



# Chapter 8

## Earth Systems and Resources

# Are Hybrid Electrical Vehicles Environmentally Friendly?



**Unnumbered 8 p207**

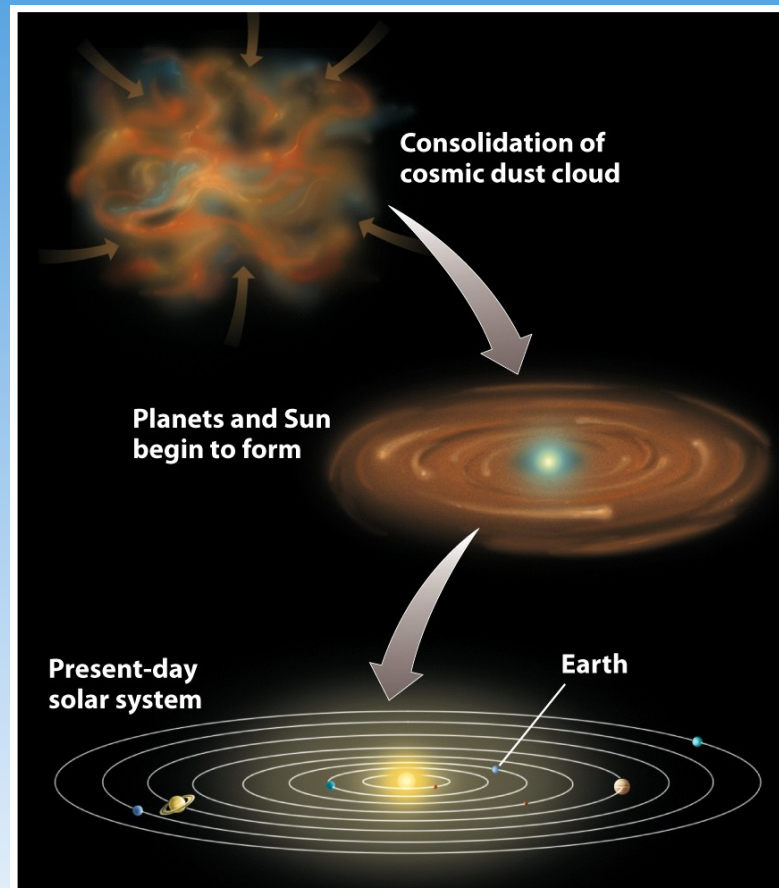
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# Need to consider...

- ▣ A) Environmental Trade-offs?
- ▣ B) Rare metals...what? Where?
- ▣ C) Impacts of extraction/processing?

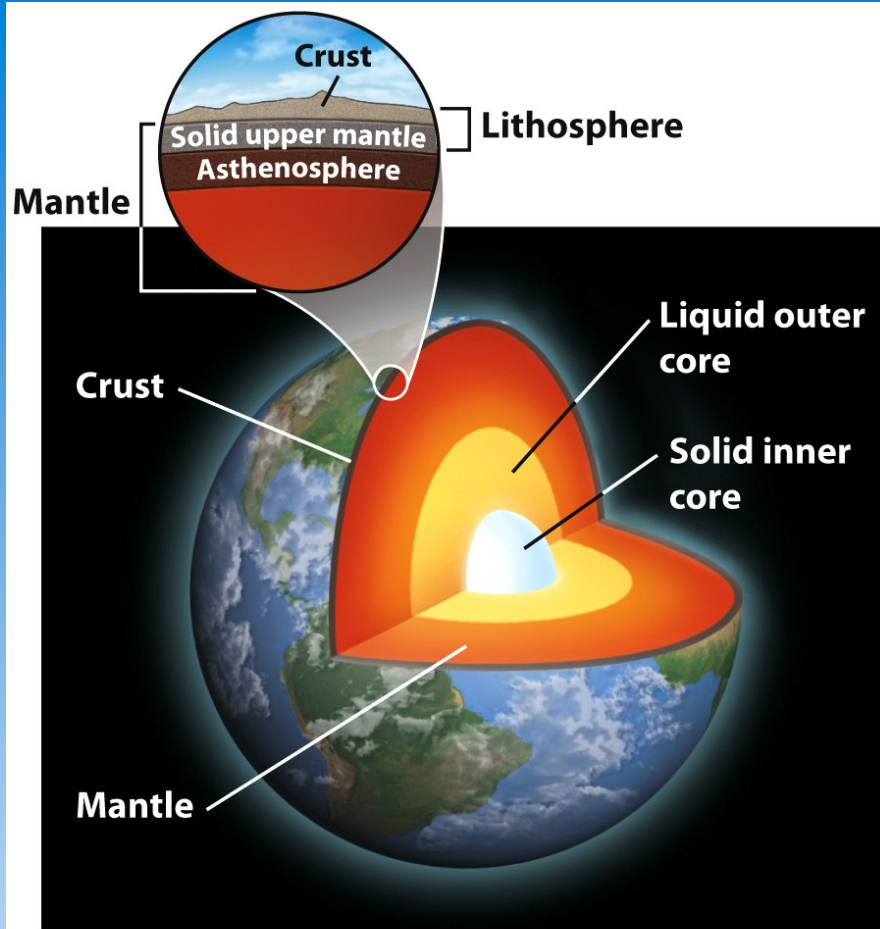
# The Earth's resources were determined when the planet formed.



**Figure 8.1**  
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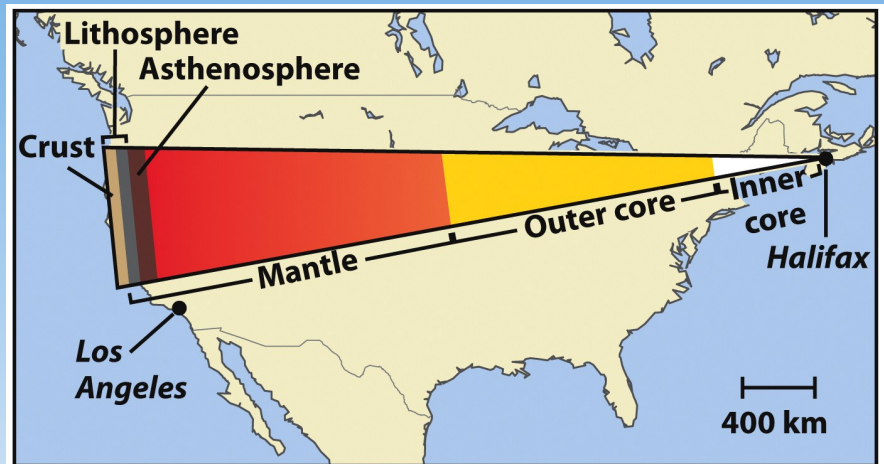
# The Earth's Layers

- ▣ **Core-** the innermost zone of the planet made of nickel and iron.
- ▣ **Mantle-** above the core containing magma
- ▣ **Crust-** the outermost layer of the planet.



**Earth's vertical zonation**

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**Scale of Earth's layers**

**Figure 8.2b**  
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# The Earth's Layers

- ▣ **Asthenosphere-** upper mantle, composed of semi-molten rock... convection currents here.
- ▣ **Lithosphere-** crust plus upper mantle...makes up the Earth's tectonic plates

# Convection and Hot Spots

- ❑ Heat from radioactive decay.
- ❑ This heat causes plumes of hot magma to well upward from the mantle.
- ❑ **Hotspots**- places where molten material from the mantle reach the lithosphere.

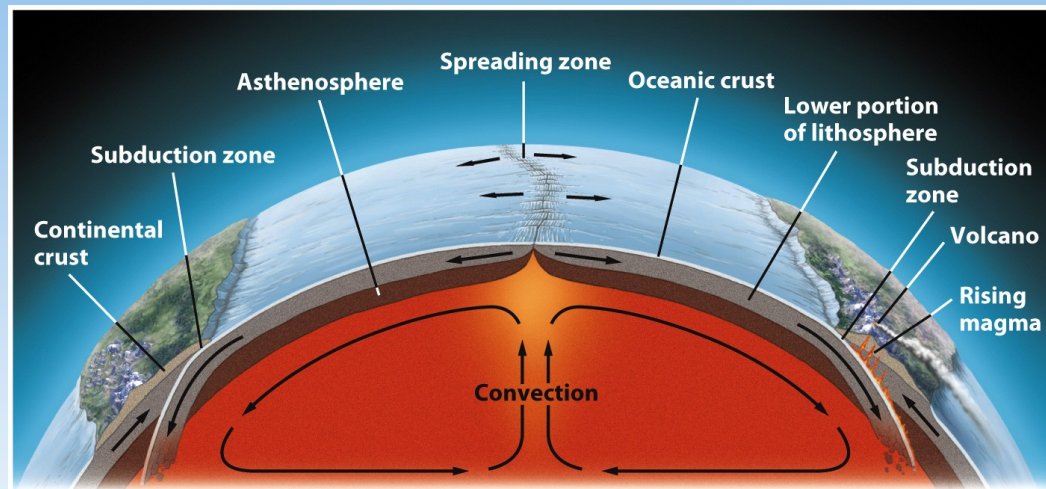
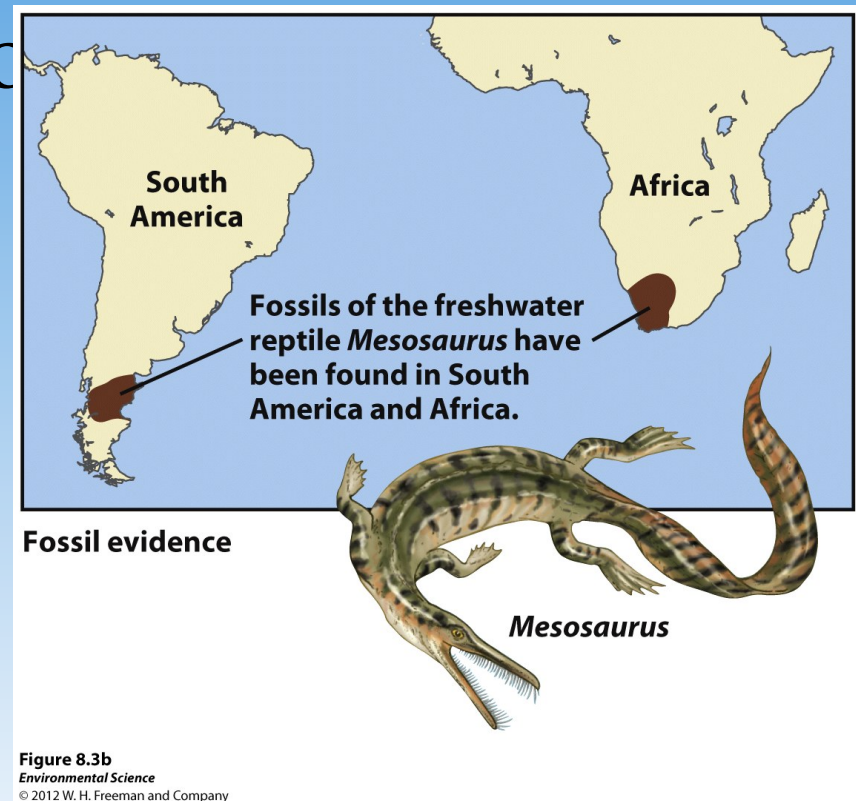


