Chapter 15

Geology

Processes, Hazards, and Soils

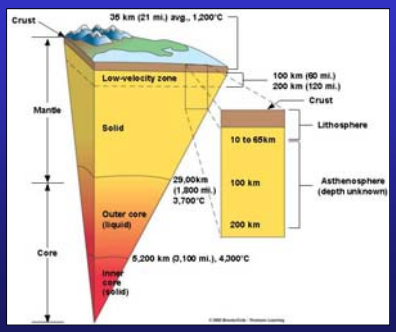
Key Concepts

- Internal geologic processes
- External geologic processes
- Minerals, rocks, and the rock cycle
- Earthquakes and volcanoes
- Soil structure and formation
- Soil conservation

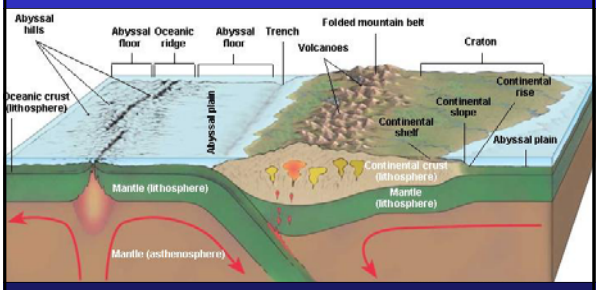
Internal Geologic Processes

- Structure of the Earth
- Features of the Crust
- Plate Tectonics

Structure of the Earth



Features of the Crust



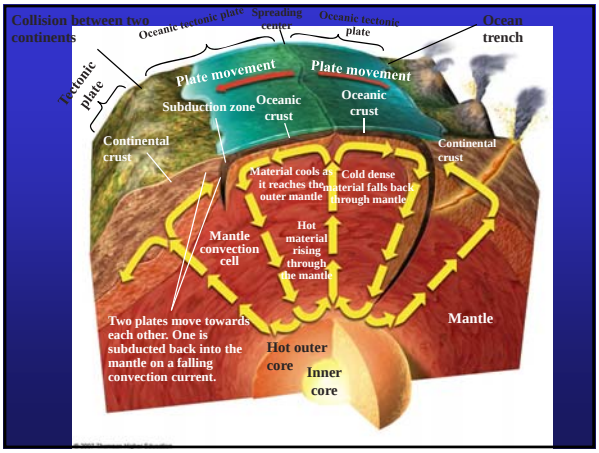


Plate Tectonics

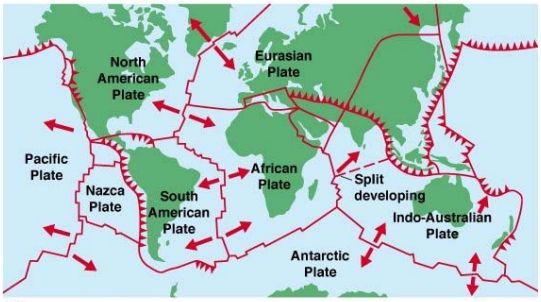


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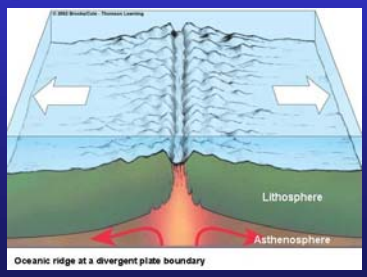
Plate Tectonics

