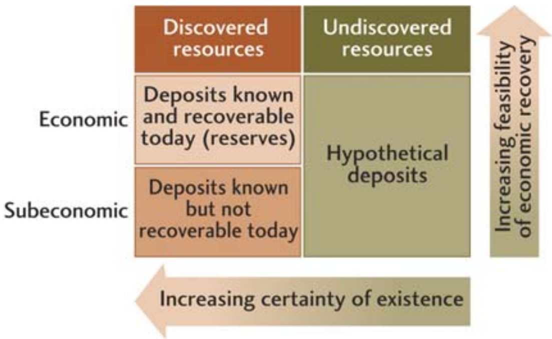
Resources and Reserves



Trans-Alaska Pipeline, Alaska

Estimated Nonrenewable Energy Resources Worldwide

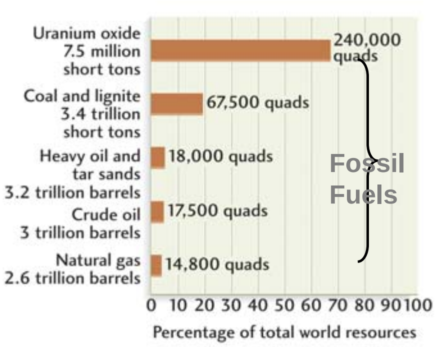
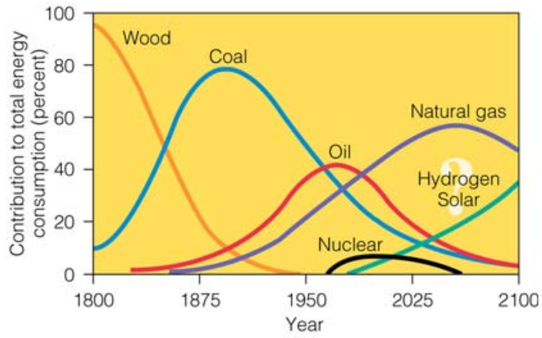
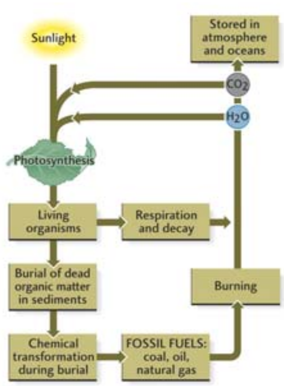


Fig. 23.5

Changes in U.S. Use of Energy Resources





The Carbon Cycle and Fossil Fuels*

* Stored solar energy!

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

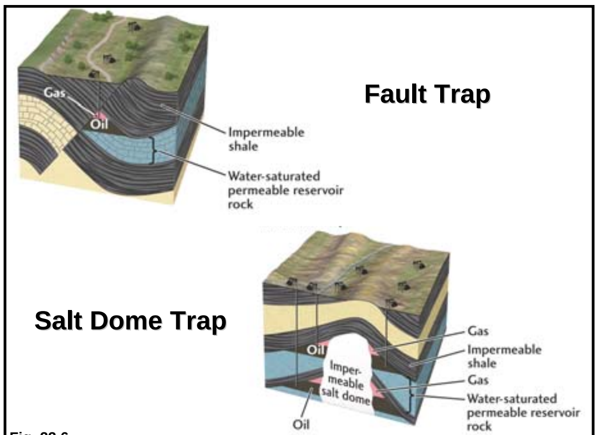


Fig. 23.6

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

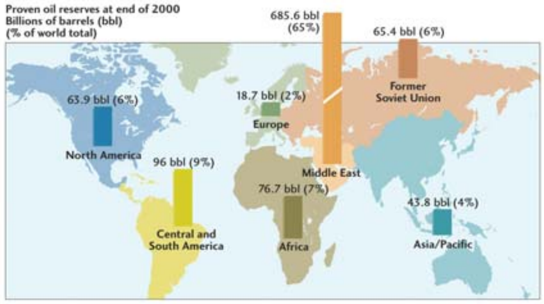
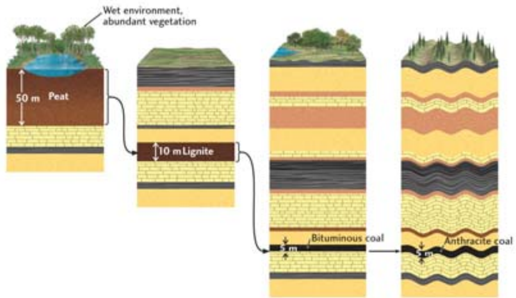