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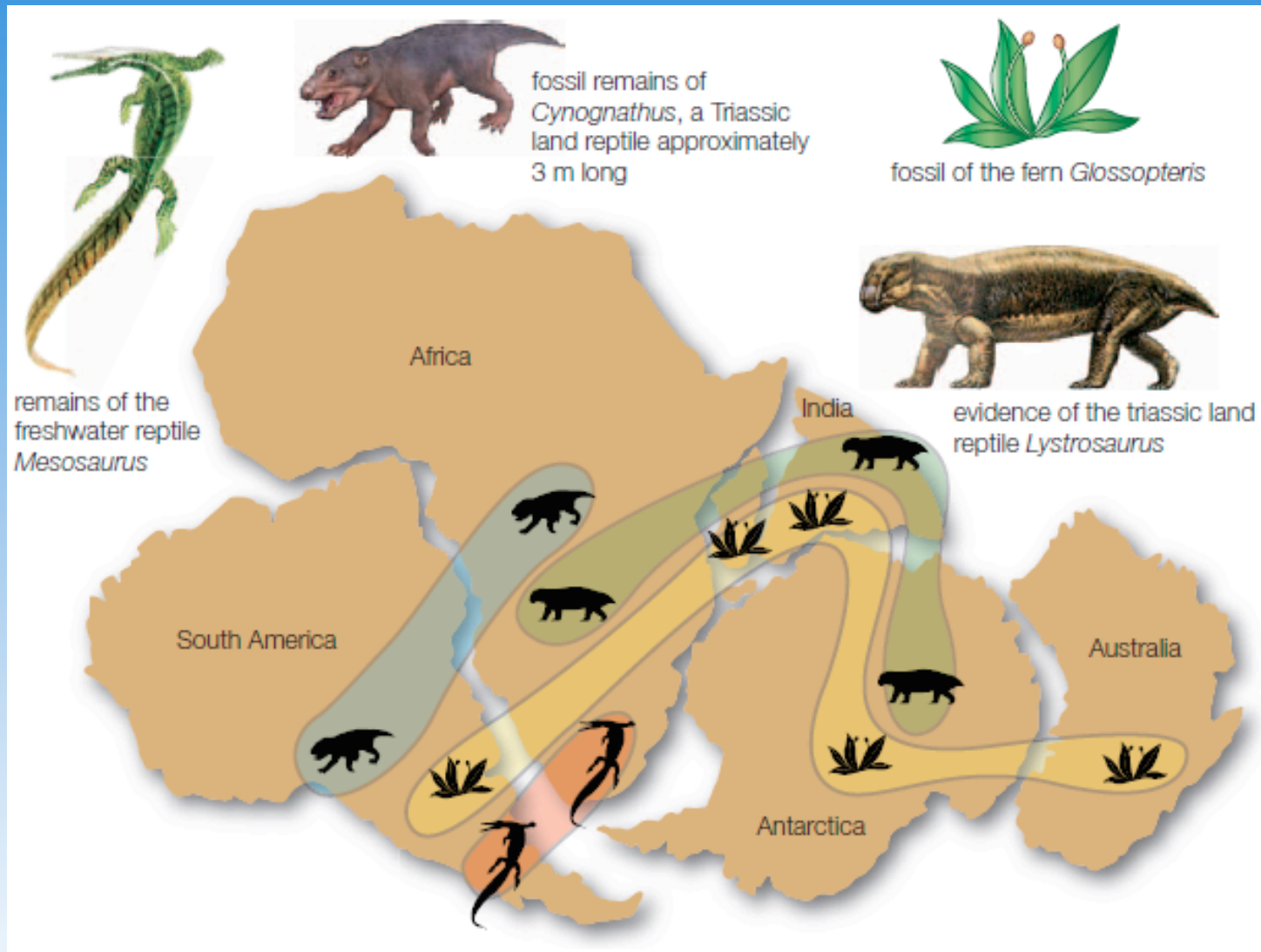


# Theory of Plate Tectonics

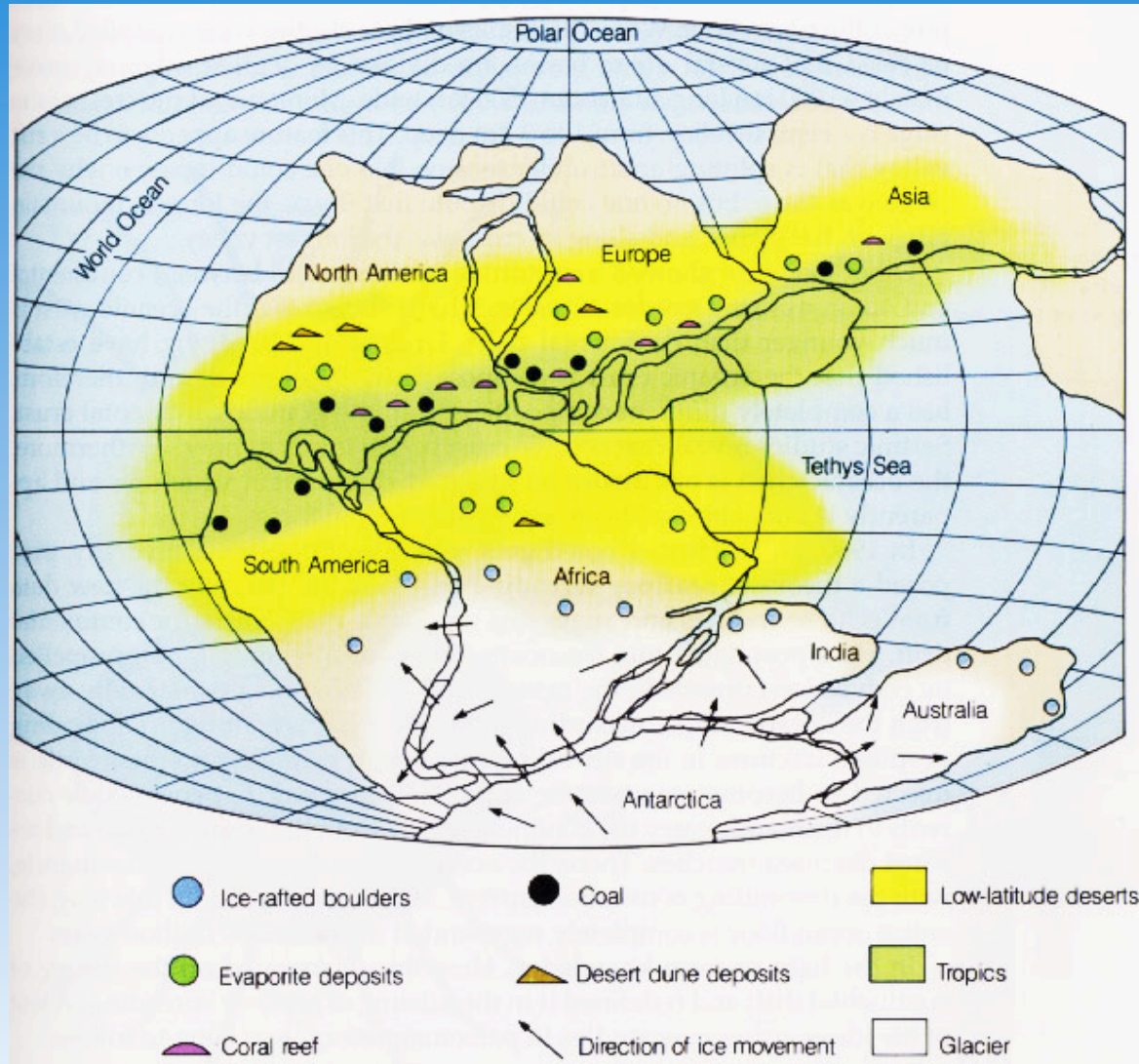
- ▣ **Plate tectonics-** the theory that states that Earth's lithosphere is divided into plates, most of which are in constant motion.



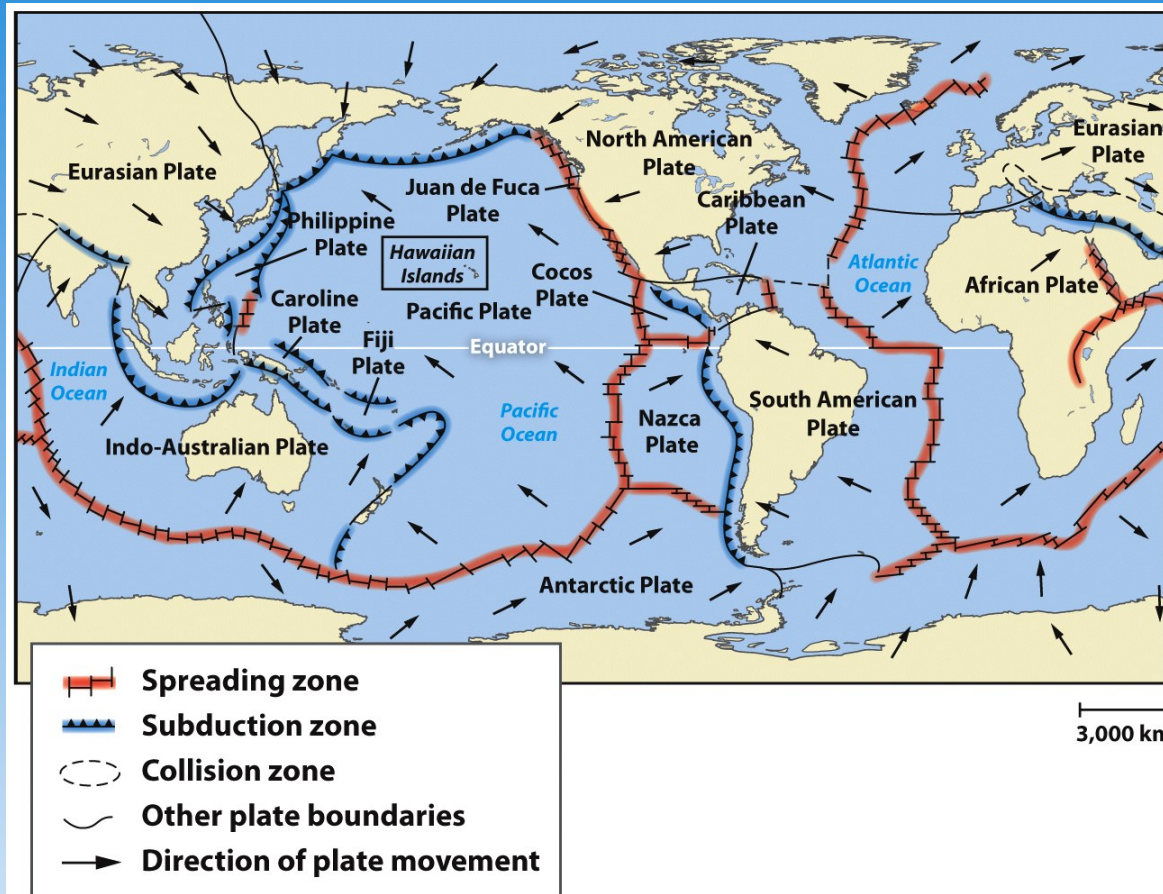
# Evidence supporting Pangea and its break-up