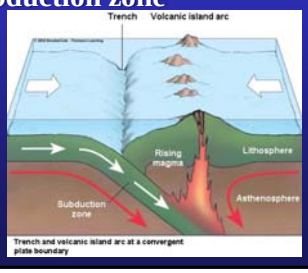
- Divergent boundary



Oceanic ridge at a divergent plate boundary

Plate Tectonics

- Convergent boundary
  - Subduction zone



Trench and volcanic island arc at a convergent plate boundary

Plate Tectonics

- Transform fault

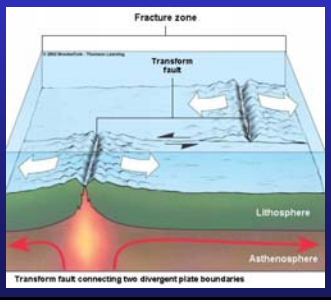
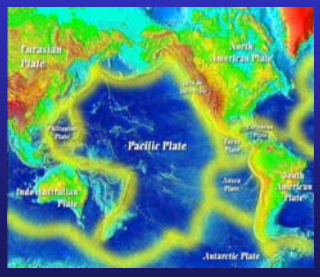
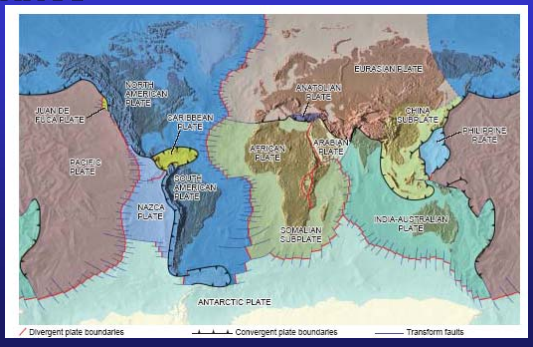


Plate Tectonics

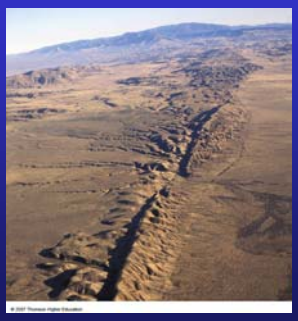
- Ring of Fire



The Earth's Major Tectonic Plates

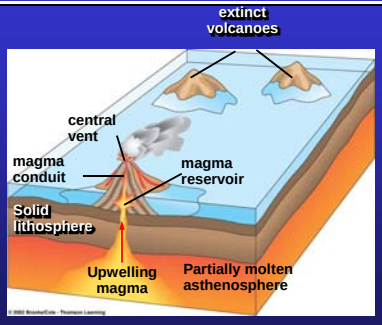


GEOLOGIC PROCESSES



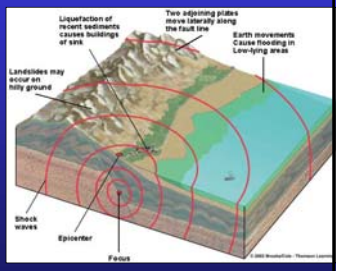
- The San Andreas Fault is an example of a transform fault.

Volcanic Eruptions

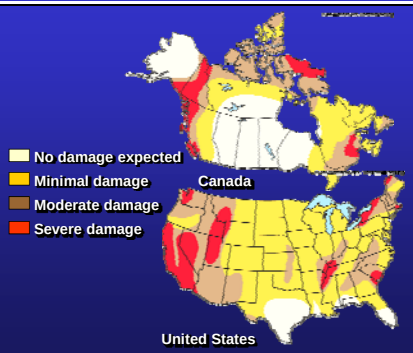


Earthquakes

- Features
- Magnitude
- Aftershocks
- Primary effects
- Secondary effects



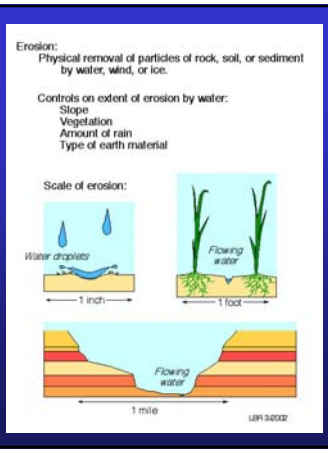
Expected Earthquake Damage



External Earth Processes

- Erosion
- Mechanical weathering
- Frost wedging
- Chemical weathering

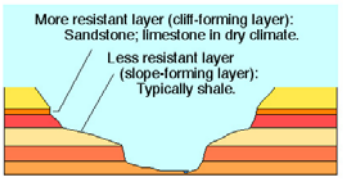
Erosion

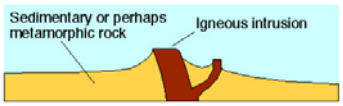


Erosion

Differential Erosion:

Different rock types erode to give different slopes.





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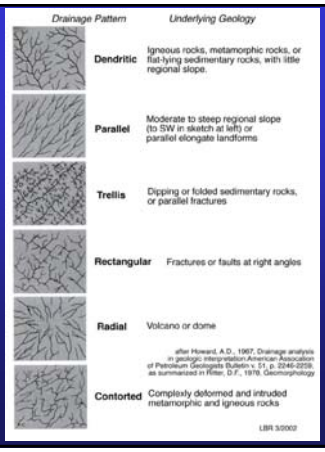
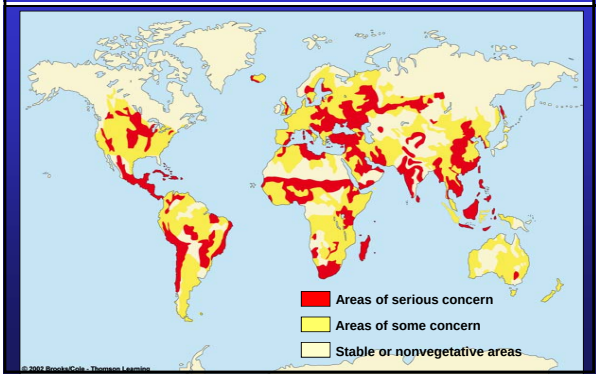
Erosion



