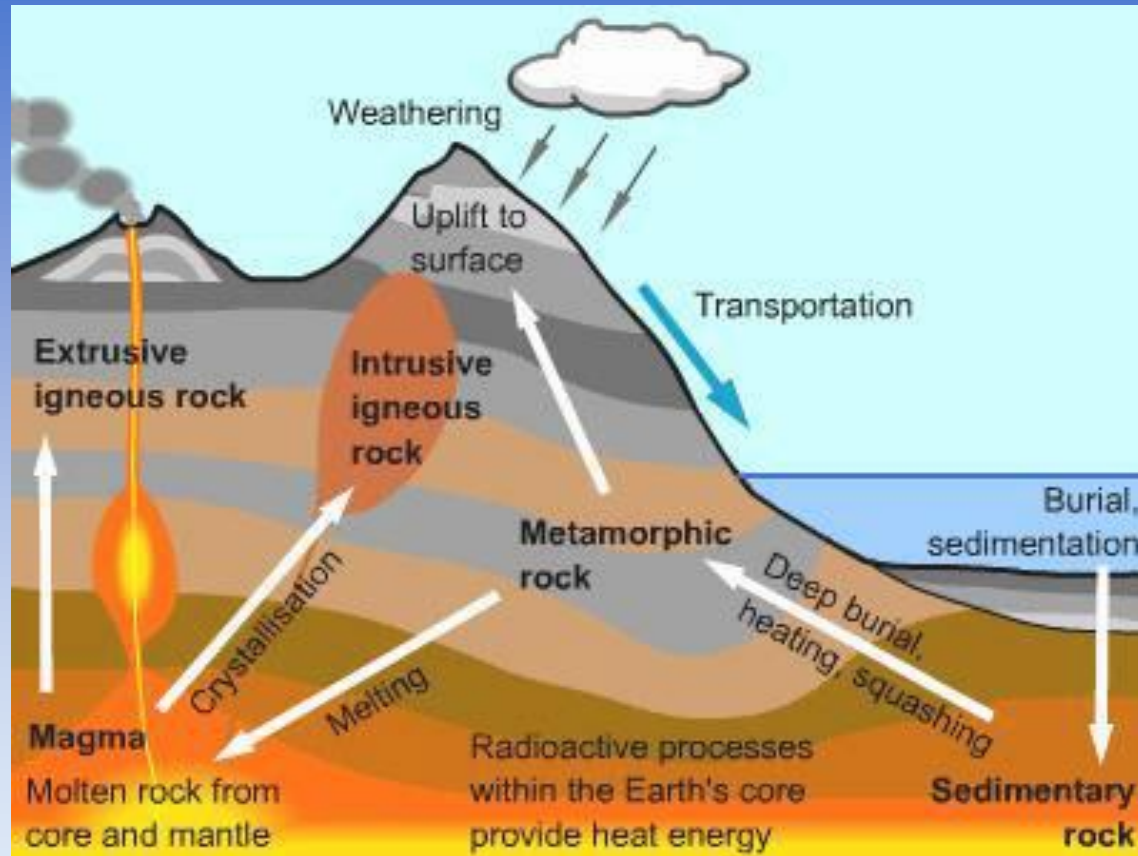




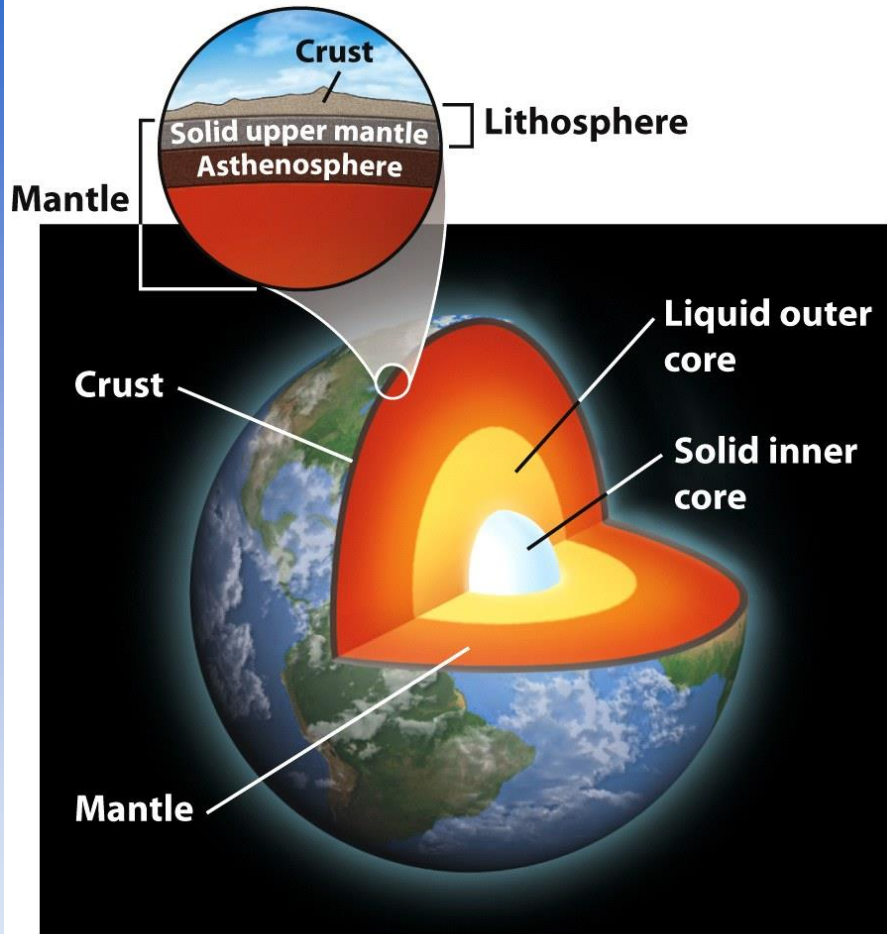
Chapter 8

Earth Systems and Resources

Rock Cycle!

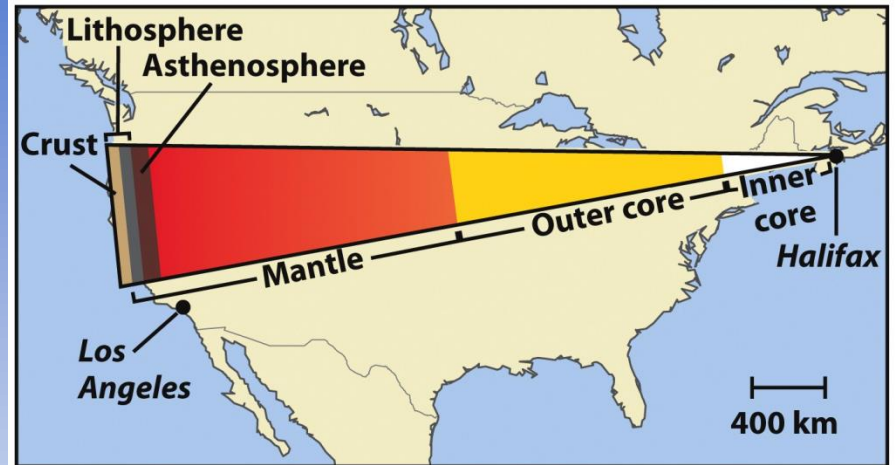


- Please take out two pieces of scratch paper



Earth's vertical zonation

Figure 8.2a
Environmental Science
 © 2012 W. H. Freeman and Company



Scale of Earth's layers

Figure 8.2b
Environmental Science
 © 2012 W. H. Freeman and Company

The outer part of the mantle, composed of semi-molten rock is the

- ▣ A. Stratosphere
- ▣ B. Asthenosphere
- ▣ C. Crust
- ▣ D. Core
- ▣ E. Lithosphere

SMART Response Qu

To set the properties right click and select
SMARTResponse Question Object->Properties...