# More evidence



# Tectonic Plates

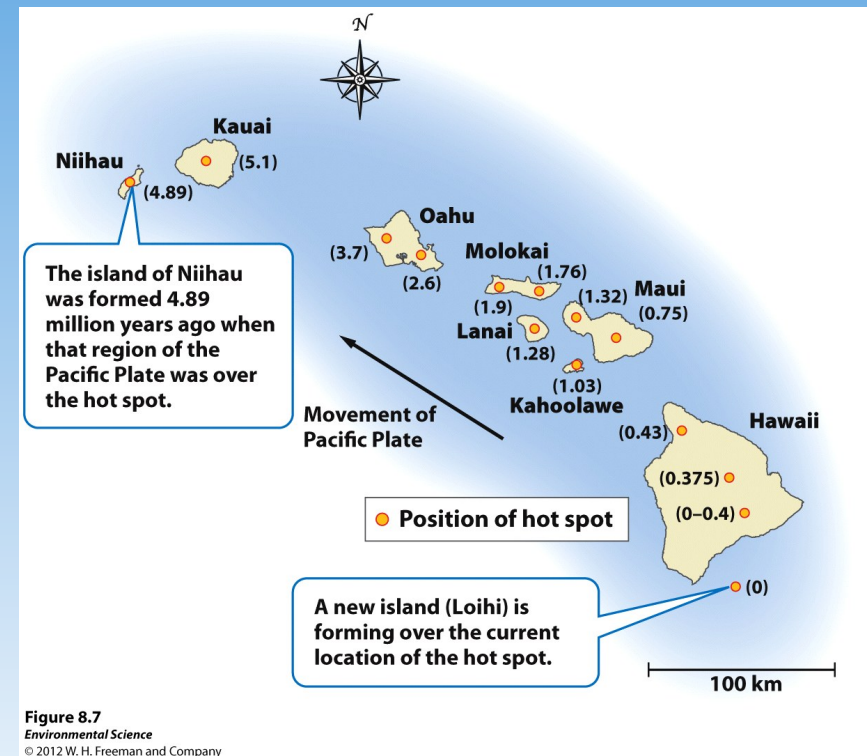


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# Consequences of Plate Movement

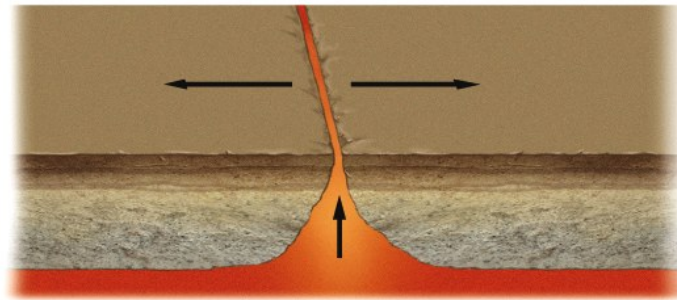
- Volcanoes- as a plate moves over a hot spot, rising magma forms a volcano.

Calculate the rate  
Of movement of  
the Pacific Plate  
In cm/yr..

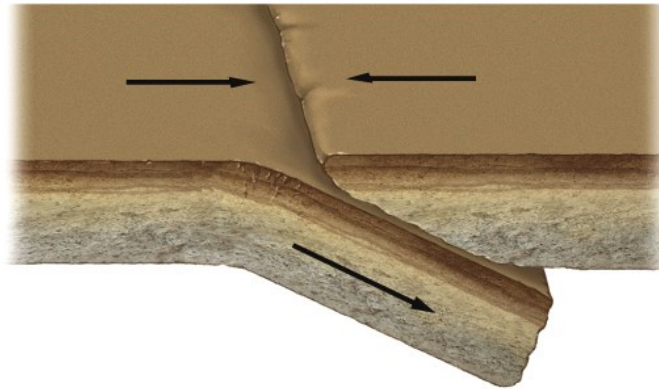


# Types of Plate Contact

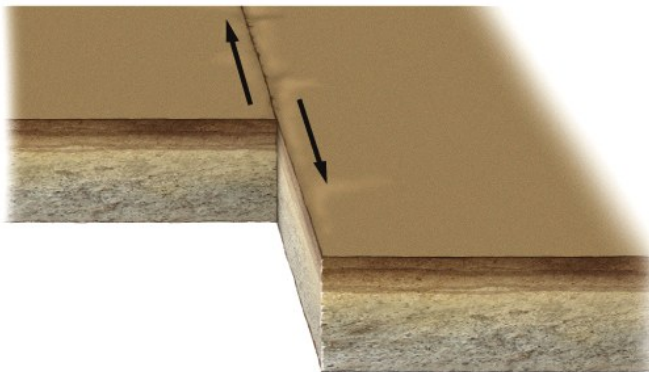
- ▣ **Divergent plate boundaries-** where plates move apart from one another.
- ▣ **Convergent plate boundaries-** where plates move toward one another and collide.
- ▣ **Transform fault boundaries-** where plates move sideways past each other.



**(a) Divergent plate boundary**



**(b) Convergent plate boundary**



**(c) Transform fault boundary**

**Figure 8.8**

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# Faults and Earthquakes

- ❑ **Faults**- a fracture in rock across which there is movement.
- ❑ **Earthquakes**- occur when the rocks of the lithosphere rupture unexpectedly along a fault.



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# Faults and Earthquakes

- ▣ **Fault zone-** large expanses of rock where movement has occurred.
- ▣ **Epicenter-** the exact point on the surface of Earth directly above the location where the rock ruptures.
- ▣ **Richter scale-** a measure of the largest ground movement that occurs during an earthquake. The scale increases by a factor of 10, so an earthquake of 7 is 10 times greater than an earthquake of 6.

# Environmental Hazards: Earthquakes and Volcanoes



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**Figure 8.13**  
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# The Rock Cycle

- ▣ **Rock cycle-** the constant formation and destruction of rock. Changes brought about by series of processes.