Fig. 23.7

The Process of Forming Coal



Peat → Lignite → Bituminous Coal → Anthracite

Fig. 23.12

U.S. Coal Fields

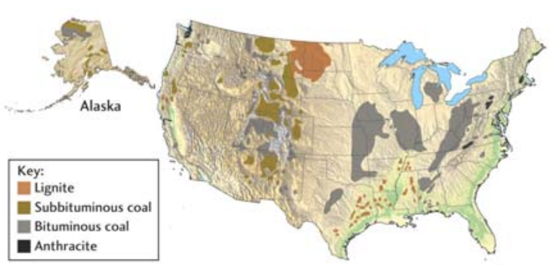


Fig. 23.13

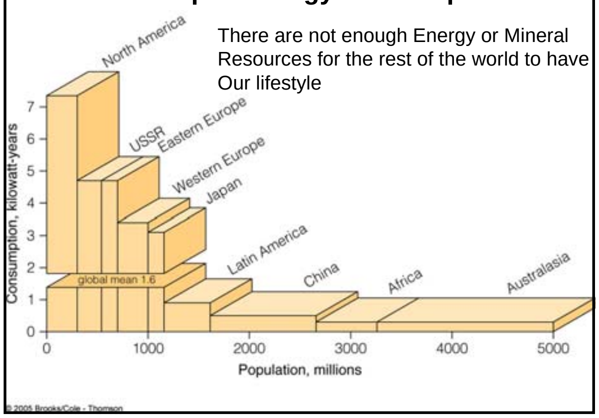
Before Reclamation

After Reclamation

Fig. 23.14

Per Capita Energy Consumption

There are not enough Energy or Mineral Resources for the rest of the world to have Our lifestyle



World Energy Demand

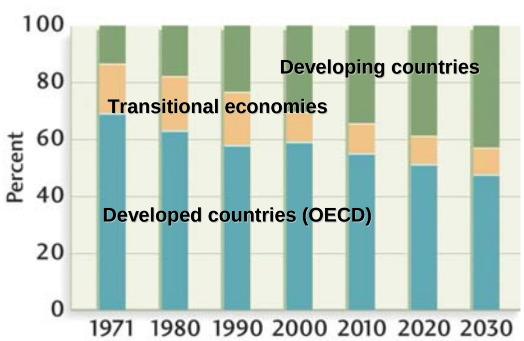
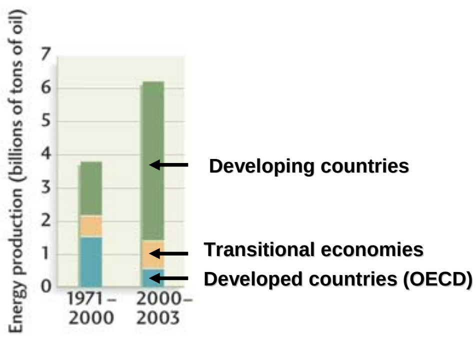


Fig. 23.4

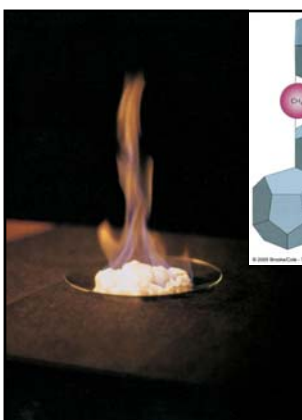
World Primary Energy Production

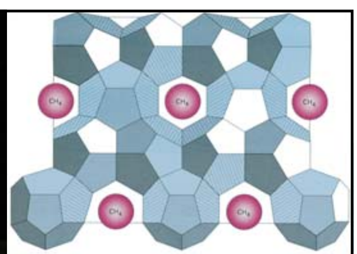


Energy Resources – Hydrocarbons (Captured Solar Energy)
- **Created in 200,000,000 years**
- **Depleted in 200 years**