Convection and Hot Spots

- ▣ The Earth is very hot at the center.
- ▣ This heat causes plumes of hot magma to well upward from the mantle.
- ▣ Hotspots- places where molten material from the mantle reach the lithosphere.

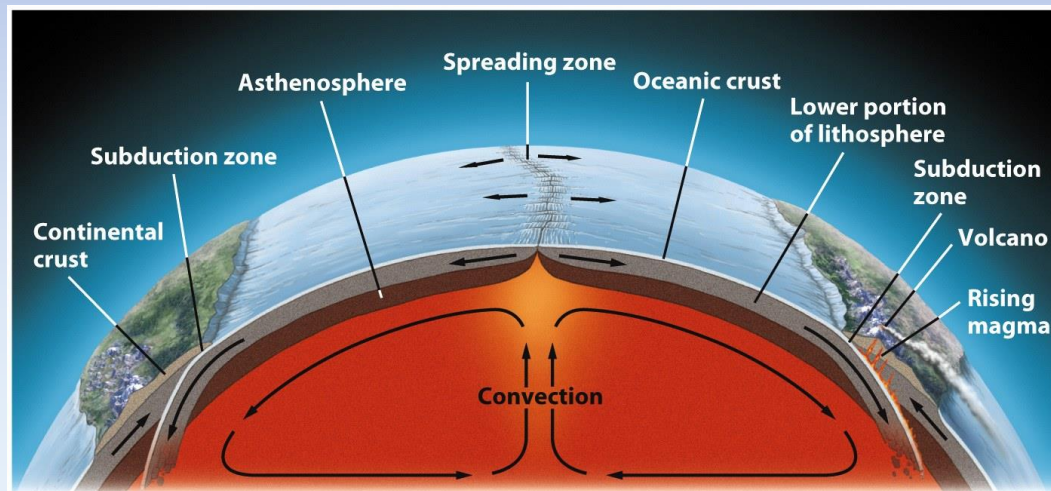
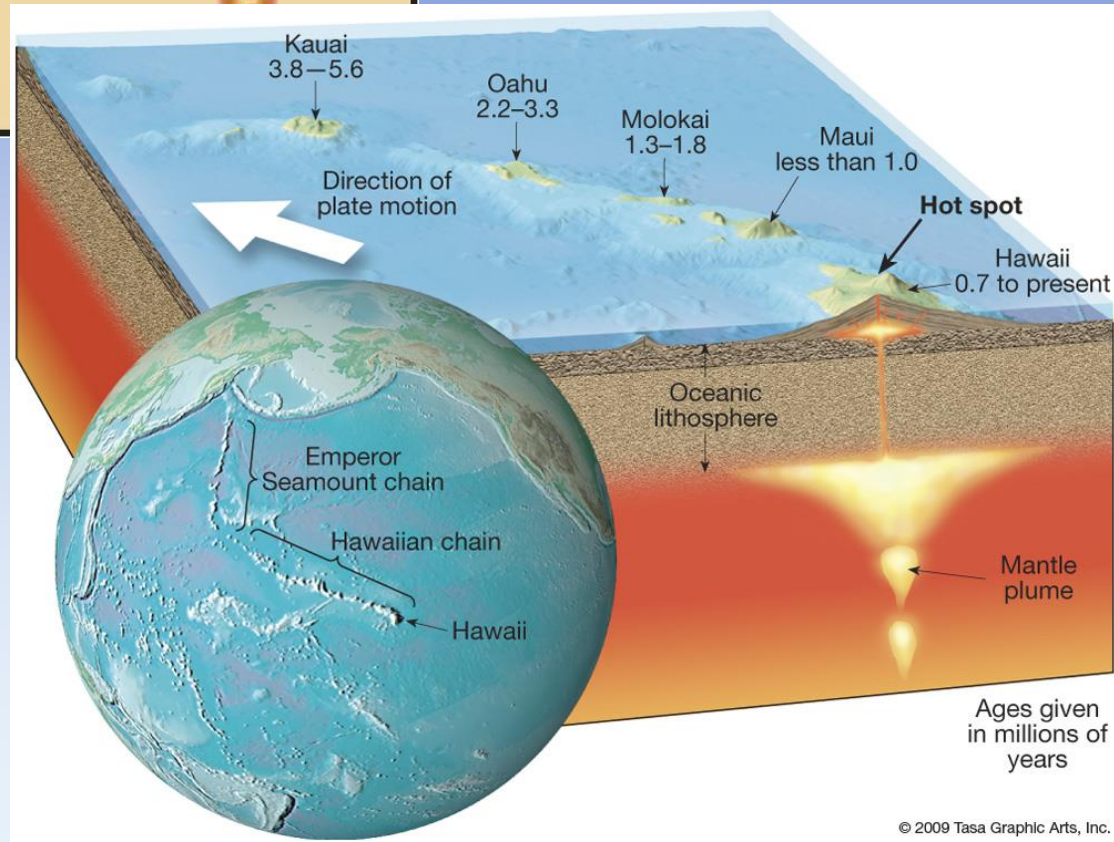
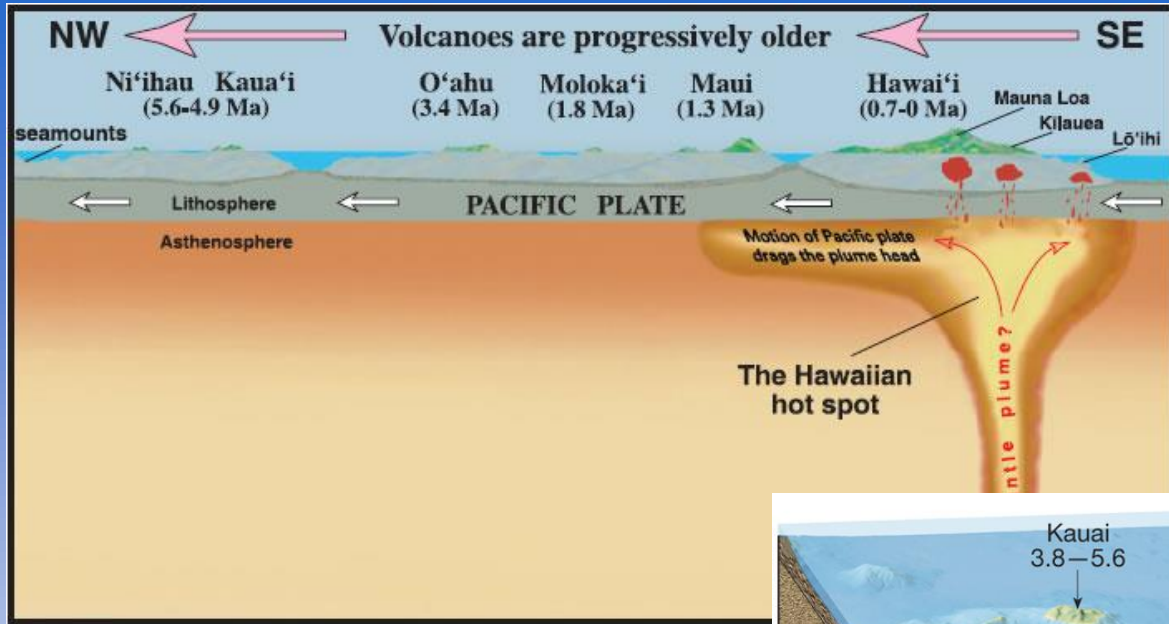