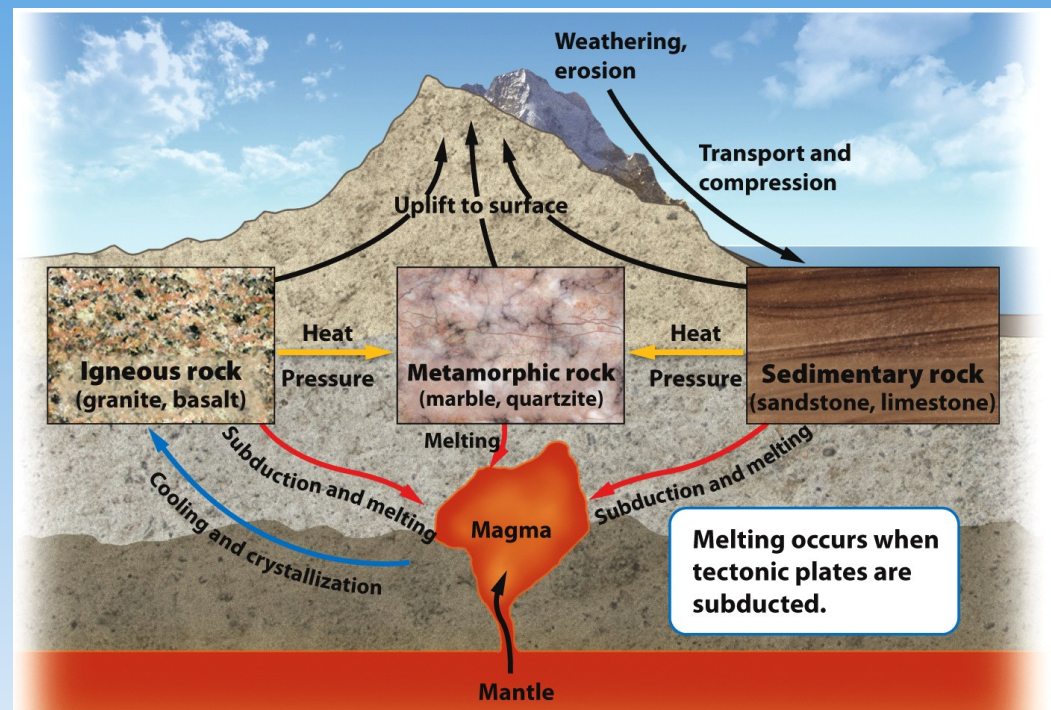
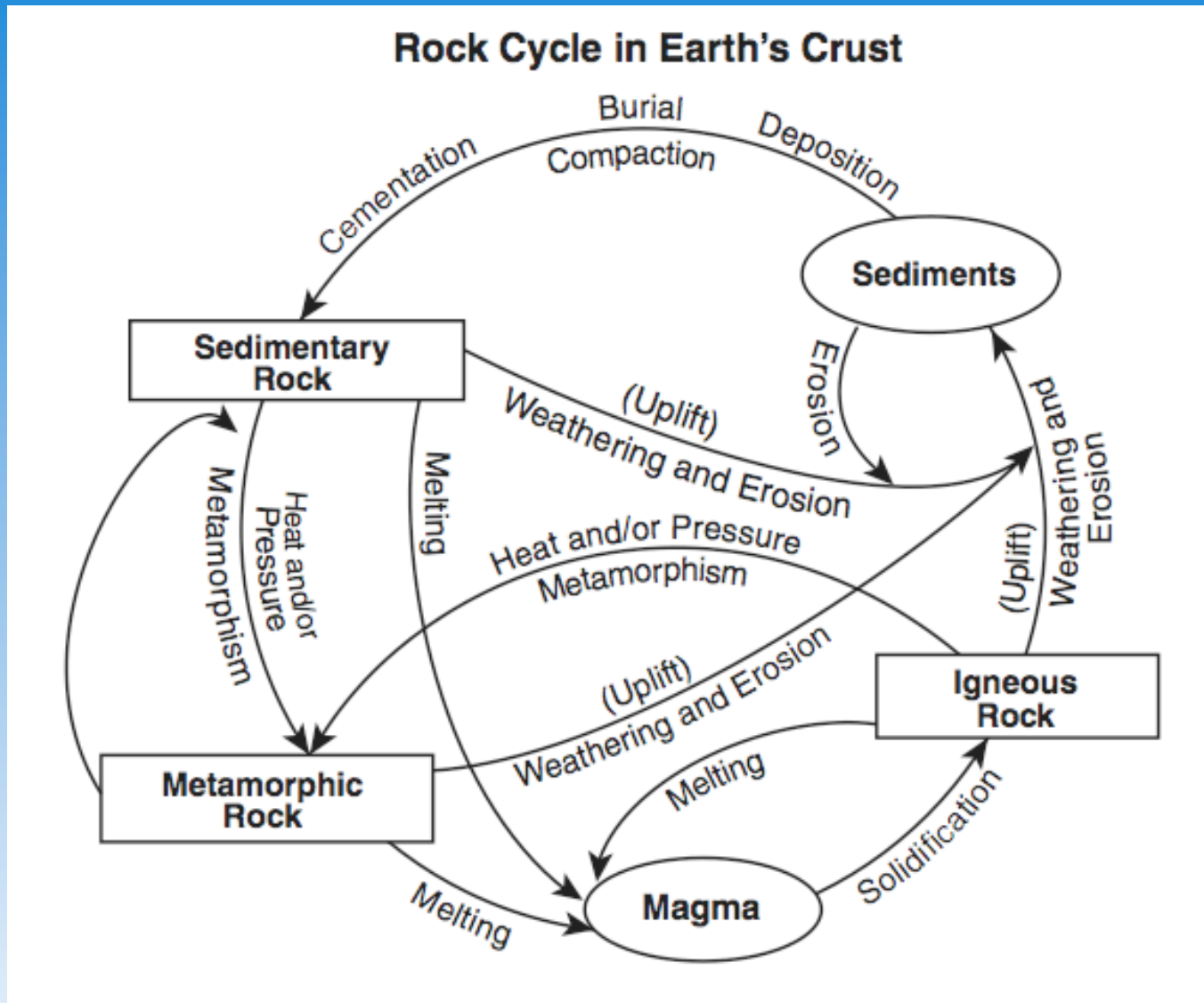


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# The Rock Cycle



# The Rock Cycle

- ▣ **Igneous rocks-** form directly from magma.
  - ▣ **Intrusive rocks-** form from within Earth as magma cools.
  - ▣ **Extrusive rocks-** form when magma cools above Earth.  
(ex. A volcano that ejects magma out will form this)
- ▣ **Sedimentary rocks-** sediments such as mud, sands, or gravels are compressed by overlying sediments.
- ▣ **Metamorphic rocks-** form when existing rocks are subjected to high temperatures and pressures, changing the physical and chemical properties of the rock.

# Igneous Rocks

## Intrusive vs. Extrusive

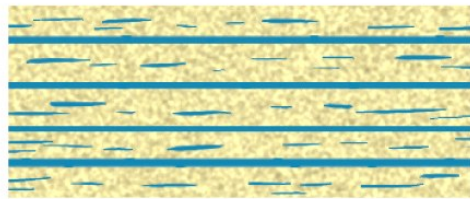
## Plutonic vs. Volcanic



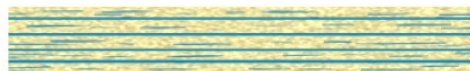
# Sedimentary Rocks

## From sediment to “solid” rock

Compaction

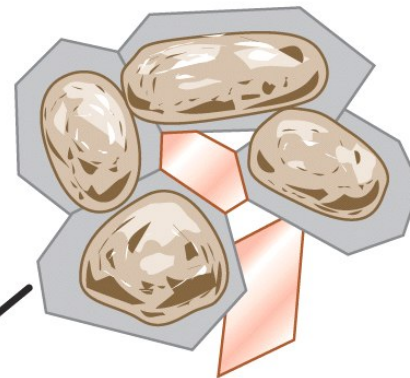


50–60% water



10–20% water

Cementation



Lithification

# Metamorphic Rocks

## Changed Rocks



**Granite**



**Metamorphism**

**Add Heat  
and/or  
pressure**



**Gneiss**



**Limestone**



**Metamorphism**

**Add Heat**



**Marble**



# Weathering and Erosion

- ▣ **Weathering-** when rocks are exposed to air, water, certain chemicals or biological agents that degrade the rock.
  - ▣ **Physical weathering-** the mechanical breakdown of rocks and minerals.



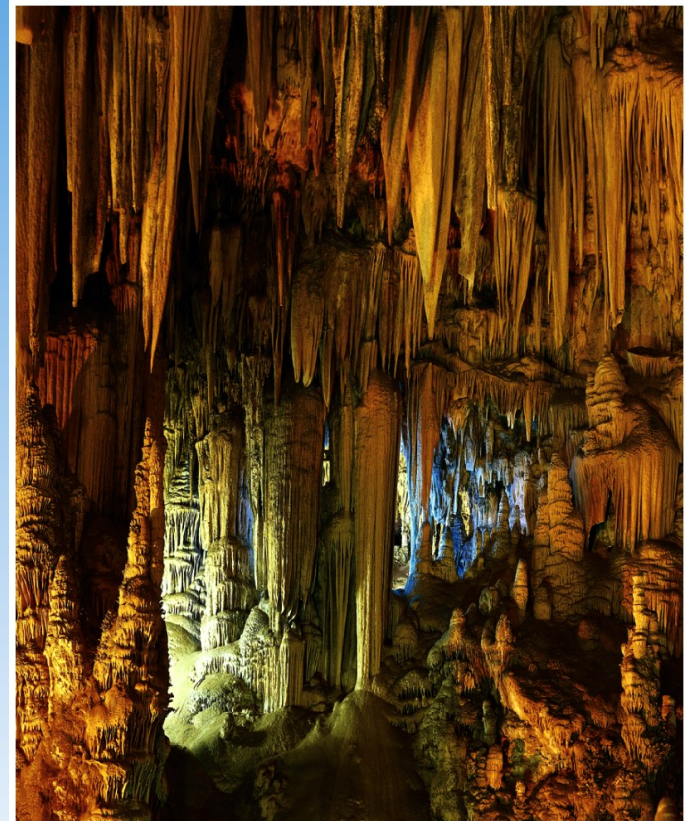
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Figure 8.16b  
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# Weathering and Erosion

- ▣ **Chemical weathering-** the breakdown of rocks and minerals by chemical reactions.



**Figure 8.17**  
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# Erosion

- ▣ **Erosion-** the physical transport of rock fragments within a landscape or ecosystem. Wind, water, ice and gravity all can transport weathered materials.
- ▣ **Deposition-** the accumulation or depositing of eroded material such as sediment, rock fragments or soil.



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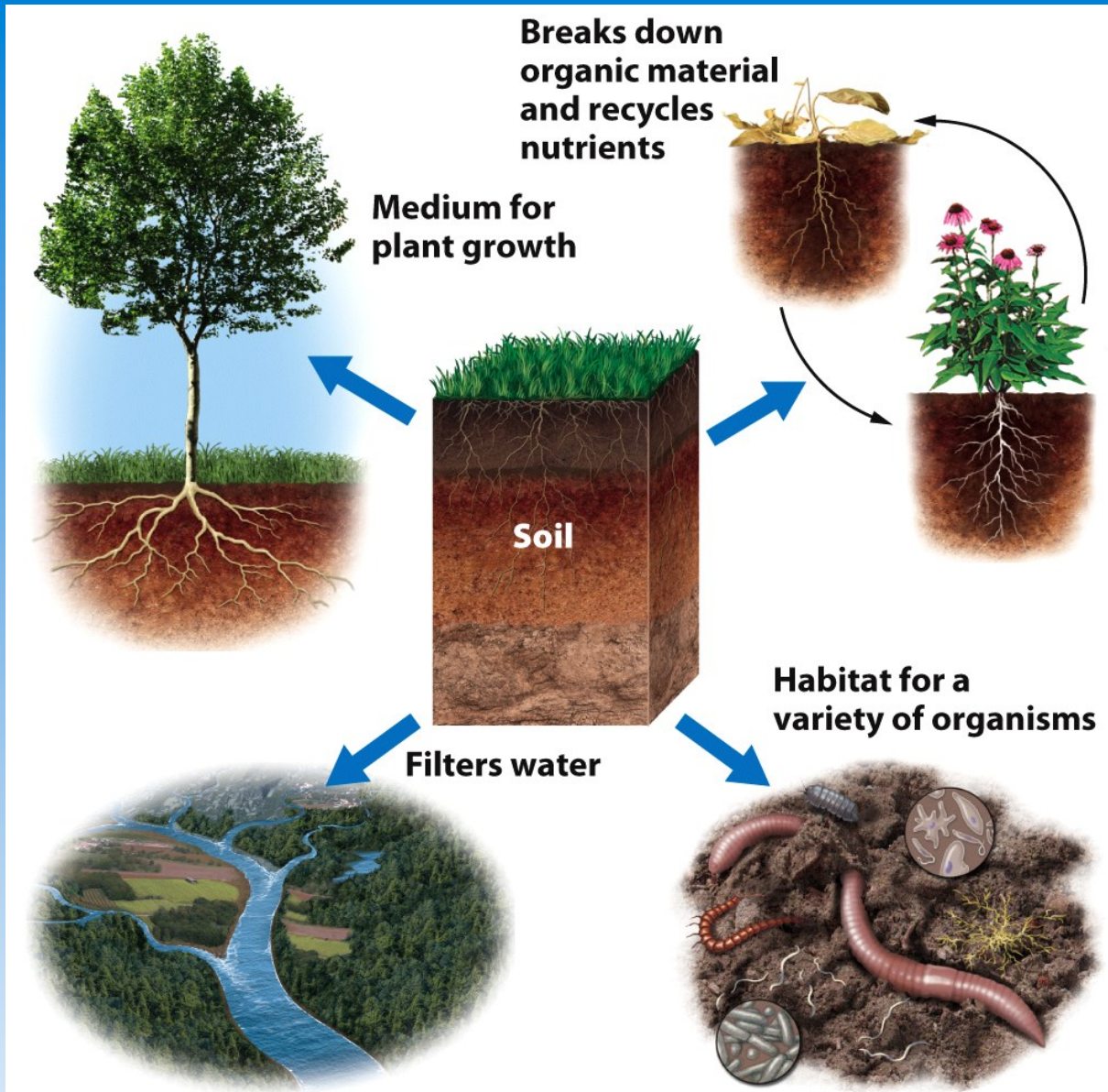
# Soil is a mixture...