Oil Shale

Tar Sand





Gas (Methane) Hydrate

Locations of Methane Hydrate Deposits

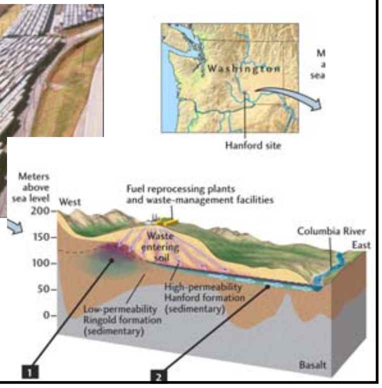
Alternatives to Fossil Fuels

1. nuclear energy

advantages: virtually inexhaustible supply

disadvantages : dangerous waste

Oak Ridge, TN



Radioactive waste leached into slow moving groundwater(1) as well as into the Columbia River(2)

Alternatives to Fossil Fuels

2. solar energy

***advantages**:* virtually inexhaustible supply

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

Solar Cells in Nepal

Fig. 23.16

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

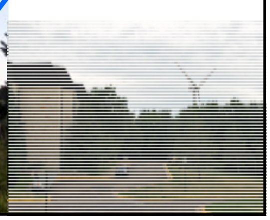
4. Wind Energy

***advantages**:* clean and quiet

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

Environmental Footprint

18 Wheeler



Human Activities Could Result in Changes in:

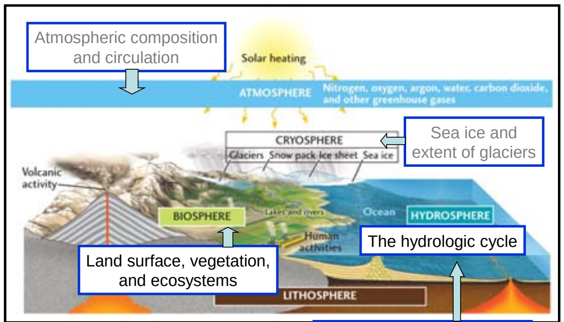


Fig. 23.7

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.