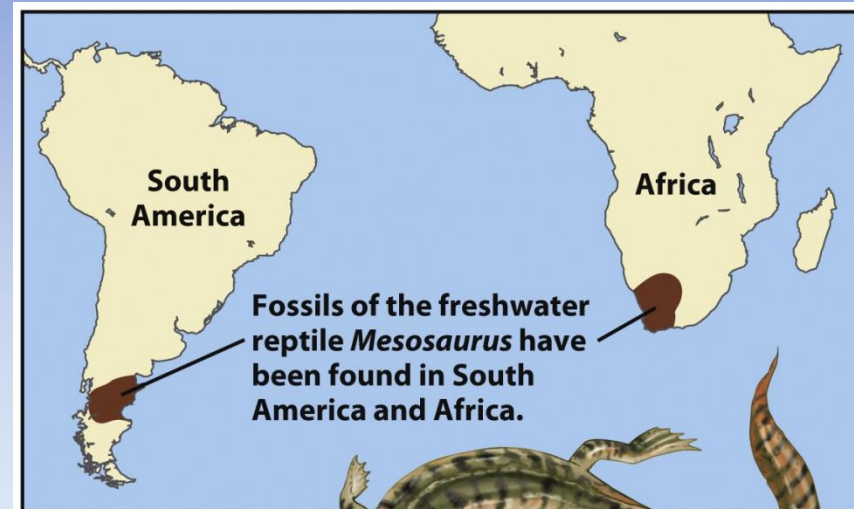
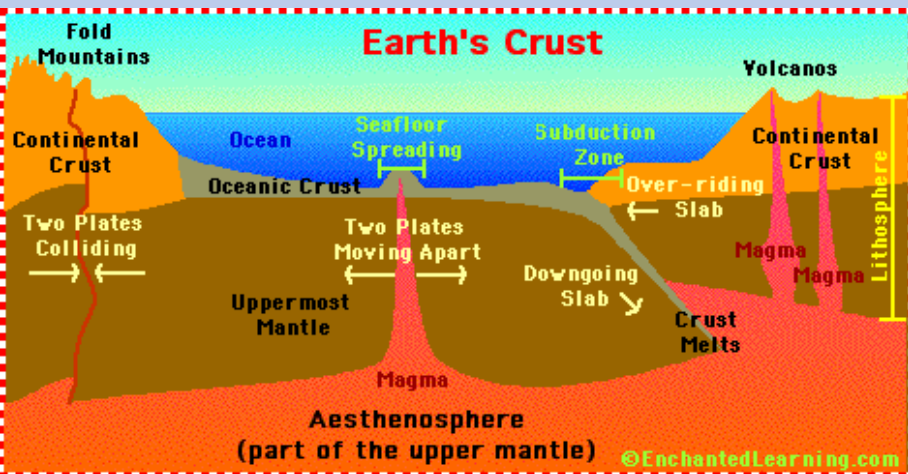
Figure 8.5
Environmental Science
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Hawaii