Geological components:  
(physical and chemical)

Biological components:

# Soil

- ▣ Soil is important because it
  - ▣ Is a medium for plant growth
  - ▣ Serves as a filter for water
  - ▣ A habitat for living organisms
  - ▣ Serves as a filter for pollutants



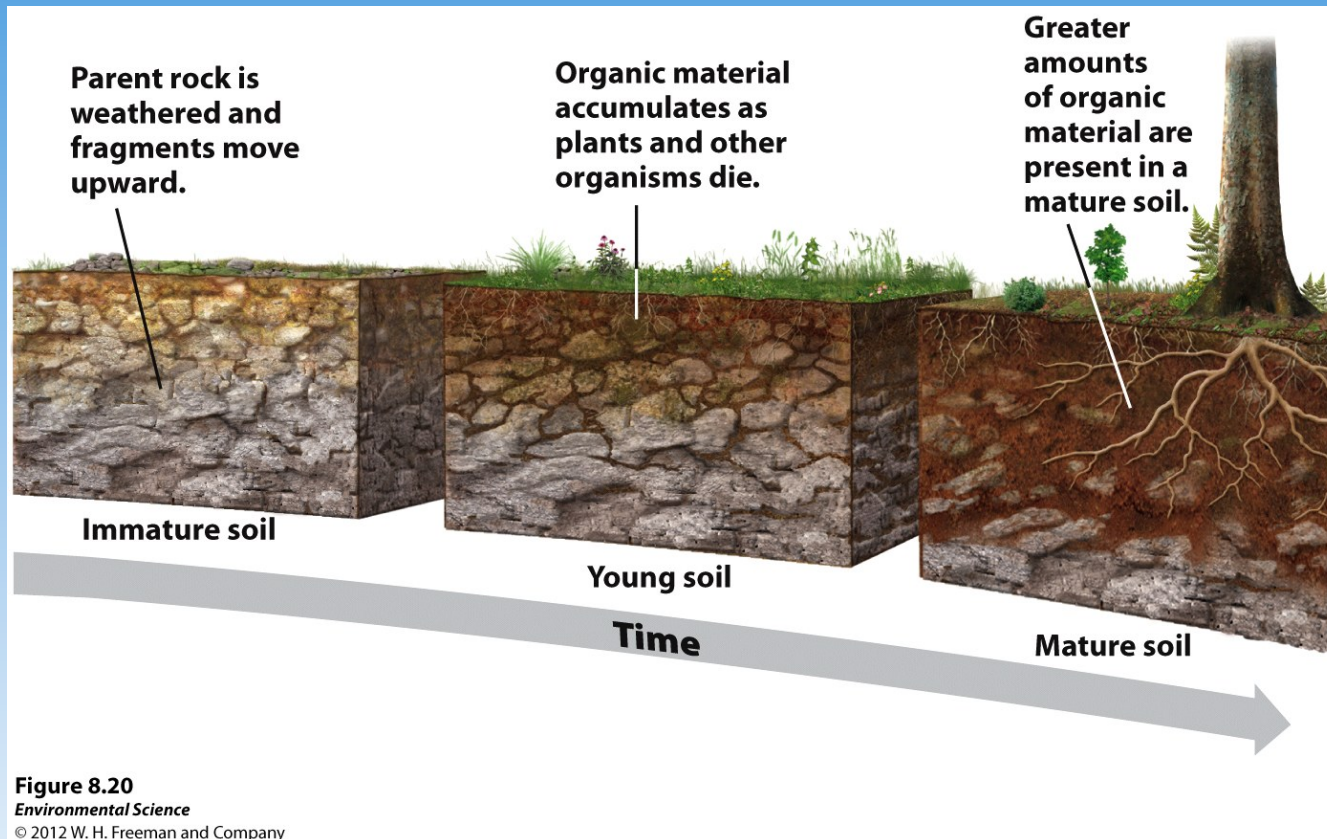
**Figure 8.19**  
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# The Formation of Soil

- **Parent material**- what the soil is made from influences soil formation
- **Climate**- what type of climate influences soil formation
- **Topography**- the surface and slope can influence soil formation
- **Organisms**- plants and animals can have an effect on soil formation
- **Time**- the amount of time a soil has spent developing can determine soil properties.

# The Formation of Soil

- ▣ **Parent Material-** the rock material from which soil is derived.





# Soil Horizons

- As soils form, they develop characteristic layers.

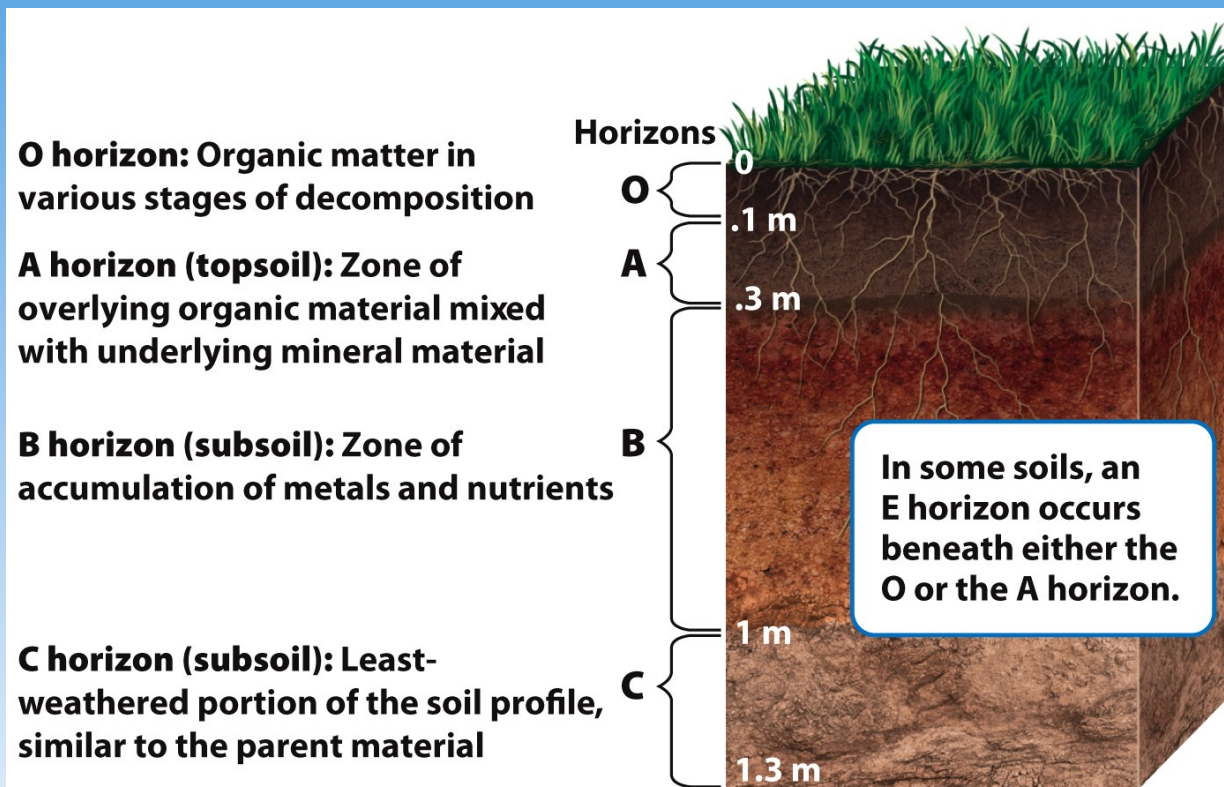


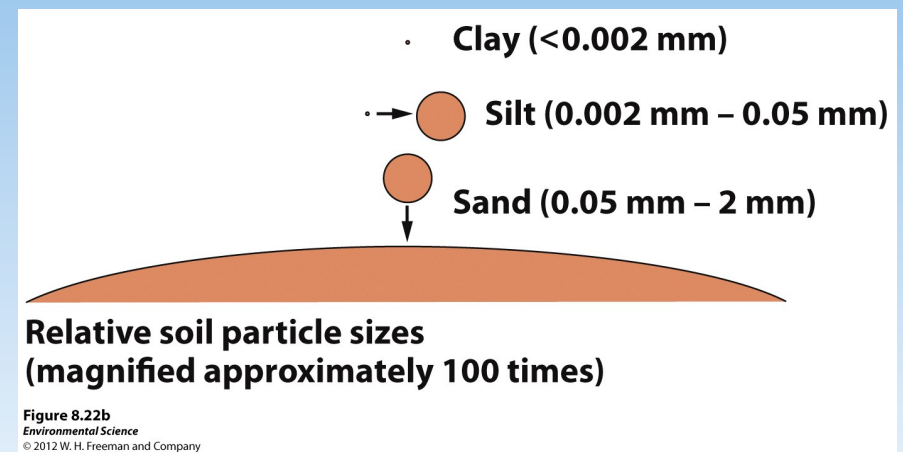
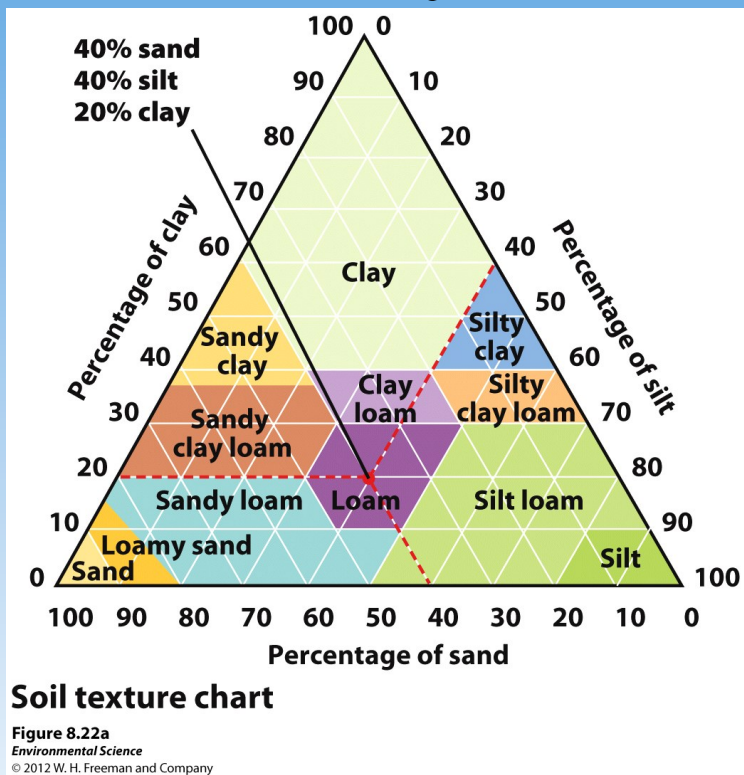
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# Soil Horizons