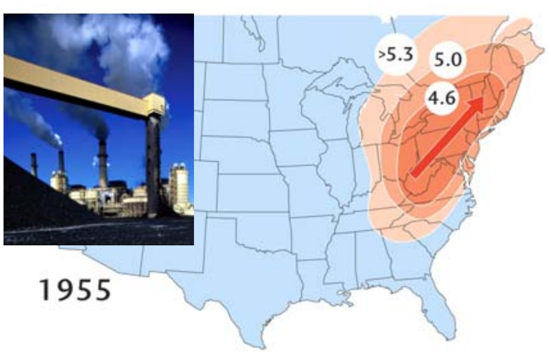


Fig. 23.19

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

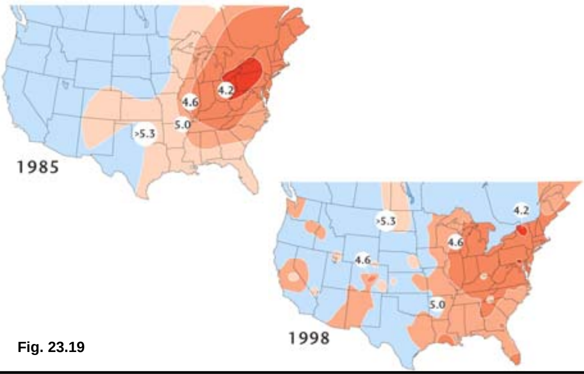


Fig. 23.19

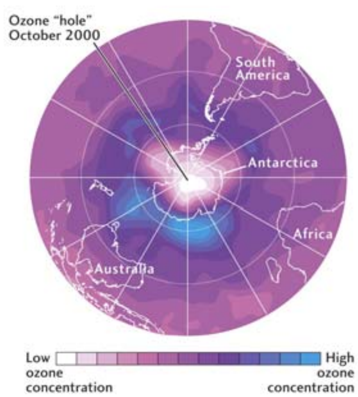


Fig. 23.20

Projected Changes in Ozone Concentration With and Without the Montreal Protocol

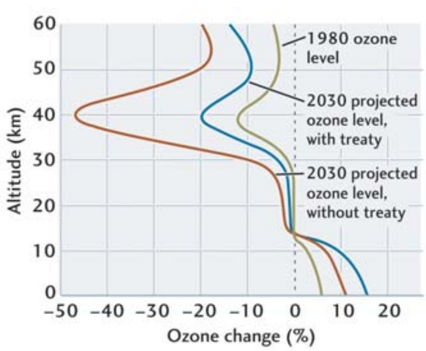


Fig. 23.21

Projected Changes in Global Temperature Under Three Different Scenarios

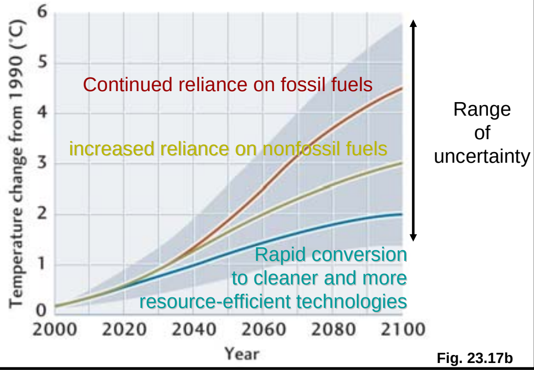


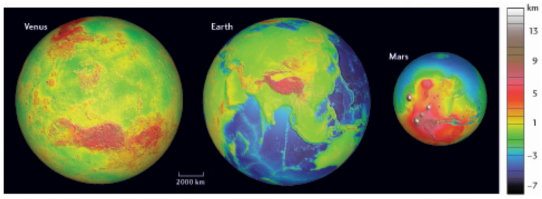
Fig. 23.17b

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

Runaway Greenhouse or Snowball?



Grotzinger et al., 2007

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

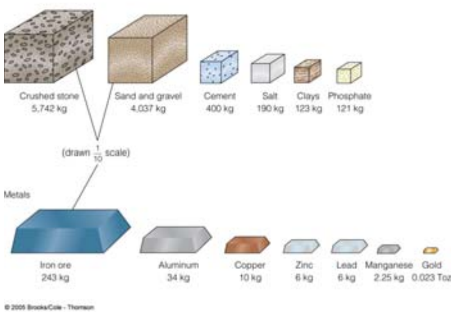
Source: Office of Technology Assessment, U.S. Congress.

Table 23.1

Mineral Resources
Your House Comes From the Ground

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

U.S. annual per capita consumption



U.S. imports large percentage of its metals

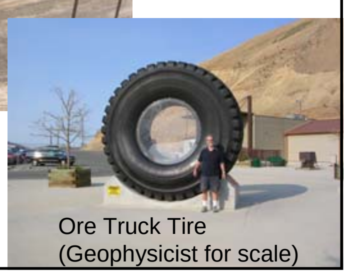
TABLE 13.2 Concentration Factors for Profitable Mining of Selected Metals

	Percentage Abundance		Concentration Factor
Metal	***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.

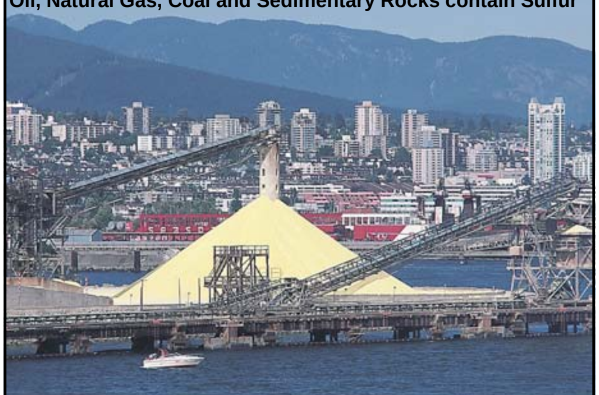
Mining would not be so expensive and destructive if metals were naturally concentrated

