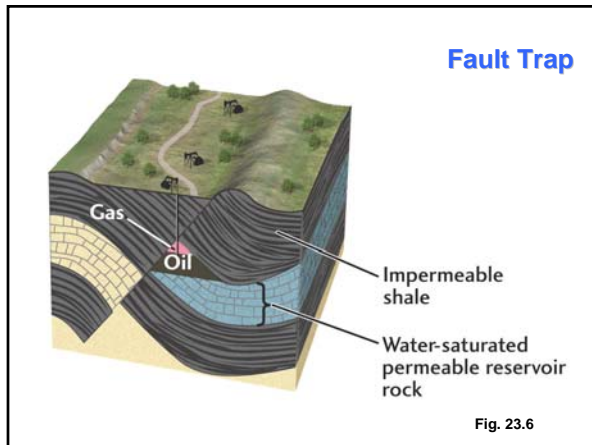


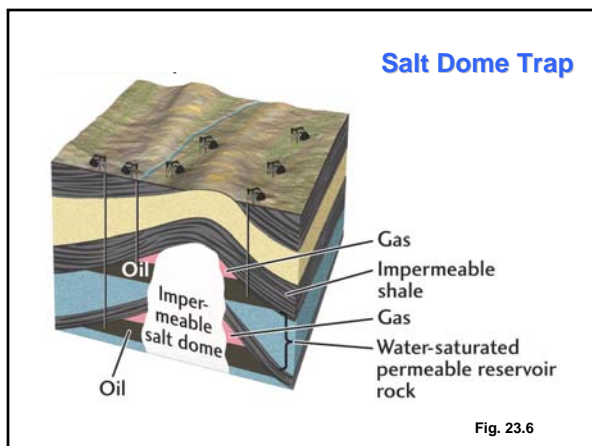
How do oil and gas deposits form?

- production
- preservation
- maturation
- migration
- trapping

Thermal Conditions of Oil Formation

- 50-200 °C (also depends on time)
- oil — wet gas — dry gas — gone





F.Y.I.

- U.S. production of oil has been decreasing since 1970.
- U.S. consumption has been largely increasing since at least 1949.
- we presently import over 50% of all the oil we use in the U.S.

Estimated Worldwide Oil Reserves by Region At the End of 2000

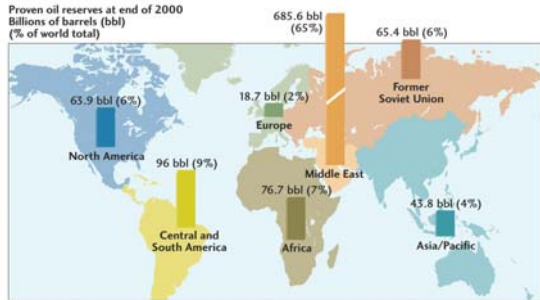
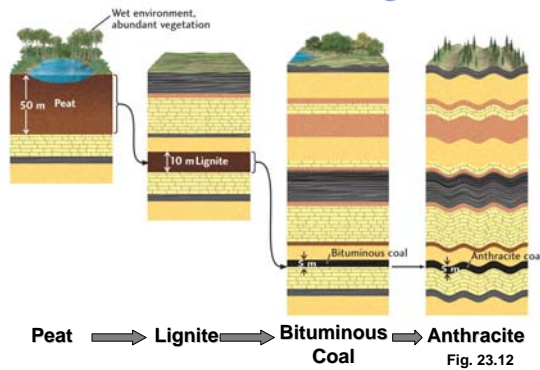
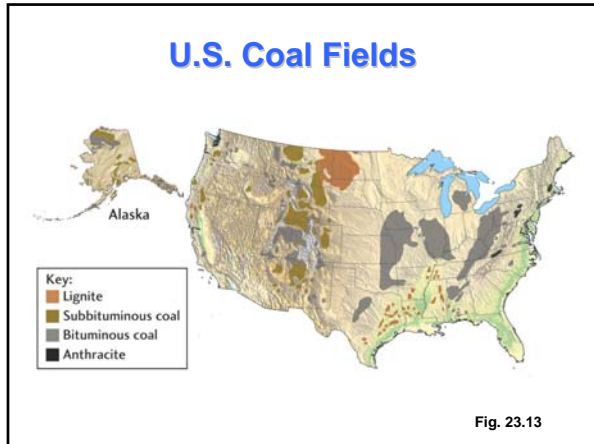