- ❑ **O horizon-** (organic layer) composed of the leaves, needles, twigs and animal bodies on the surface.
- ❑ **A horizon-** (topsoil) the zone of organic material and minerals mixed together.
- ❑ **B horizon-** (subsoil) composed primarily of mineral material with very little organic matter
- ❑ **C horizon-** (parent material) the least weathered horizon and is similar to the parent material.

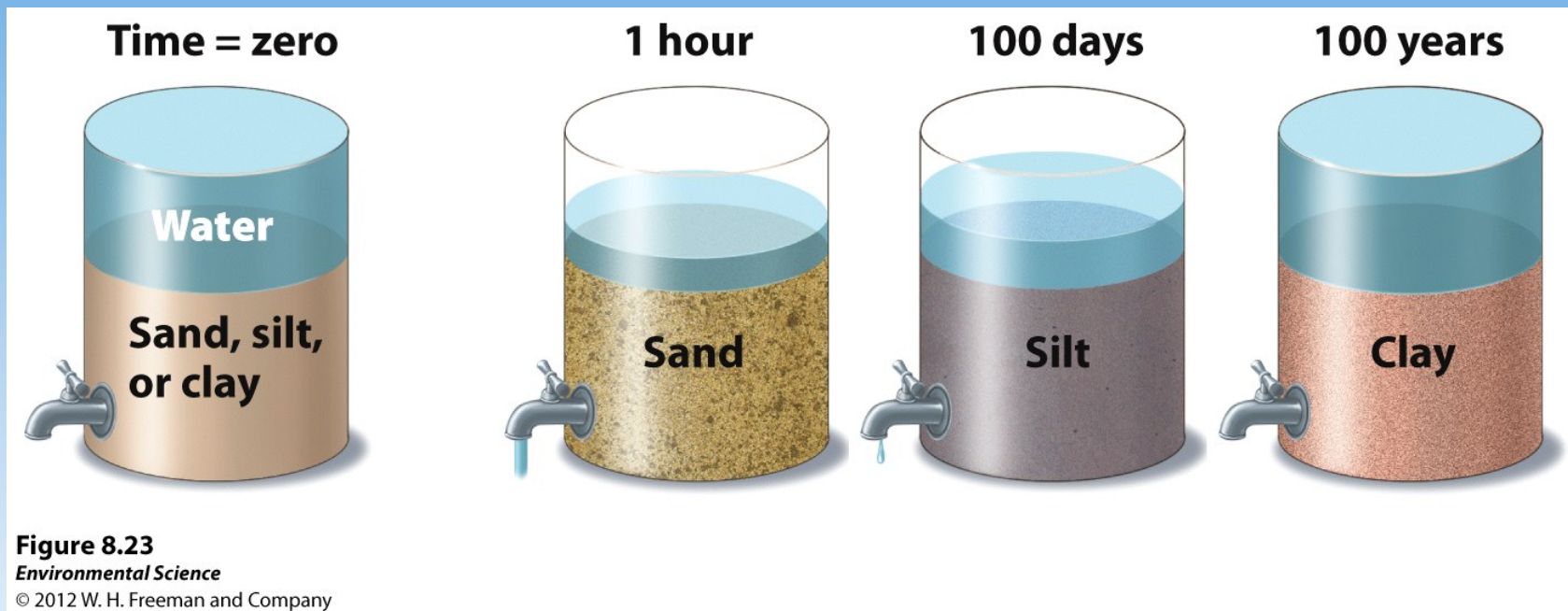
# Physical Properties of Soil

- **Texture-** the percentage of sand, silt and clay the soil contains.



# Physical Properties of Soil

- ▣ **Porosity**- how quickly the soil drains (which depends on its texture)...**Permeability!**



# Chemical Properties of Soil

**Cation exchange capacity (CEC)**- the ability of a soil to adsorb and release cations, positively charged mineral ions.

**Soil bases**- calcium, magnesium, potassium and sodium

**Soil Acids**- aluminum, hydrogen, sulfur

**Base saturation**- the proportion of soil bases to soil acids

# Chemical Properties

## Key Plant Nutrients

**FERTILIZER**

**21-3-20**  
N P K

50 lbs.

Nitrogen: key nutrient in plant growth.  
21% N in a 50 lb. bag = 10.5 lbs. N

Phosphorus: important for establishment.  
3% P in a 50 lb. bag = 1.5 lbs. P

Potassium: will increase stress tolerance.  
20% K in a 50 lb. bag = 10 lbs. K

P & K needed only as soil test indicates

# Biological Properties of Soil

- ▣ Many organisms are found in the soil including fungi, bacteria, protozoans, rodents and earthworms.

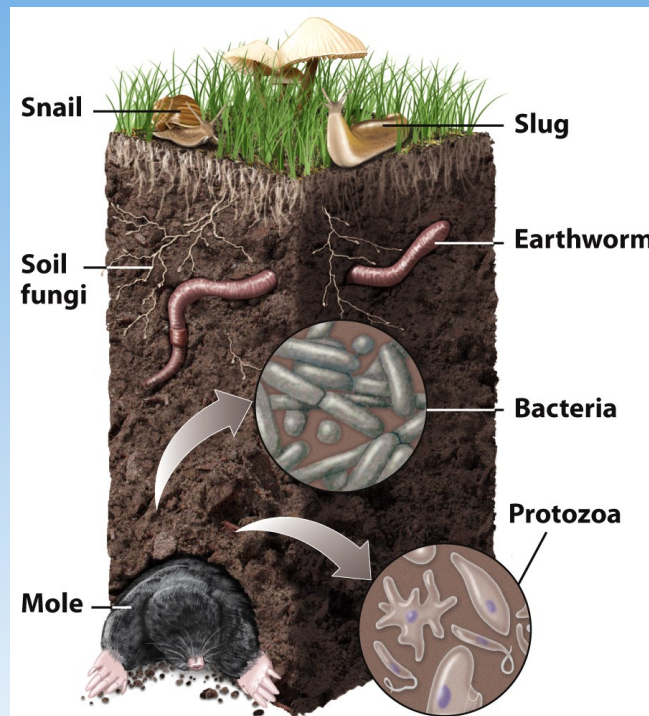


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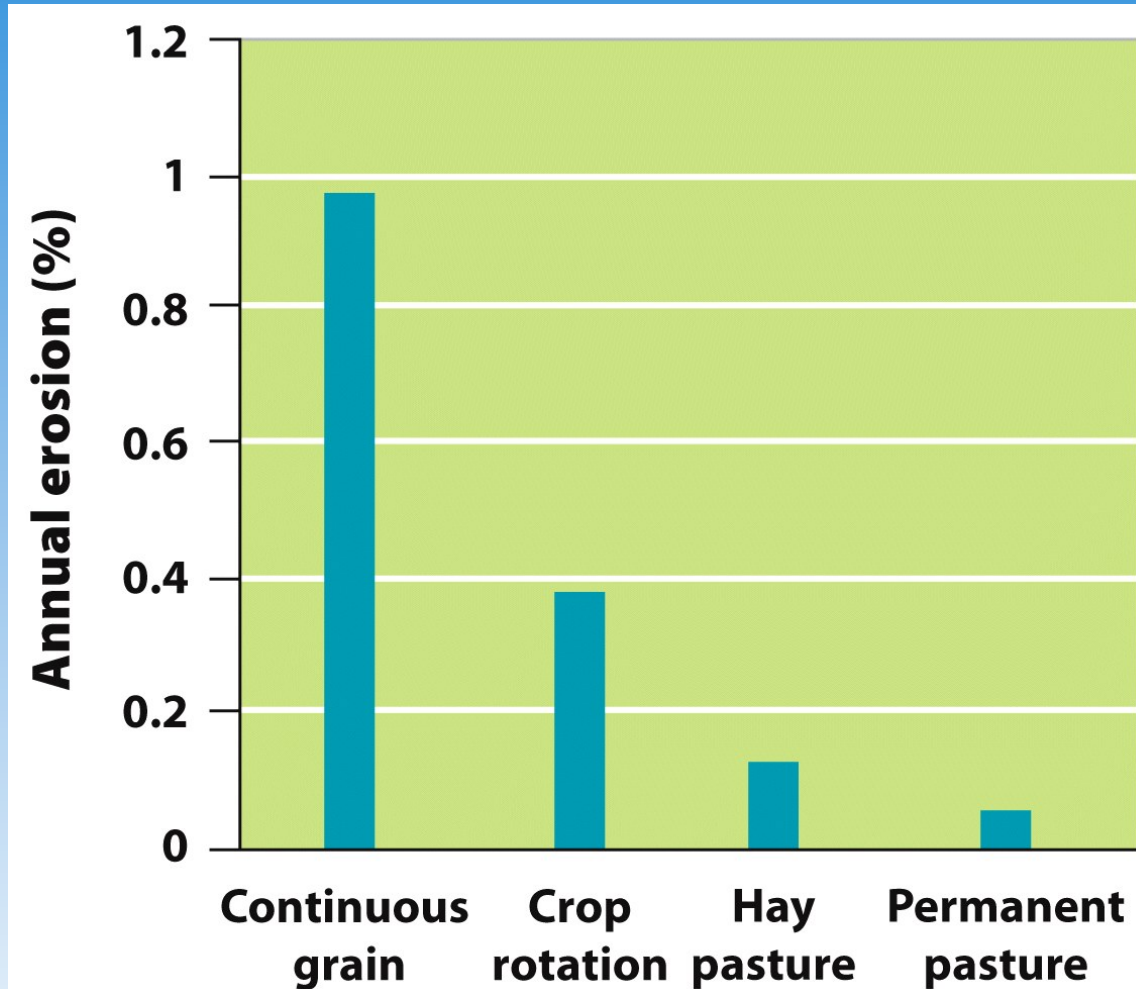
**Figure 8.25**