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

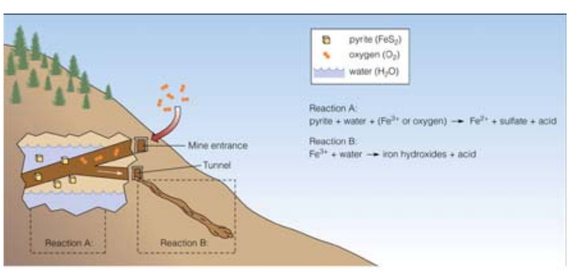


One of 2000 abandoned mines in Colorado

Oil, Natural Gas, Coal and Sedimentary Rocks contain Sulfur



Sulfur + Water + Oxygen -> Sulfuric Acid



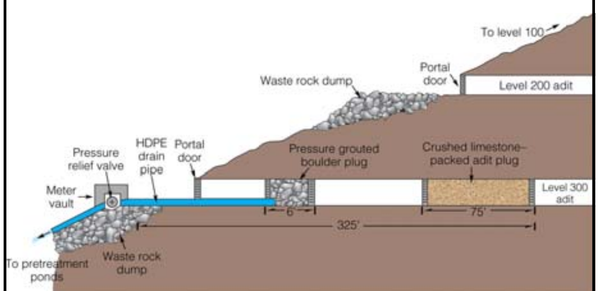
Sulfuric acid from weathering of pyrite

Acid leaches out heavy metals

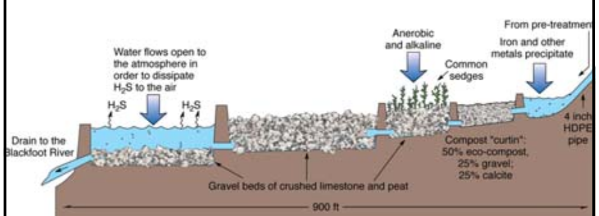
Process continues for centuries

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

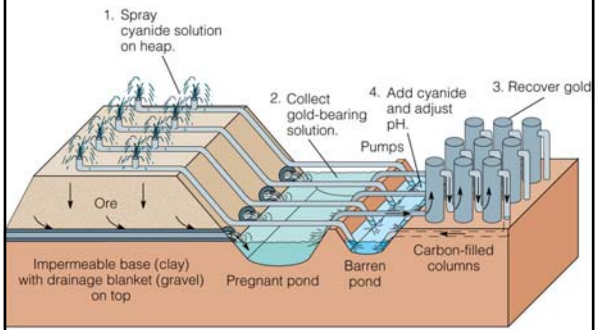
AMD remediation, Mike Horse Mine



Treatment of AMD



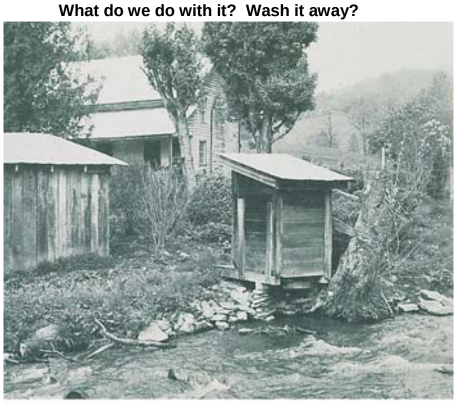
Cyanide Heap Leach Gold Recovery



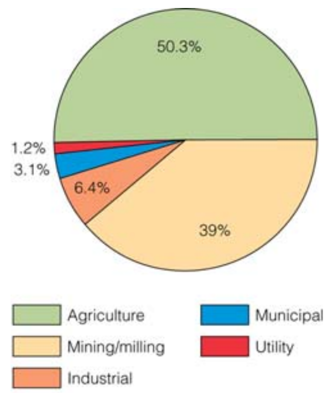
Pregnant Pond (gold in cyanide solution)

Note - netting to keep birds/animals out

Six Billion People Produce a Lot of Waste.
What do we do with it? Wash it away?



Relative Contributions to Total U.S. Solid Waste

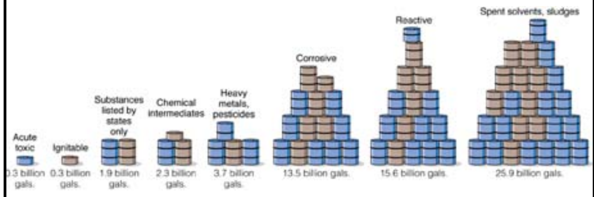


Full, graded landfill prior to planting

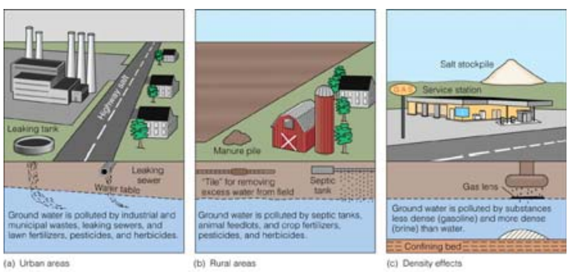
World's Largest Landfill, NYC

(a)

U.S. Toxic Waste generated in 1981



Sources of Pollution/Density



(a) Urban areas (b) Rural areas (c) Density effects

Modern Landfill design with Lechate and Methane controls