Fig. 23.7

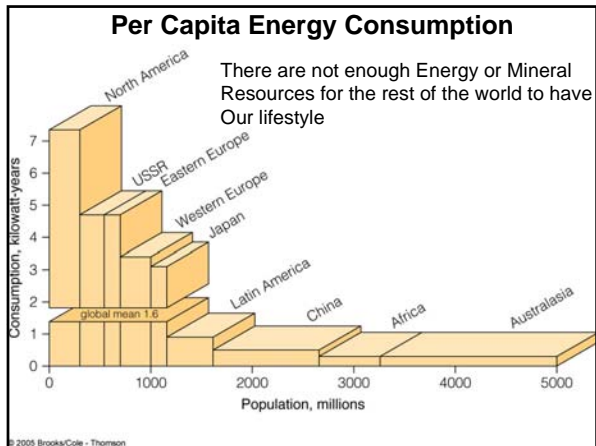
The Process of Forming Coal

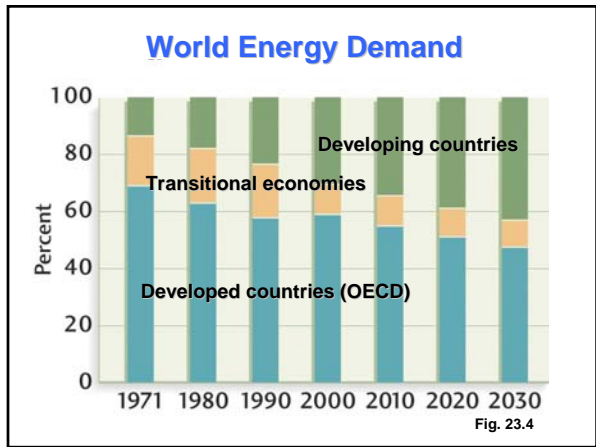


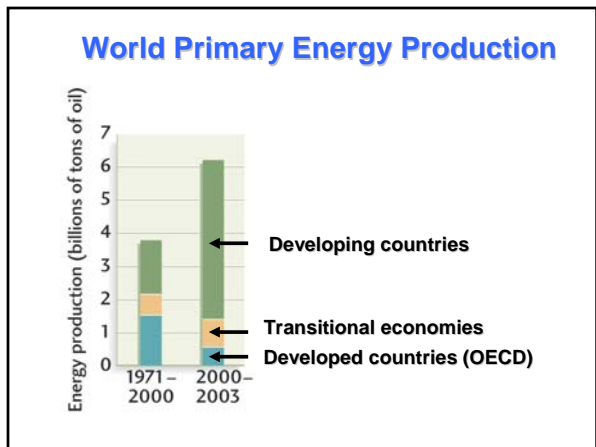












Energy Resources – Hydrocarbons (Captured Solar Energy)

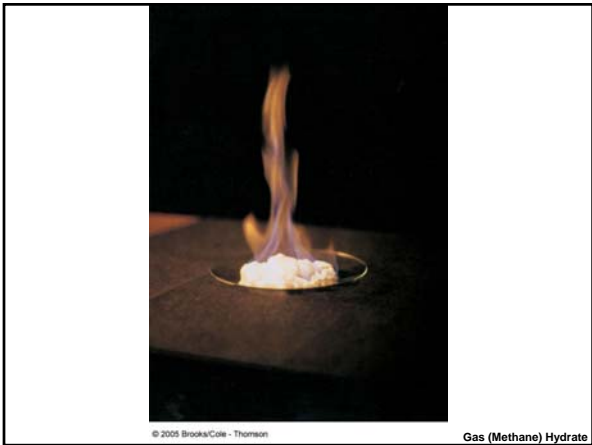
- Created in 200,000,000 years
- Depleted in 200 years