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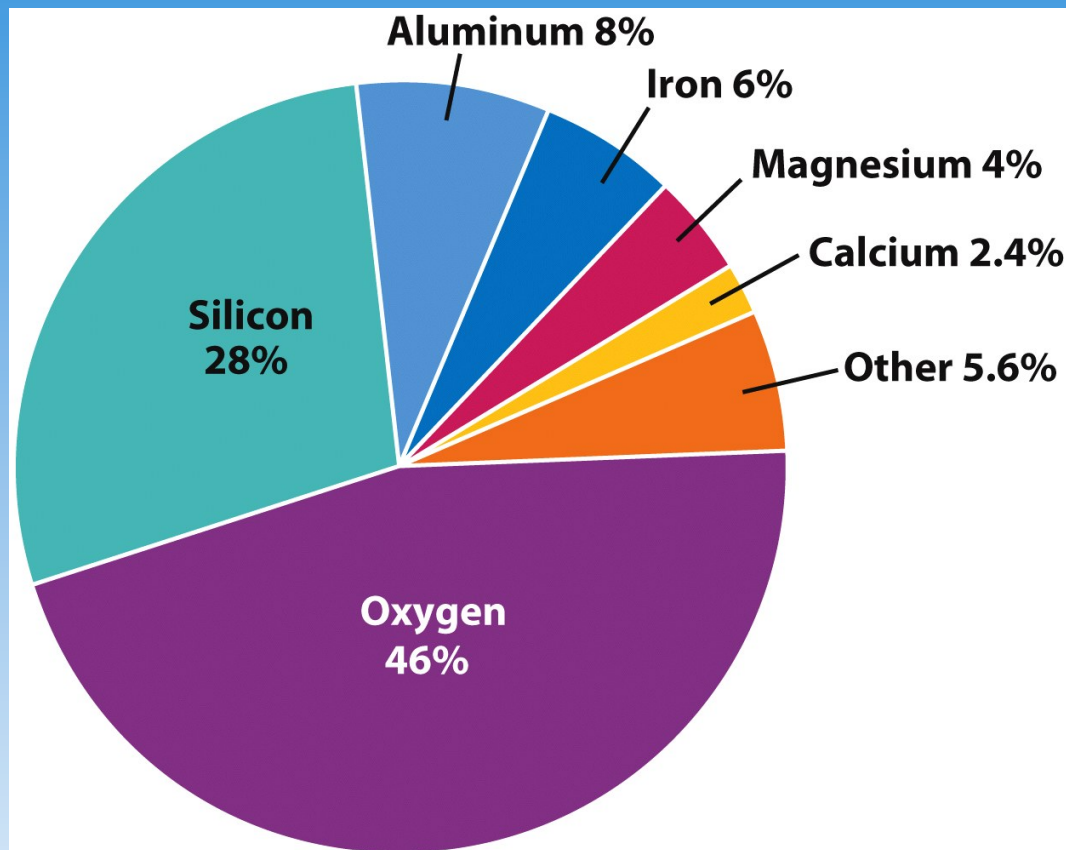
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# Agriculture Techniques and Soil Erosion

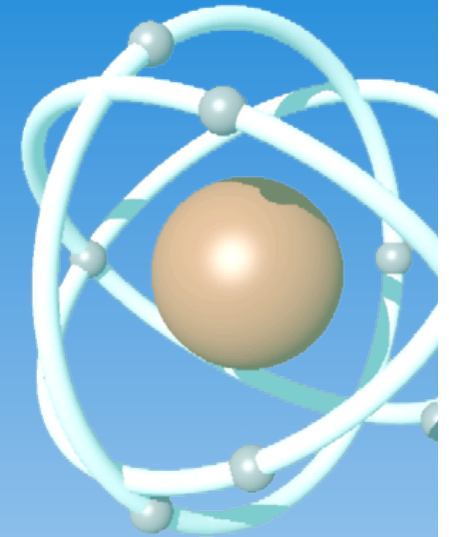


# Elemental Composition of the Earth's Crust

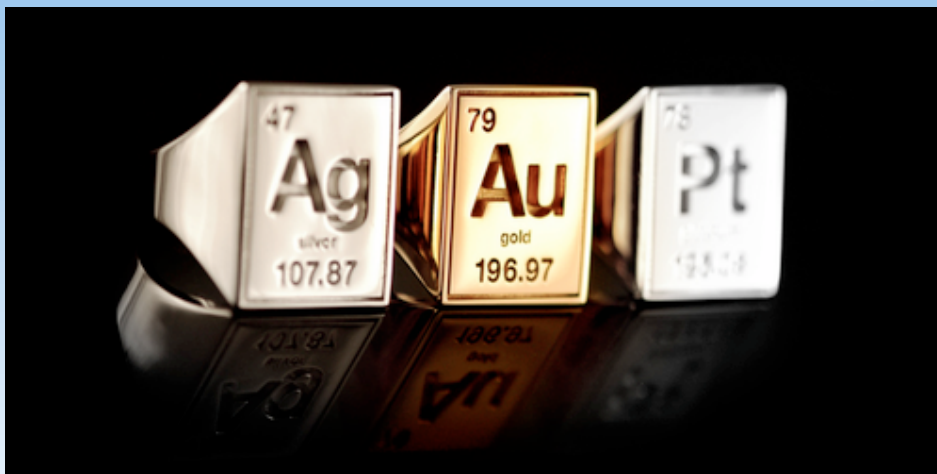


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# Metals



Platinum (Pt) - Periodic Table of Elements - Precious Metals



# Ores



# Disseminated Deposits



Copper

Silver



# Reserves

- ▣ **Reserves-** the known quantity of a resource that can be economically recovered.

<b>TABLE 8.1 Approximate supplies of metal reserves remaining</b>		
<b>Metal</b>	<b>Global reserves remaining (years)</b>	<b>U.S. reserves remaining (years)</b>
Iron (Fe)	120	40
Aluminum (Al)	330	2
Copper (Cu)	65	40
Lead (Pb)	20	40
Zinc (Zn)	30	25
Gold (Au)	30	20
Nickel (Ni)	75	0
Cobalt (Co)	50	0
Manganese (Mn)	70	0
Chromium (Cr)	75	0

Sources: S. Marshak, *Earth: Portrait of a Planet*, 3rd ed. (W. W. Norton, 2007); U.S. Geological Survey Mineral Commodity Summaries, <http://minerals.er.usgs.gov/minerals/pubs/mcs/>.

# Increasing Reserves...they are not fixed (but may be finite)

- ▣ Employ the 3 R's!
- ▣ Find more! Use new technologies!
- ▣ Raise the price! Helps with the first 2....

# Non-Metallic Resources

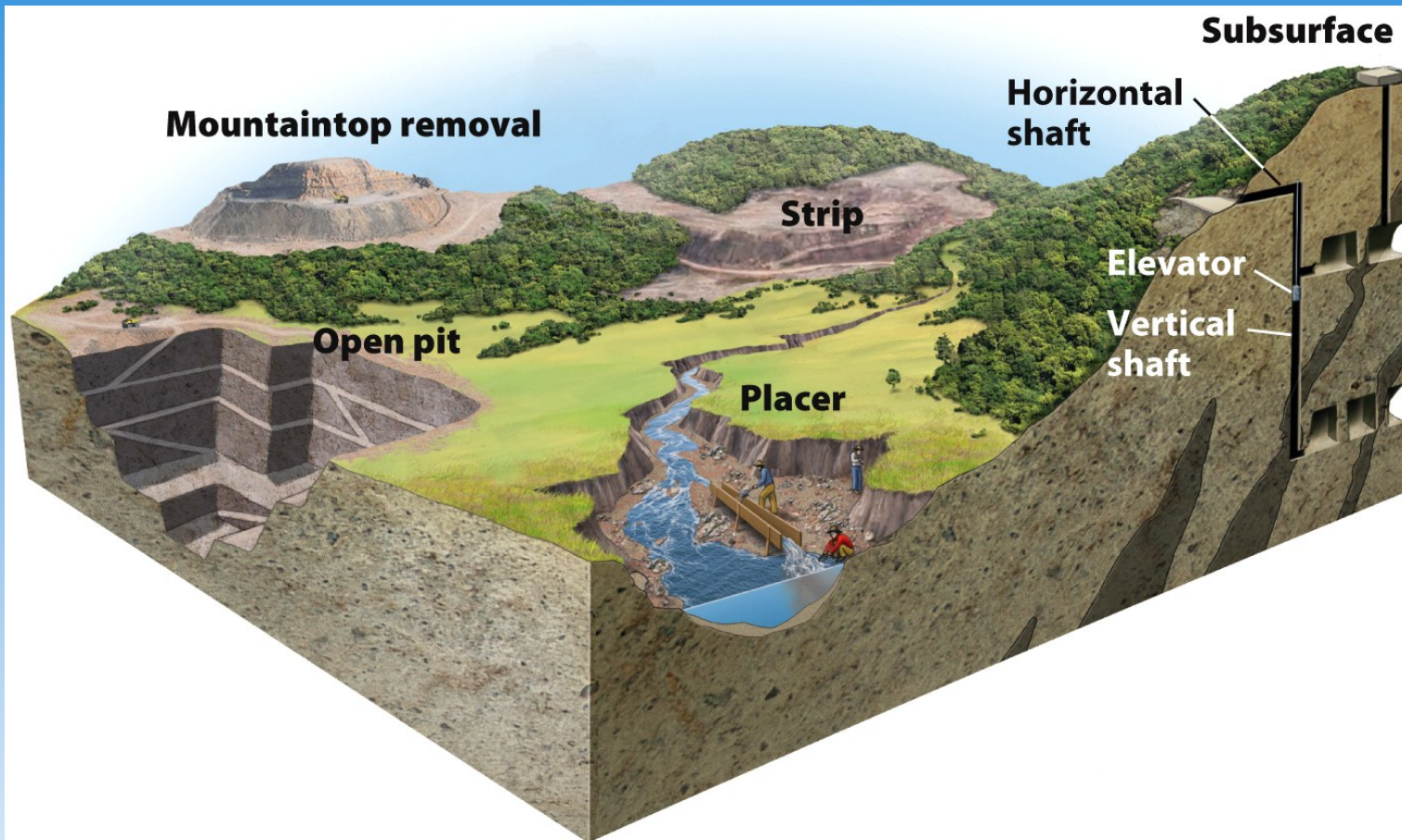
- ▣ Coal
- ▣ Salt
- ▣ Gypsum
- ▣ Precious Gems
- ▣ Semi-precious stones
- ▣ Dimension stone
- ▣ Aggregate



# Types of Mining

- ▣ **Surface mining-** removing minerals that are close to Earth's surface.
  - ▣ **Strip mining-** removing strips of soil and rock to expose ore.
  - ▣ **Open pit mining-** the creation of a large pit or hole in the ground that is visible from the surface.
  - ▣ **Mountain top removal-** removing the entire top of a mountain with explosives.
  - ▣ **Placer mining-** looking for metals and stones in river sediments.