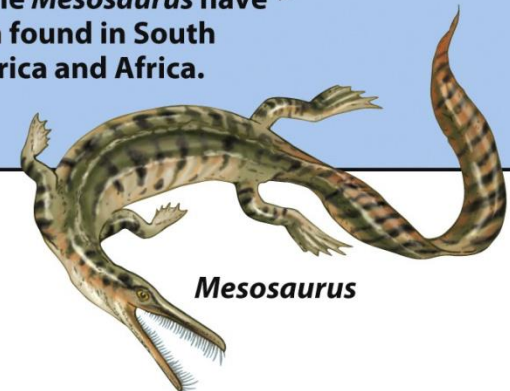


Theory of Plate Tectonics

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



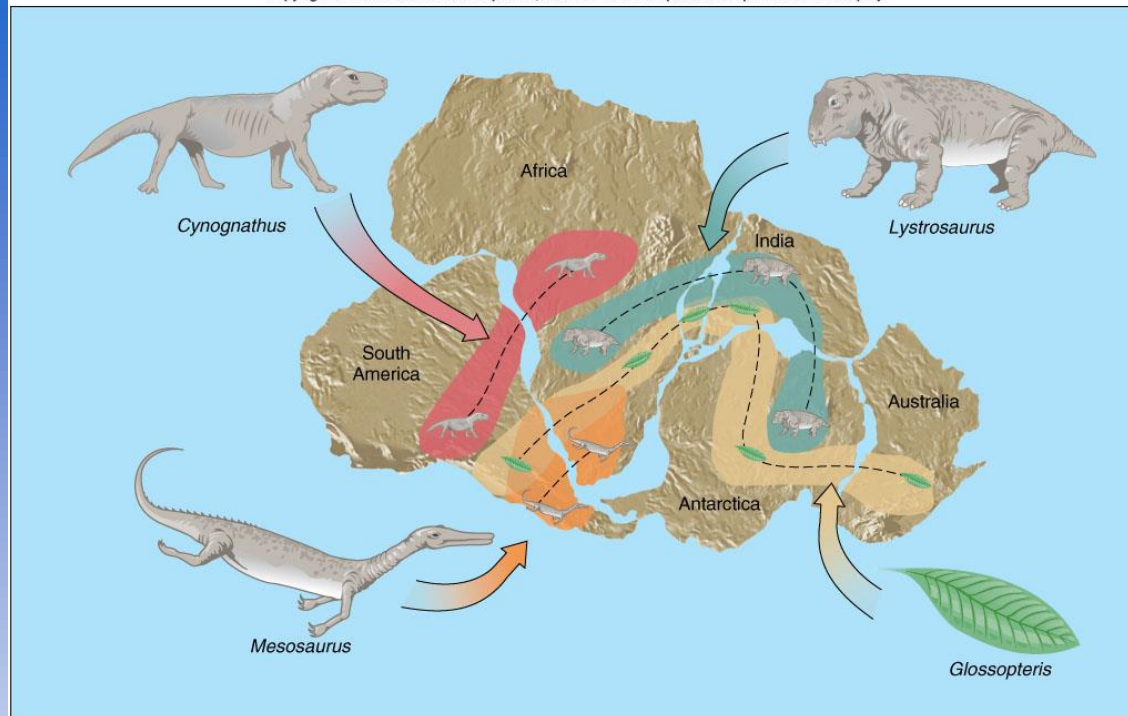
Fossil evidence



Mesosaurus



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Freshwater
Mesosaurus



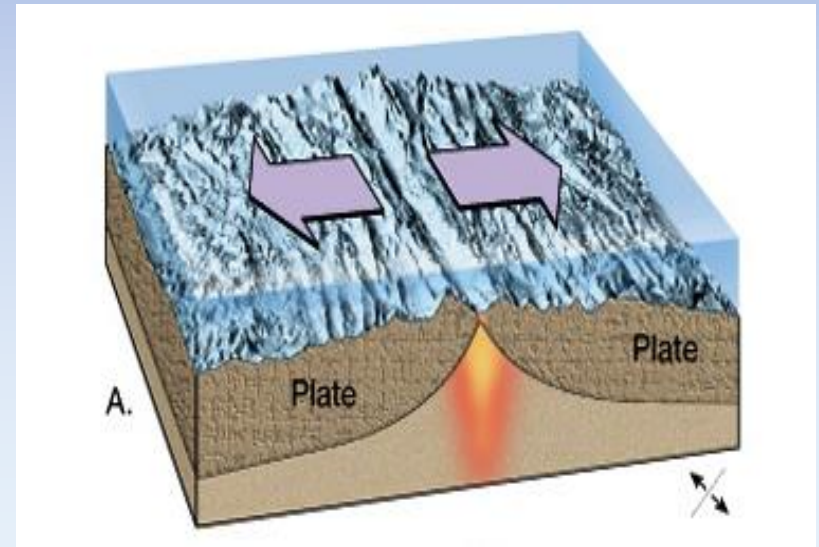
- Alfred Wegener in the 1920's first proposed the concept of "Continental Drift" based on evidence he found on the margins of continents.

