Course Code:MCC102A
Course Title:Environmental Studies

Lecture No: 5

Title: Mineral resources

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Topics

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

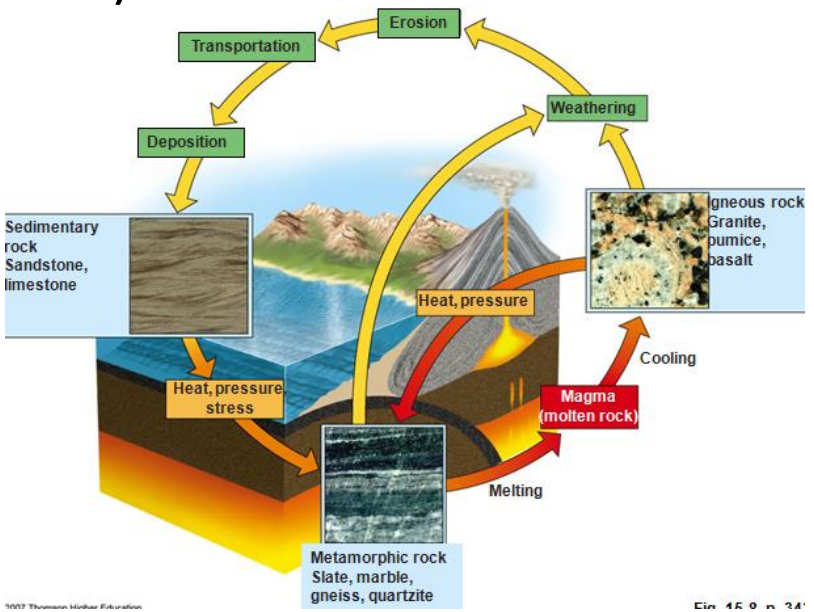
Intended Learning Outcomes

At the end of this lecture, students will be able to

- Classify Mining methods
- Deduce ill-effects of Mining
- Explain the economic and environmental sustainability

Mineral resources

- Deposits of nonrenewable mineral resources in the earth's crust vary in their abundance and distribution.
- A very slow chemical cycle recycles three types of rock found in the earth's crust:
  - Sedimentary rock (sandstone, limestone).
  - Metamorphic rock (slate, marble, quartzite).
  - Igneous rock (granite, pumice, basalt).



Types of Mineral Resources:

- Minerals can be categorized into three classes:
  - Fuel → Constitutes ~87% of the total mineral production
  - Metallic and
  - Non-metallic

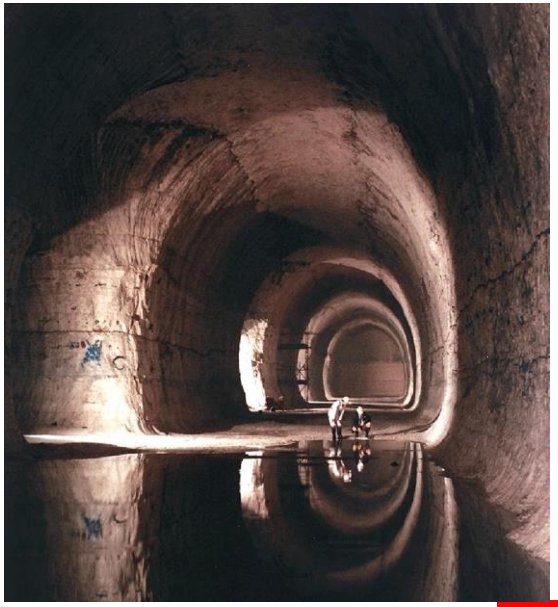
  } Constitutes ~10%

- Fuel : e.g. coal, crude oil and natural gas are the basic fossil fuels.
- Metallic: e.g. iron, copper, and aluminum
- Non metallic: e.g. salt, gypsum, clay, sand, phosphates

Mineral Extraction:

- The process of mineral extraction is called mining.
- Mining is broadly classified into
  - Surface mining: shallow deposits are removed.
  - Subsurface mining: deep deposits are removed.

Surface mining



Subsurface mining

Mining Methods

- Minerals are removed through a variety of methods that vary widely in their costs, safety factors, and levels of environmental harm.
- A variety of methods are used based on mineral depth.
  - **Surface mining**: shallow deposits are removed.
  - **Subsurface mining**: deep deposits are removed.

Mining Methods

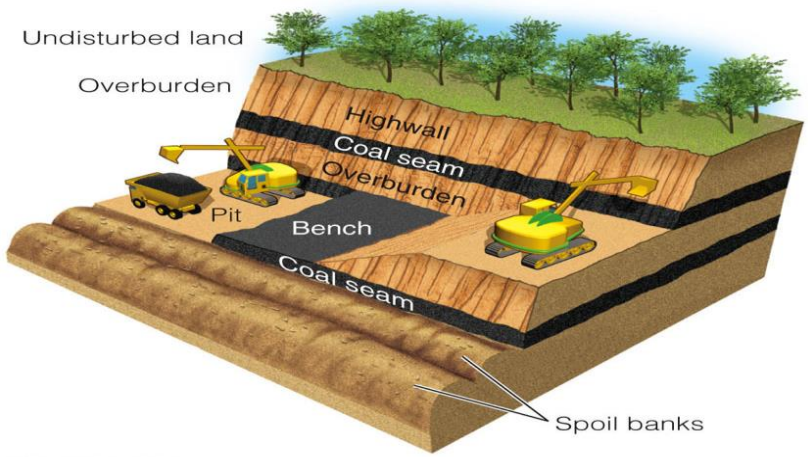
Open-pit Mining

- Machines dig holes and remove ores, sand, gravel, and stone.
- Toxic groundwater can accumulate at the bottom.