Oil Shale

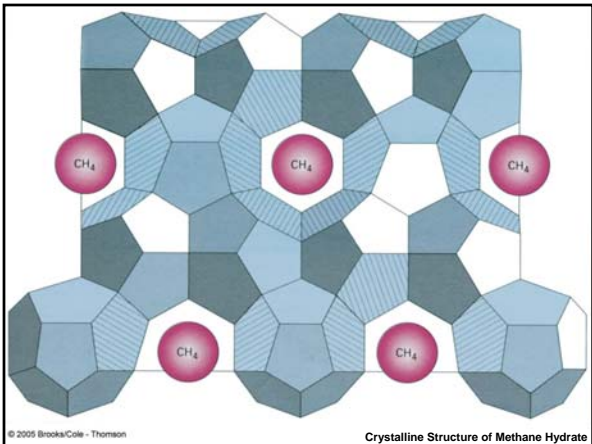
Tar Sand



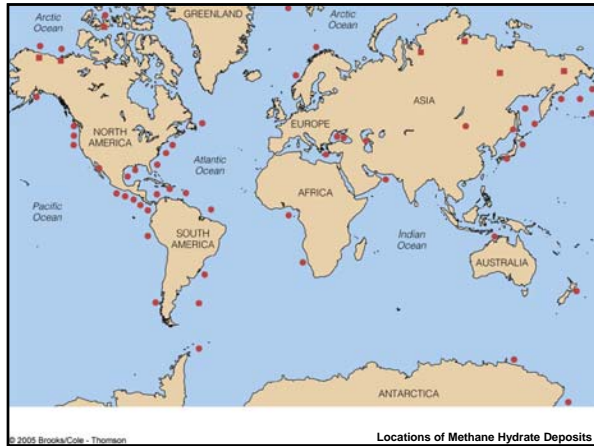


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Gas (Methane) Hydrate



Crystalline Structure of Methane Hydrate



Locations of Methane Hydrate Deposits



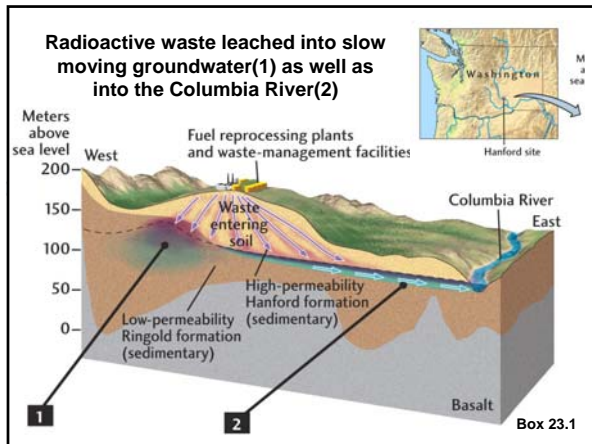
Methane Hydrate from Blake Ridge, offshore Florida

Alternatives to Fossil Fuels

1. nuclear energy

advantages: virtually inexhaustible supply

disadvantages : dangerous waste



Alternatives to Fossil Fuels

2. solar energy

advantages: virtually inexhaustible supply

disadvantages: very expensive with current technology; and not as portable as hydrocarbons



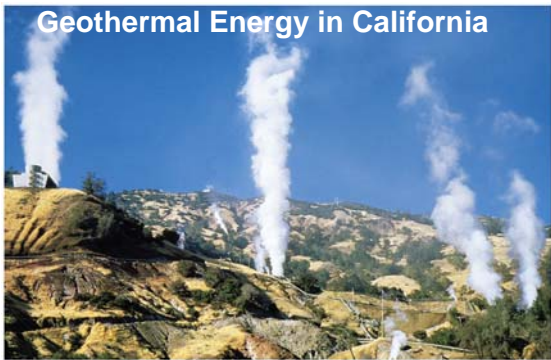
Alternatives to Fossil Fuels

3. geothermal energy

advantages: cheap and clean

disadvantages : cannot be transported
long distances

Geothermal Energy in California



Alternatives to Fossil Fuels

4. Wind Energy

advantages: clean and quiet

disadvantages : expensive with current
technology; birds;
opposition from (wealth)
home owners

Energy Alternatives



Environmental Footprint



18 Wheeler

Human Activities Could Result in Changes in:

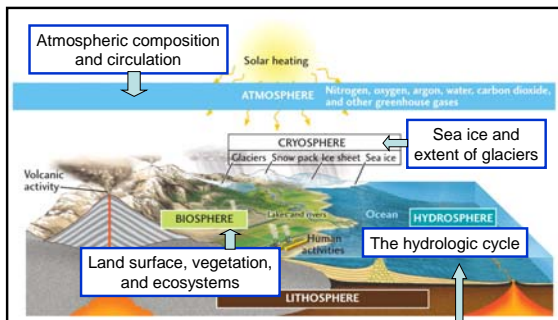


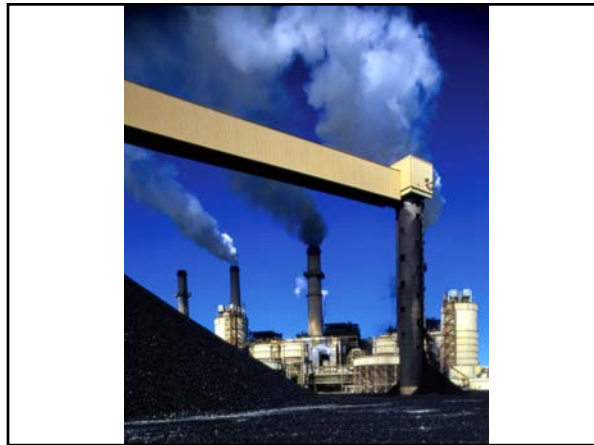
Fig. 23.7

Oceanic circulation, sea level, and geochemistry

Before and After the Effects of Acid Rain



Fig. 23.18



Burning high-sulfur coal generates atmospheric sulfuric acid which falls as acid rain down-wind, to the northeast.

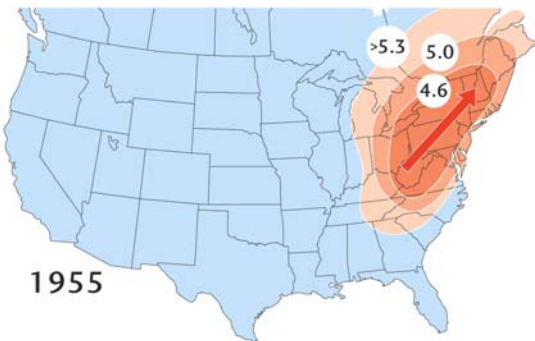


Fig. 23.19

Rains became more acidic and affected broader areas until sulfur-reducing regulations were enacted...

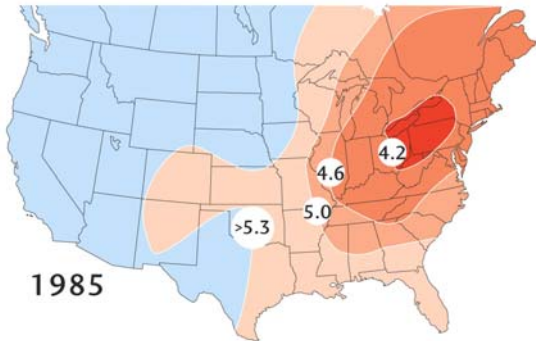


Fig. 23.19

...reducing acid rain in the Northeast, however coal-fired power plants in the Southwest have increased acid rain there.

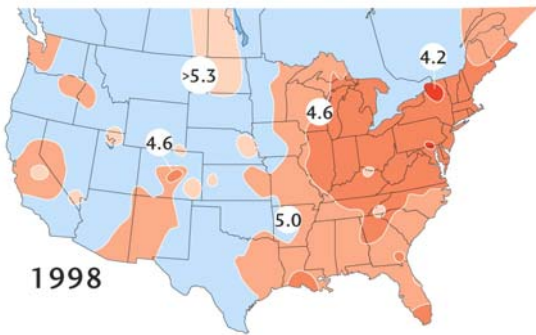
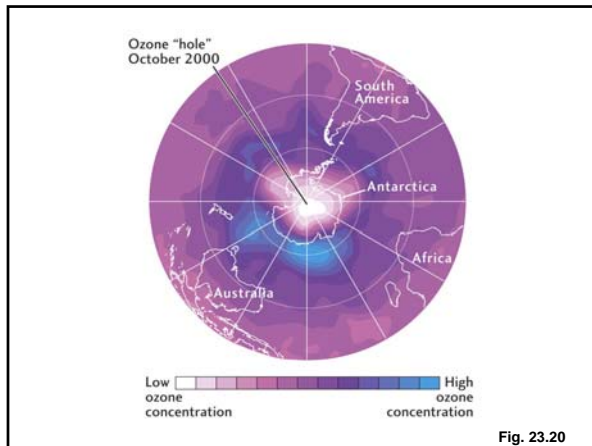
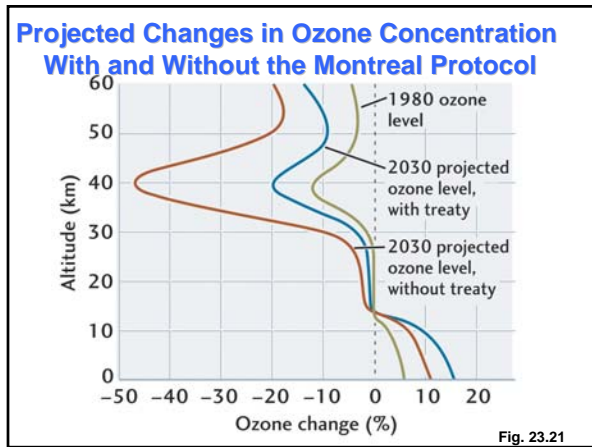