# Extraction Techniques



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# Strip Mining



**Figure 8.28a**

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# Strip Mine – Reclaimed!



**Figure 8.28b**

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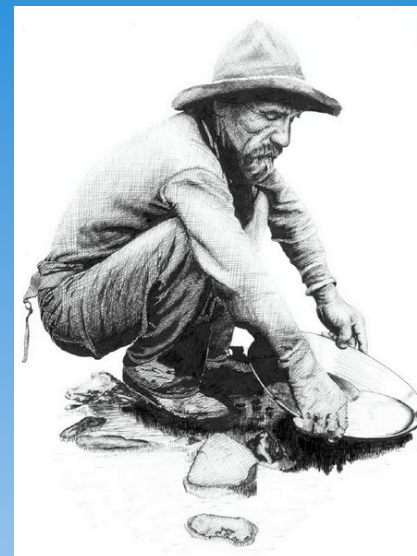
# Open Pit Mining



# Mountain Top Removal



# Panning for Placer Deposits



# Types of Mining

- ▣ Subsurface mining- mining for resources that are 100 m below Earth's surface.

<b>TABLE 8.2 Types of mining operations and their effects</b>					
<b>Type of mining operation</b>	<b>Effects on air</b>	<b>Effects on water</b>	<b>Effects on soil</b>	<b>Effects on biodiversity</b>	<b>Effects on humans</b>
<b>Surface mining</b>	<b>Significant dust from earth-moving equipment</b>	<b>Contamination of water that percolates through tailings</b>	<b>Most soil removed from site; may be replaced if reclamation occurs</b>	<b>Habitat alteration and destruction over the surface areas that are mined</b>	<b>Minimal in the mining process, but air quality and water quality can be adversely affected near the mining operation</b>
<b>Subsurface mining</b>	<b>Minimal dust at the site, but emissions from fossil fuels used to power mining equipment can be significant</b>	<b>Acid mine drainage as well as contamination of water that percolates through tailings</b>		<b>Road construction to mines fragments habitat</b>	<b>Occupational hazards in mine; possibility of death or chronic respiratory diseases such as black lung disease</b>

**Table 8.2**

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# Subsurface Mining



# Problems of Mining Spoils and Tailings



# Problems of Mining

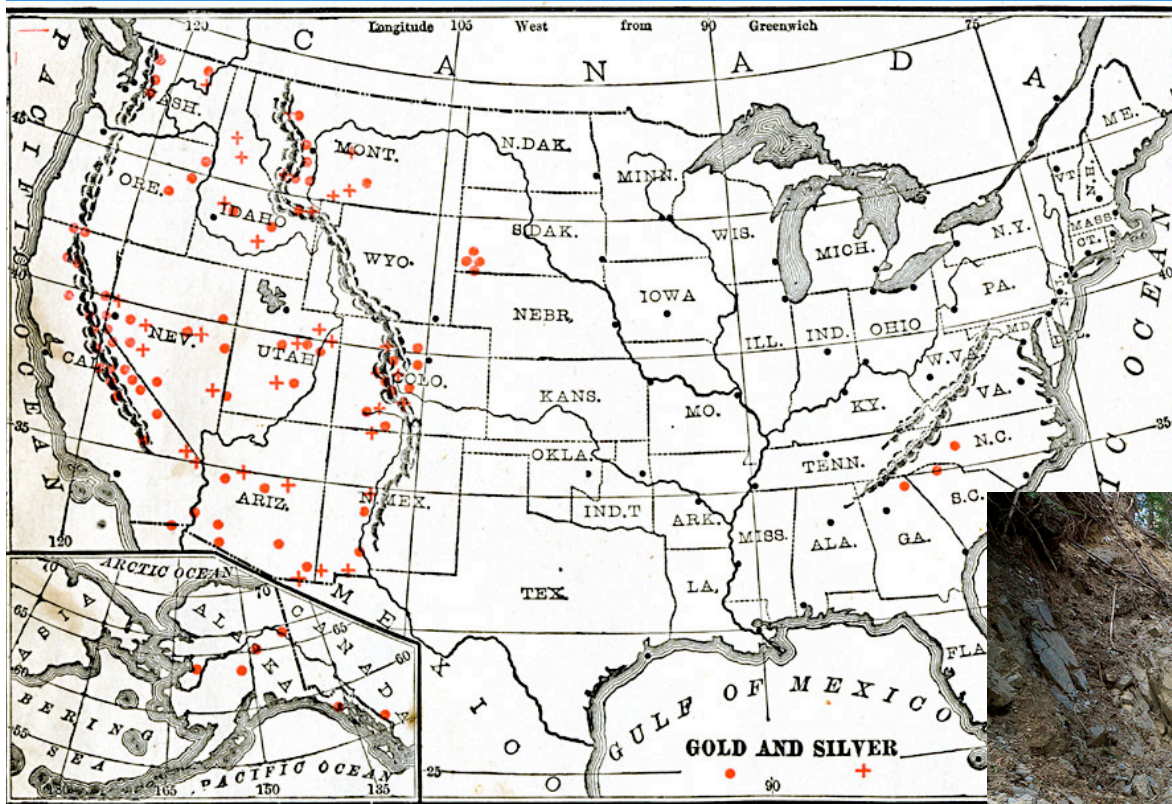
## Acid Mine Drainage/Water Pollution



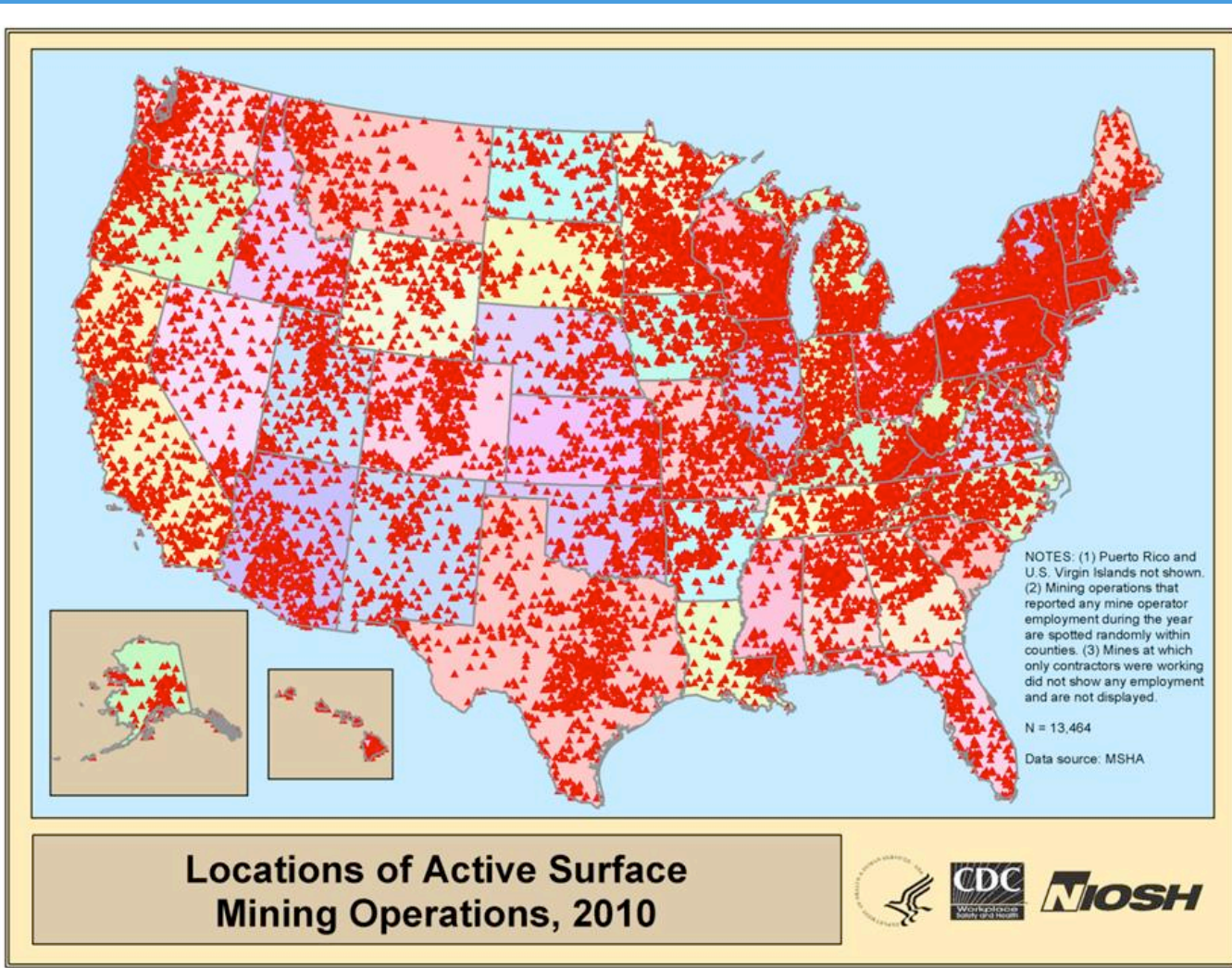
# Problems of Mining Air Pollution and Safety



# Legislation: 1872 – General Mining Act



# 1977 Surface Mining Control and Reclamation Act



# Strip Mining



# Reclamation of a strip mine



**Figure 8.28b**

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