Area Strip Mining

- Earth movers strips away overburden, and giant shovels removes mineral deposit.
- Often leaves highly erodible hills of rubble called **spoil banks**.

Mining Methods



Contour Strip Mining

- Used on hilly or mountainous terrain.
- Unless the land is restored, a wall of dirt is left in front of a highly erodible bank called a **highwall**.

Mountaintop Removal

- Machinery removes the tops of mountains to expose coal.
- The resulting waste rock and dirt are dumped into the streams and valleys below.

Subsurface mining: Methods

Room-and-pillar mining

- A network of entries, called rooms, are cut into a seam. Between the rooms, pillars are left standing to support the roof.
- When the mining of rooms is completed, the pillars are then removed, beginning with pillars at the farthest point in the mine.

Longwall Mining

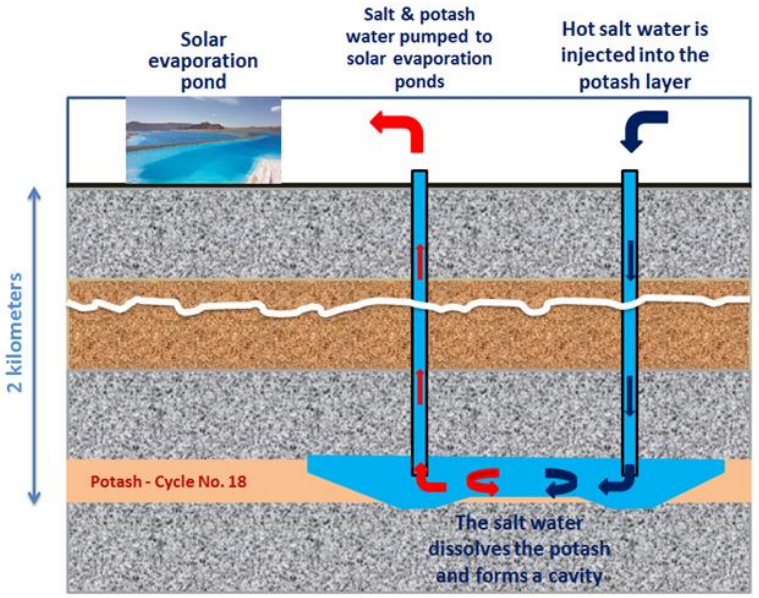
- In longwall mining, a machine called a shearer moves back and forth across the face of a coal seam.
- As coal is sheared from the face, it falls onto a conveyor. The conveyor transports the coal out of the mine.
- A row of hydraulic roof supports protects the miners and the equipment.

Subsurface mining: Methods

Solution Mining

- For underground deposits of soluble mineral ores such as potash, salt, and sulfur, solution mining is an economical mining method.

- In solution mining, hot water is injected into the ore and dissolves it. Compressed air is then pumped into the dissolved ore, and air bubbles lift it to the surface.



Environmental Impacts of Mining

- Acid Mine Drainage
- Erosion and Sedimentation
- Cyanide & Other Toxic Releases
- Dust Emissions
- Habitat Modification
- Surface and Groundwater Contamination