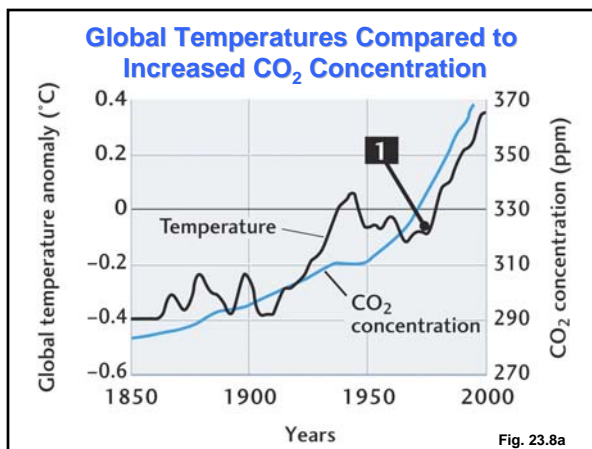
Fig. 23.19

What are the greenhouse gases?
(excluding H₂O)

- Carbon Dioxide: 49%
- Methane: 18%
- "CFC's": 14%
- Nitrous Oxides: 6%
- Others: 13%







Projected Changes in Global Temperature Under Three Different Scenarios

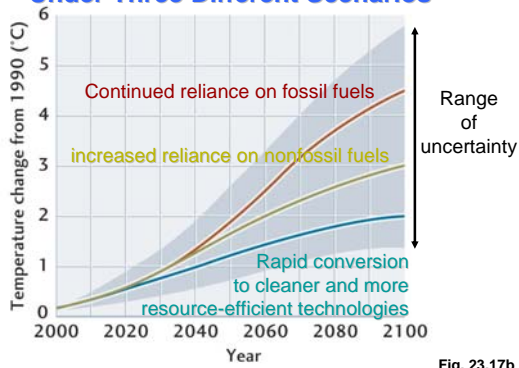


Fig. 23.17b



Global warming is projected to reduce the north polar ice cap, disrupting Arctic ecosystems, but possibly improving navigation.

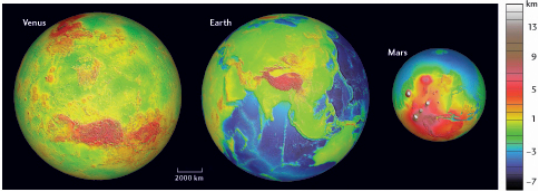
Fig. 23.18

Shorter Pack Ice Season is causing Stress for Polar Bears



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Runaway Greenhouse or Snowball?



Potential Climate-Change Effects on Various Systems

Systems	Potential Effects
Forests and terrestrial vegetation	Migration of vegetation Reduction in inhabited range Altered ecosystem composition
Species diversity	Loss of diversity Migration of species Invasion of new species
Coastal wetlands	Inundation of wetlands Migration of wetlands
Aquatic ecosystems	Loss of habitat Migration to new habitats Invasion of new species
Coastal resources	Inundation of coastal development Increased risk of flooding

Source: Office of Technology Assessment, U.S. Congress.

Table 23.1

Potential Climate-Change Effects on Various Systems

Systems	Potential Effects
Water resources	Changes in supplies Changes in drought and floods Changes in water quality and hydropower production
Agriculture	Changes in crop yields Shifts in relative productivity and production
Human health	Shifts in range of infectious diseases Changes in heat-stress and cold-weather afflictions
Energy	Increase in cooling demand Decrease in heating demand Changes in hydropower output
Transportation	Fewer disruptions of winter transportation Increased risk for summer inland navigation Risks to coastal roads

Source: Office of Technology Assessment, U.S. Congress.

