tailings piles** that can pollute the air and water and also be a landslide hazard.

Smelting (separation from host mineral) to concentrate desired material often produces large amounts of air pollution, which can cause acid deposition and the release of toxic metals. Create **dead zones** around large smelting areas (Sudbury, Ontario). Large, short-term outlays to reduce pollution can lower long-term costs.

Environmental Impacts of Mining

- Acid Mine Drainage
- Erosion and Sedimentation
- Cyanide & Other Toxic Releases
- Dust Emissions
- Habitat Modification
- Surface and Groundwater Contamination
- Strip mining causes severe soil erosion and chemical runoff

Impact of mining

(i) Devegetation and defacing of landscape: The topsoil as well as the vegetation are removed deforestation leads to several ecological losses, increase the landscape. prone to soil erosion.

(ii) Subsidence of land: Mainly associated with underground mining which results in tilting of buildings, cracks in houses, buckling of roads, bending of rail tracks and leaking of gas from cracked pipelines leading to serious disasters.

(iii) Groundwater contamination:

Mining disturbs the natural hydrological processes and also pollutes the groundwater. Sulphur, usually present as an impurity in many ores is known to get converted into sulphuric acid

through microbial action, thereby making the water acidic. Some heavy metals also get leached into the groundwater and contaminate it posing health.

iv) Surface water pollution: The acid mine drainage often contaminates the nearby streams and lakes. Sometimes uranium, Cr, Pb, Cd, As contamination by mine wastes kill aquatic animals and creating human health hazards. Heavy metal pollution of water bodies near the mining areas is a common feature creating health hazards.

Acid drainage

Sub-surface mining frequently goes below the water table so water must be constantly pumped from the mine. Acid mine drainage results from the outflow of water from metal mines, coal mines, or other areas in which the ground has been disturbed. Metal salts, such as Fe^{+2}, are oxidized upon contact with air to more highly acidic aquo species. Sulfur containing molecules are air oxidized to sulfuric acid. Certain bacteria, called acidophiles, promote the oxidation of iron sulfides in the presence of oxygen and water.

$$2FeS_{2(s)} + 7O_{2(g)} + 2H_2O_{(l)} \longrightarrow 2Fe^{2+}_{(aq)} + 4SO_4^{2-}{}_{(aq)} + 4H^{+}_{(aq)}$$

(sulfide minerals on exposed rock surfaces react with oxygen and rainwater to produce sulfuric acid)

Toxic Inorganic Pollutants

Mining operations release heavy metals that can be extracted by water. Depending on the mine and its location, Ni, V, Cr, Mn, Cu, Pb, Zn and As can be released into the hydrosphere.

Mercury

Mercury was widely used to in California gold mines to extract the precious metal from solid ore. Between the years 1850 and 1981, more than 220,000,000 lb of mercury was used in mining in that state.

Cyanide

Cyanide salts are widely used to extract gold from finely crushed ore because they combine with about 97% of the elemental gold. Typically, the NaCN solution is sprayed on heaps of ore and the liquid extract is collected. Of course, a great deal of the toxic cyanide salt remains on the mineral partials and is washed into ground and surface water in the rain.

$$4\ Au + 8\ NaCN + O_2 + 2\ H_2O \longrightarrow 4\ NaAu(CN)_2 + 4\ NaOH$$

Once the gold has been extracted, zinc is used to recover solid gold from solution:

$2\ Au(CN) + Zn \longrightarrow 2\ Au + Zn(CN)_4^{-2}$

Arsenic

Arsenic containing minerals are exposed to surface water during mining. Arsenite ($H_2AsO_3^-$) is the more serious problem because of its high solubility in water.

Occupational health hazards

Most of the miners suffer respiratory diseases like asbestosis, silicosis, black lung etc. and skin diseases due to constant exposure to the suspended particulate matter and toxic substances.

On an average, there are 30 non-fatal but disabling accidents per ton of mineral produced and one death per 2.5 tons of mineral produced.

Besides this, the following environmental problems also arises with mining

- Mountaintop removal causes enormous damage
- Subsurface mining is harmful to human health
- Mine shaft collapses
- Inhalation of coal dust can lead to fatal black lung disease
- Costs to repair damages of mining are very high
- These costs are not included in the market prices of fossil fuels, which are kept inexpensive by government subsidies
- Mining companies must restore landscapes, but the impacts are still severe
- Looser of restrictions in 2002 allowed companies to dump rock and soil into valleys, regardless of the consequences
- Gold is treated with a Cyanide compound which produces a Gold-Cyanide complex which is soluble

Major mines causing severe Environmental problems

- i) Jaduguda Uranium Mine: , Jharkhand.exposing local people to radioactive hazards.
- (ii) Jharia coal mines: Jharkhand.underground fire leading to land subsidence and forced displacement of people.
- (iii) Sukinda chromite mines, Orissa. seeping of hexavalent chromium into river posing serious health hazard, Cr^{6+} being highly toxic and carcinogenic.
- (iv) Kudremukh iron ore mine, Karnataka.causing river pollution and threat to biodiversity.
- (v) East coast Bauxite mine, Orissa.Land encroachment and issue of rehabilitation unsettled.
- (vi) North-Eastern Coal Fields: Assam.Very high sulphur contamination of groundwater.

How can mining become more environmentally sustainable?(Preventive Measures)

It is a vital industry which contributes to the economy of many countries simultaneously it is also damaging the environment.

There are ways that mining companies can become more environmentally sustainable as outlined below.

Reduce inputs

The mining industry uses a large amount of water and land in their operations. One solution to becoming more environmentally sustainable is to reduce the input of the mine. By diverting surface water and pumping groundwater, mines can reduce both the quantity and quality of water available downstream for aquatic ecosystems and other use.

- The energy consumed by the mining sector can be modified using alternative resources like solar energy or wind power.
- By reducing the energy usage, a mine can reduce greenhouse gases and extend the life of fossil fuel reserves.

Reduce outputs

- Mining produces materials such as solid waste, mine water and air particles, all of which vary in their makeup and potential for environmental contamination.
- Waste management plans are required in order to prevent soil, air and water pollution.
- These plans are also in place to appropriately store the large volumes of waste produced at mine sites.
- To reduce waste output, environmentally friendly modern equipment can be used.

Proper waste disposal

- Correct waste disposal is vital to curbing the environmental impact of mines, as some mining companies do not dispose of their waste according to guidelines.
- Water can be reused on mining sites as grey water for washing equipment or flushing staff toilets.
- Scrap materials can be recycled or sold to companies who can reuse them in order to reduce the amount of waste produced on site.
- Improving the manufacturing process
- The efficiency of the mining process can often leave much to be desired, but improving the efficiency of this process can help towards lessening the environmental impact. This also allows companies to regulate processes which may be lacking in environmental friendliness.

Other preventive measures are

1. Top soil replacement using uncontaminated soil
2. Reintroduction of flora and fauna
3. Neutralizing acidic waters
4. Backfilling and sealing of abandoned underground mines
5. Stabilizing the slope to reduce erosion

CONCLUSION

- Mineral deposits in the earth are limited.
- We should use them carefully.
- We should not exhaust all of our resources un-thoughtfully.
- We should find some alternative to minerals.
- We should use solar, wind and water energy as an alternative to coal and petrol.