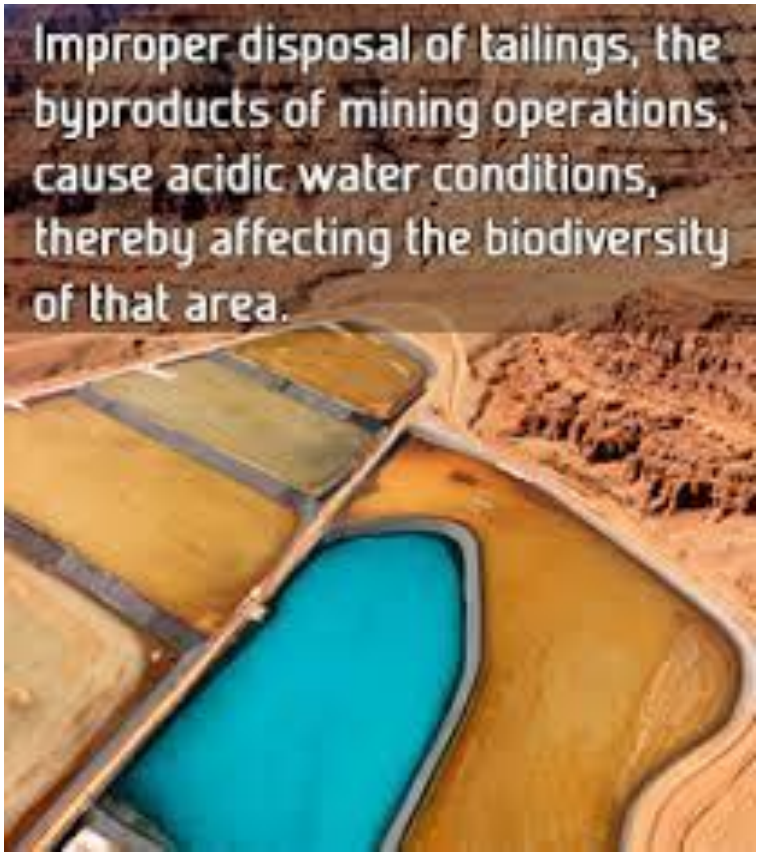
Coal mining affects the environment

Strip mining causes severe soil erosion and chemical runoff

- **Acid drainage** = sulfide minerals on exposed rock surfaces react with oxygen and rainwater to produce sulfuric acid

Environmental Impacts of Mining

- Mountaintop removal causes enormous damage



Environmental Impacts of Mining

Risk	Affected compartments	Released toxic compounds
Overtopping of tailing dam	Groundwater, surface water, soil	Water emissions • In most cases radionuclides, mainly thorium and uranium • Heavy metals • Acids • Flourides Air emissions: • In most cases radionuclides, mainly thorium and uranium • Heavy metals • HF,HCl, SO2 etc.
Collapse of tailing dam due to poor construction	Groundwater, surface water, soil	
Collapse of tailing dam by seismic events	Groundwater, surface water, soil	
Pipe leakage	Groundwater, surface water, soil	
Ground of tailing pond not leak proof	Groundwater	
Waste rock exposed to rainwater	Groundwater, surface water, soil	
Dusts from waste rock and tailings	Air, soil	
No site rehabilitation after cease of mining operation	Land-use, long term contaminated land	
Processing without flue gas filters	Air, soil	
Processing without waste water treatments	Surface water	

Coal mining

- 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

Mining Waste

- Subsidence is a phenomenon where the surface collapses directly above a subsurface mine.
- Spoils are the unwanted rock and other waste left over after mining either on the surface or subsurface
- **Tailings** are the materials left over after the process of separating the valuable fraction from the worthless fraction of an ore.

What to do with the waste?

Incorporate the mine waste into

- Concrete for buildings
- Backfill for roads
- Extraction of other minerals

Case Study…..Granny Smith Gold Mine

- The Granny Smith Gold mine is a joint venture between Delta Gold and Placer Dome, located approximately 25 km south-southwest of the township of Laverton, surrounded by a number of other mines, in the north-eastern goldfields region of Western Australia
- Laverton has a population of about 500 people,

Case Study…..Granny Smith Gold Mine

- The processing plant has been producing gold from ore since 1990. Originally envisaged to have a 10 year lifespan, the discovery of additional gold deposits in 1998 will see another 20 or more years, providing both the company and the community time to find ways to diversify local industry with a goal of a longer term sustainable future.

- Granny Smith Gold Mine aims to encourage beneficial environmental, economic and social outcomes, to relations in both the immediate vicinity of the mine site and with the local community of Laverton.

Case Study….Environmental sustainability

- Revegetation has been planned and designed for both operations and closures.
- The revegetation strategy includes final terrafarming of disturbed land, planting schemes for tailings areas and general rehabilitation of the Granny Smith location
- The seed, save and sow method is used, where original plants at dig sites are de-seeded for propagation and later replanting/reseeding to ensure the integrity of local ecosystems is retained
- With a goal of diversification of the local economy, an experimental crop of 200 olive trees has also been planted and is growing well

Case Study….Environmental sustainability

- Granny Smith has a worm farm for recycling of all cardboard, paper and food scraps on the mine site, thus providing fertility for the olive trees while solving a waste management issue
- The "Ruggies" recycling program initiated in 1997 to reduce material disposed to landfill.
- Material recycled includes steel from mill balls, copper from cables and aluminium from drink cans

Environmental sustainability

- Transport contractors that once returned from minesites to Perth empty are now taking saleable cargoes back with them
- Money raised benefits children's hospital and charities
- All people work voluntarily for the Ruggies Recycling initiative

Economic sustainability

- The mine is working with the community on developing the local economy, so that when the mine eventually closes, the community has alternative means of generating income. Harnessing previously undeveloped local potential is essential to providing a truly sustainable vision for the area
- With this in mind the potential for olive farming, tourism, and crafts sales are being investigated to diversify the local economy

Summary

- Minerals can be categorized into three classes
  - Fuel
  - Metallic
  - Non-metallic

- In surface mining shallow deposits are removed

- In subsurface mining deep deposits are removed

- Coal mining affects the environment and strip mining causes severe soil erosion and chemical runoff.

Summary

- Incorporate the mine waste into
  - Concrete for buildings
  - Backfill for roads
  - Extraction of other minerals