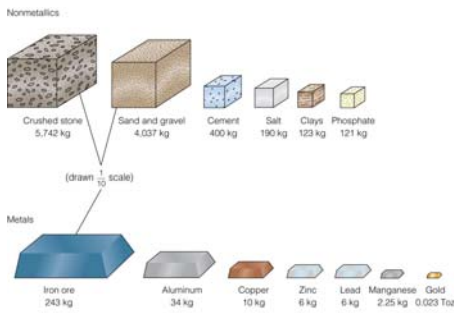
Table 23.1

Mineral Resources Your House Comes From the Ground



250,000 lbs of minerals/metals are mined to make a 2,000 ft² house

U.S. annual per capita consumption



U.S. imports large percentage of its metals

TABLE 13.2 Concentration Factors for Profitable Mining of Selected Metals

Metal	Percentage Abundance		Concentration Factor
	Average in Earth's Crust	In Ore Deposit	
Aluminum	8	35	4
Copper	0.0063	0.4-0.8	80-160
Gold	0.0000004	0.001	2,500
Iron	5	20-69	4-14
Lead	0.0015	4	2,500
Mercury	0.00001	0.1	10,000
Silicon	28.2	46.7	2
Titanium	0.57	32-60	56-105

Source: U.S. Geological Survey professional paper 820, 1973.

Mining would not be so expensive and destructive if metals were naturally concentrated



Kennecott Bingham Canyon mine, Utah (0.8 km by 4 km)



A line of Ore Trucks



Ore Truck



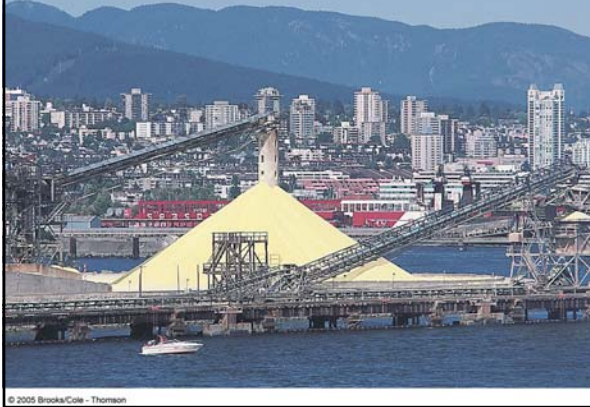
Ore Truck Tire
(Geophysicist for scale)

One of 2000 abandoned mines in Colorado



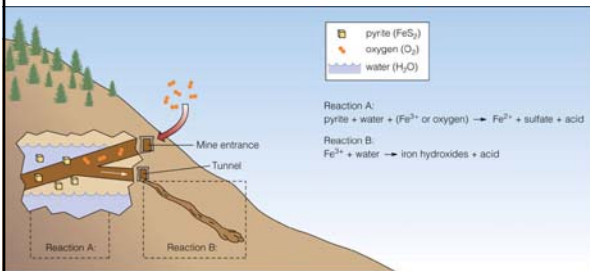
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Oil, Natural Gas, Coal and Sedimentary Rocks contain Sulfur



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Sulfur + Water + Oxygen -> Sulfuric Acid



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Sulfuric acid from weathering of pyrite

Acid leaches out heavy metals

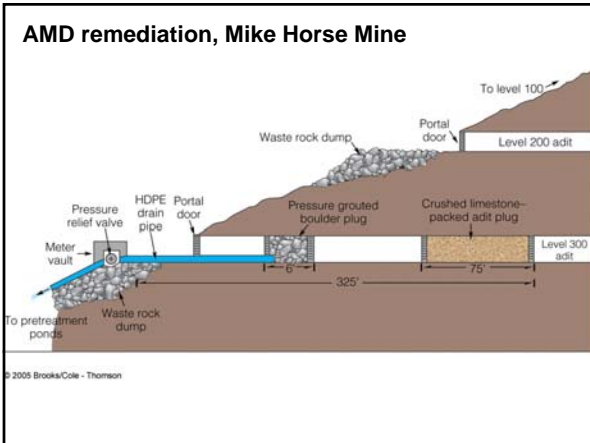
Process continues for centuries

Acid Mine Drainage (pH = 3) , Mike Horse Mine, Montana



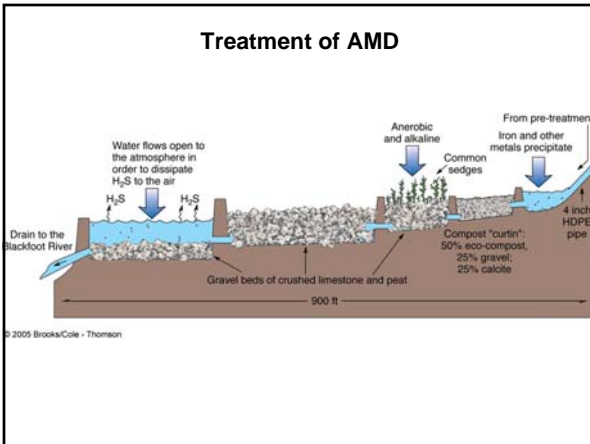
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AMD remediation, Mike Horse Mine