Global Soil Erosion



Soils: Erosion

- Sheet erosion
- Rill erosion
- Gully erosion

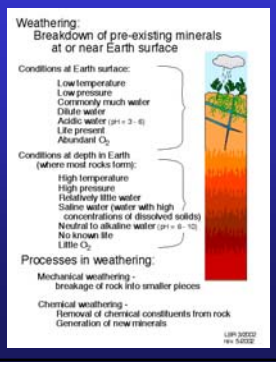
Sheet Erosion

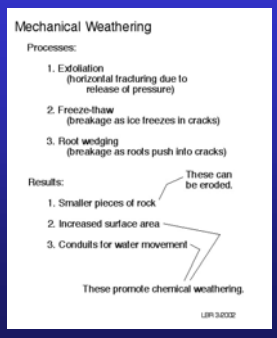
Sheet Erosion

Rill Erosion

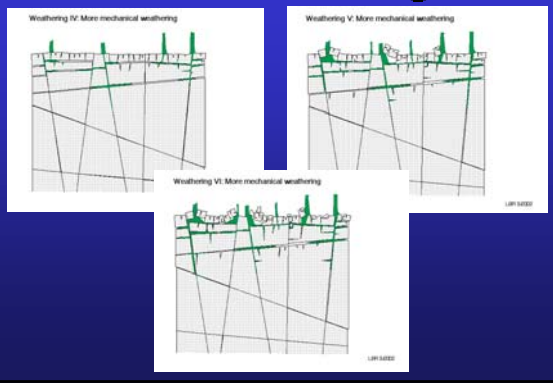
Gully Erosion

Mechanical Weathering





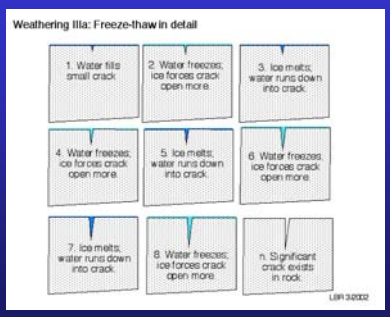
Mechanical Weathering



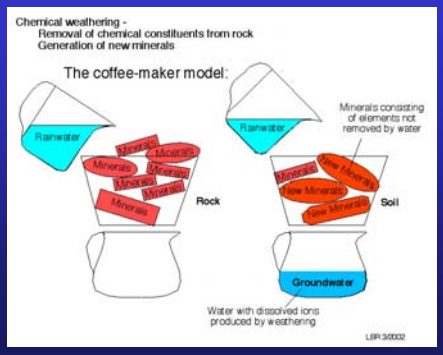
Mechanical Weathering

Mechanical Weathering

Frost Wedging

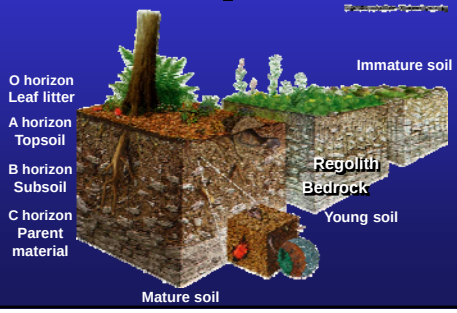


Chemical Weathering



Soils: Formation

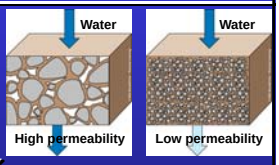
- Soil horizons
- Soil profile
- Humus

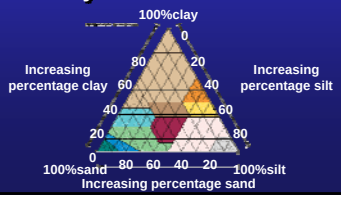


Soil Properties

- Infiltration
- Leaching
- Porosity/permeability
- Texture
- Structure
- pH

Fig. 10-17 p. 217



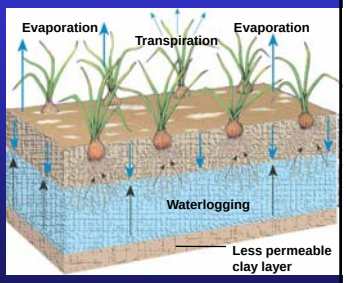


Soil Characteristics

Texture	Nutrient Capacity	Infiltration	Water-Holding Capacity	Aeration	Tilth
Clay	Good	Poor	Good	Poor	Poor
Silt	Medium	Medium	Medium	Medium	Medium
Sand	Poor	Good	Poor	Good	Good
Loam	Medium	Medium	Medium	Medium	Medium

Soils: Degradation

- Desertification
- Salinization
- Waterlogging



Minerals and Rocks

- Mineral (diamond, bauxite)

Rock Types

- Igneous (granite, lava)
- Sedimentary (limestone, sandstone)
- Metamorphic (marble, slate)

Solutions: Soil Conservation

- Conventional-tillage
- Conservation tillage
- Cropping methods
- Windbreaks
- Land Classification

Conventional Tillage

- Plowing the soil in a normal manner
  - The soil is churned up, allowing for the possibility of erosion
  - The planting surface is then smoothed over

Conservation Tillage

- Crops are planted with as little soil disturbance as possible.
- This prevents or lessens the amount of possible erosion.
- Also lower labor costs and energy savings.

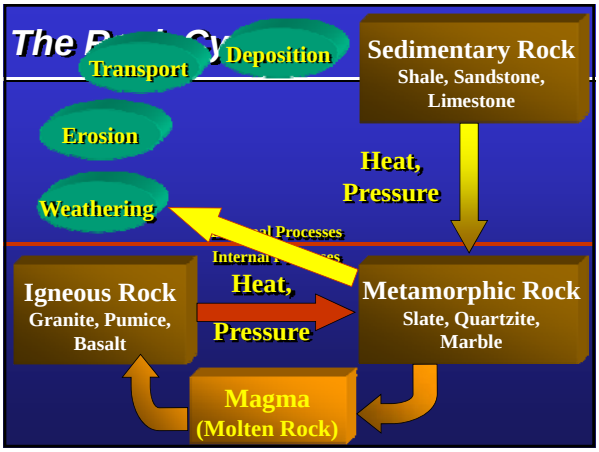
Cropping Methods

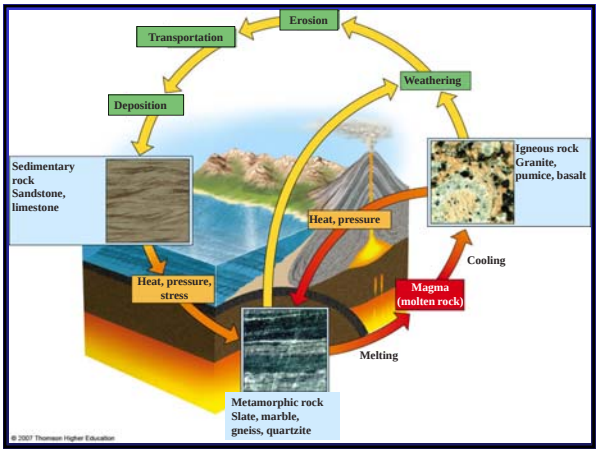
- Contour Farming
- Strip Cropping
- Terracing

Windbreaks

Soil Restoration

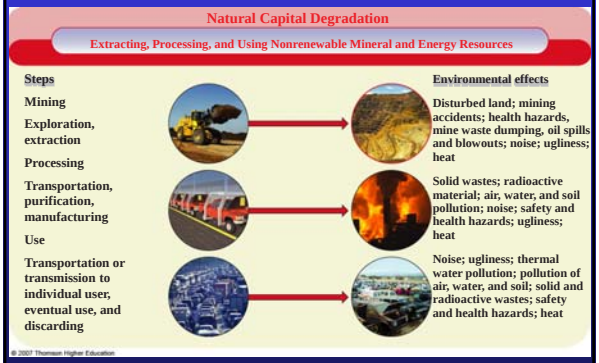
- Organic fertilizer
- Animal manure
- Green manure
- Compost
- Crop rotation
- Commercial inorganic fertilizer





ENVIRONMENTAL EFFECTS OF USING MINERAL RESOURCES

- The extraction, processing, and use of mineral resources has a large environmental impact.



ENVIRONMENTAL EFFECTS OF USING MINERAL RESOURCES

- 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.