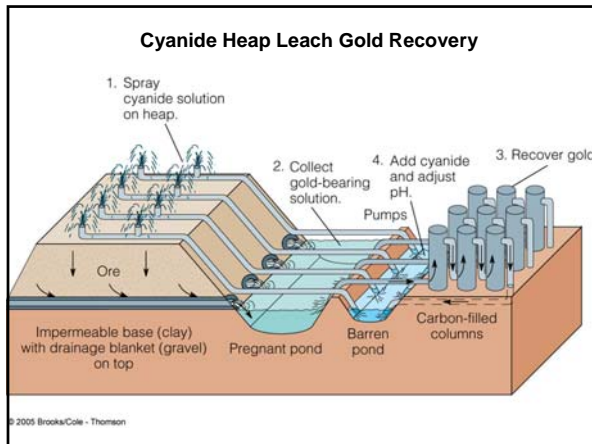


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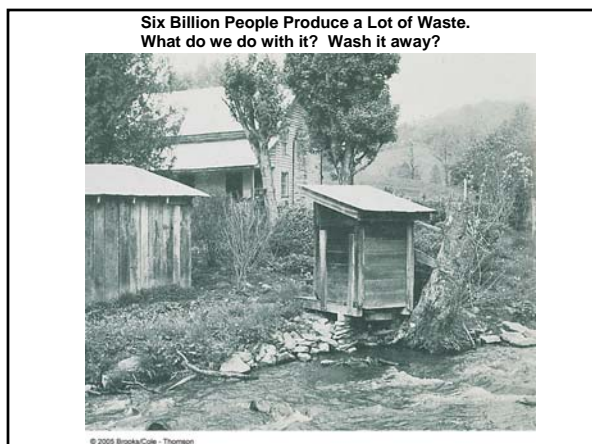
Treatment of AMD

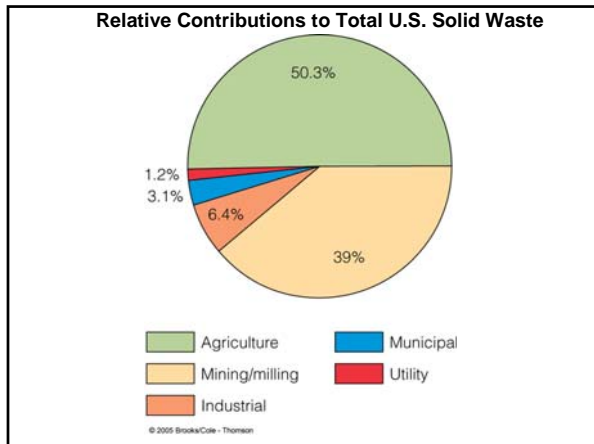


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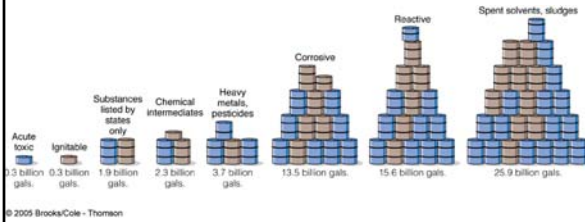




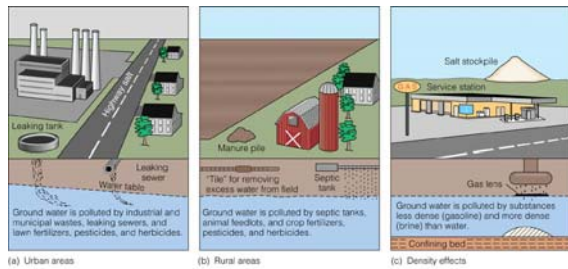




U.S. Toxic Waste generated in 1981



Sources of Pollution/Density



Modern Landfill design with Leachate and Methane controls