Open-pit Mining

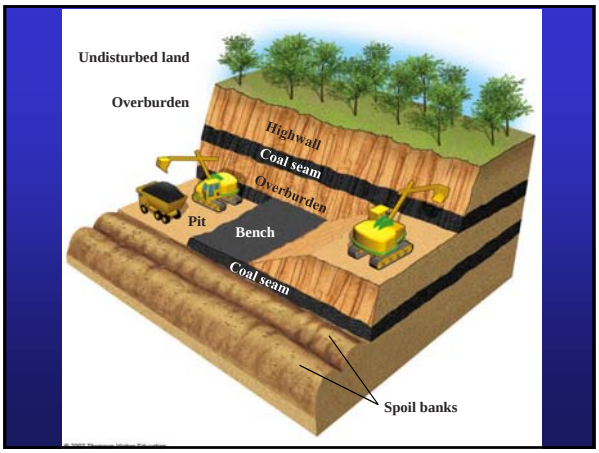
- Machines dig holes and remove ores, sand, gravel, and stone.
- Toxic groundwater can accumulate at the bottom.

Area Strip Mining

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

Contour Strip Mining

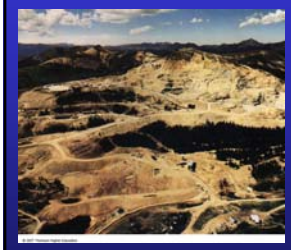
- Used on hilly or mountainous terrain.
- Unless the land is restored, a wall of dirt is left in front of a highly erodible bank called a ***highwall***.



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.

Mining Impacts

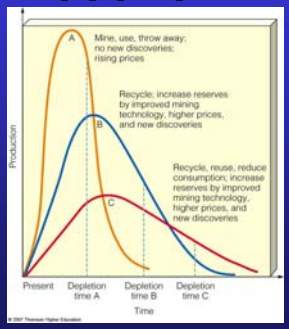


- Metal ores are smelted or treated with (potentially toxic) chemicals to extract the desired metal.

SUPPLIES OF MINERAL RESOURCES

- The future supply of a resource depends on its affordable supply and how rapidly that supply is used.
- A rising price for a scarce mineral resource can increase supplies and encourage more efficient use.

SUPPLIES OF MINERAL RESOURCES

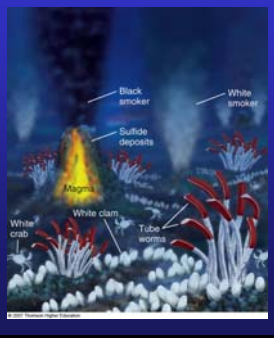


- Depletion curves for a renewable resource using three sets of assumptions.
  - Dashed vertical lines represent times when 80% depletion occurs.

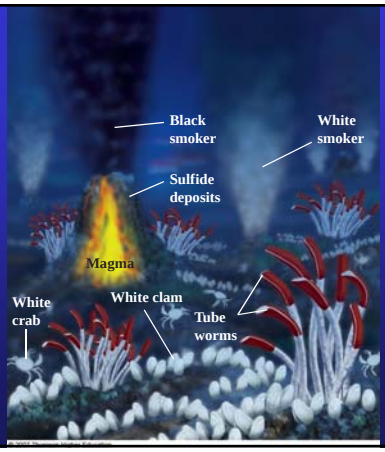
SUPPLIES OF MINERAL RESOURCES

- New technologies can increase the mining of low-grade ores at affordable prices, but harmful environmental effects can limit this approach.
- Most minerals in seawater and on the deep ocean floor cost too much to extract, and there are squabbles over who owns them.

Getting More Minerals from the Ocean



- Hydrothermal deposits form when mineral-rich superheated water shoots out of vents in solidified magma on the ocean floor.



USING MINERAL RESOURCES MORE SUSTAINABLY

- Scientists and engineers are developing new types of materials as substitutes for many metals.
- Recycling valuable and scarce metals saves money and has a lower environmental impact then mining and extracting them from their ores.

Solutions

Sustainable Use of Nonrenewable Minerals

- Do not waste mineral resources.
- Recycle and reuse 60–80% of mineral resources.
- Include the harmful environmental costs of mining and processing minerals in the prices of items (full-cost pricing).
- Reduce subsidies for mining mineral resources.
- Increase subsidies for recycling, reuse, and finding less environmentally harmful substitutes.
- Redesign manufacturing processes to use less mineral resources and to produce less pollution and waste.
- Have the mineral-based wastes of one manufacturing process become the raw materials for other processes.
- Sell services instead of things.
- Slow population growth.