Spreading Boundaries

- ▣ Movement is divergent.
- ▣ Result of movement is new crust
- ▣ Most occur at the mid-ocean ridge
- ▣ Also occur on land. A rift valley forms

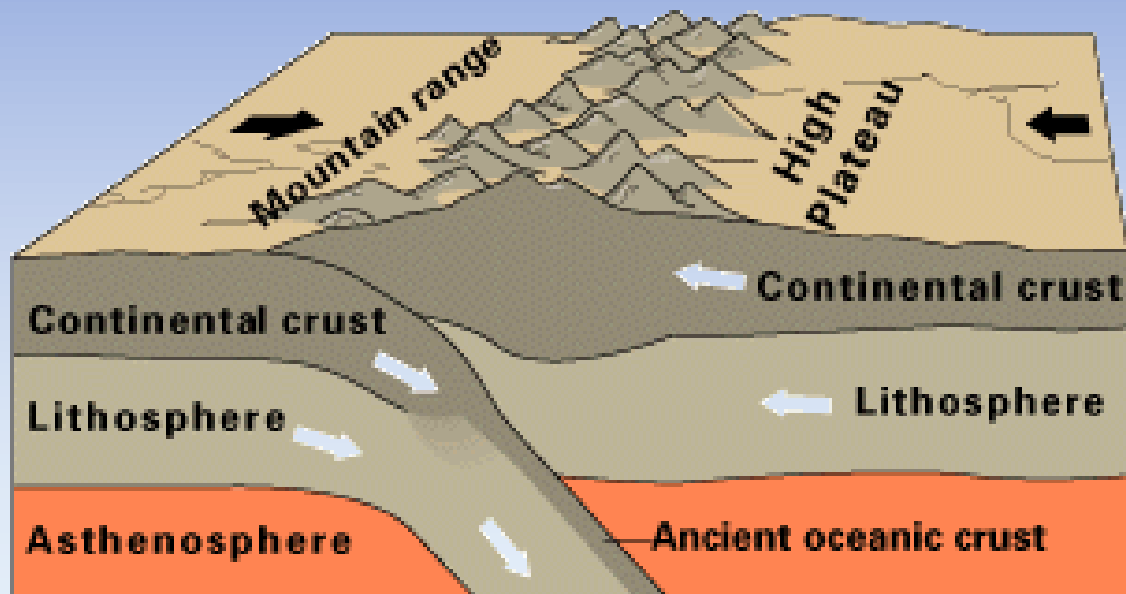


The Great Rift Valley in Africa



Collision

- Movement is convergent
- Result is mountains (Himalayas and Mt. Everest)



Continental-continental convergence



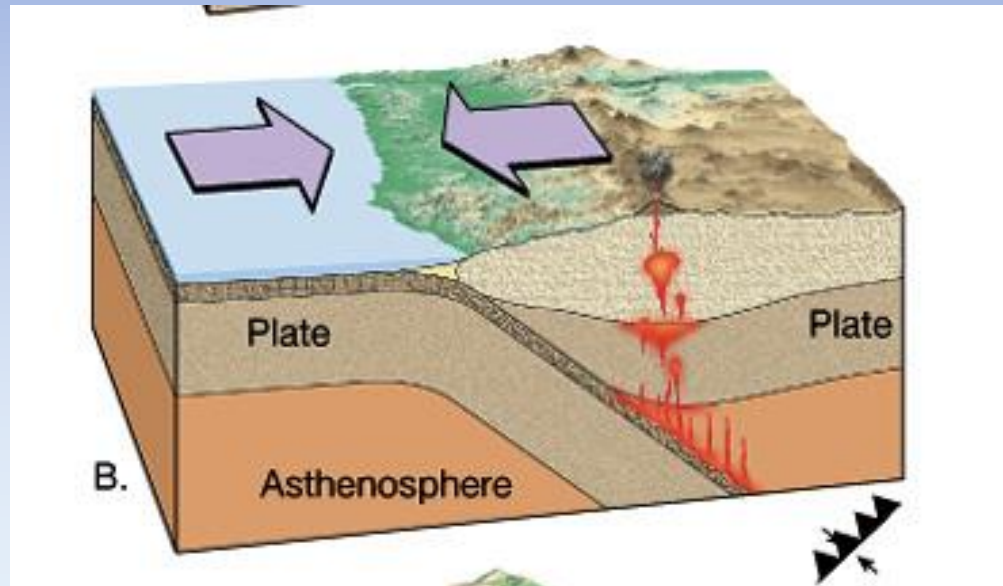
- Himalayan Mountains as seen from the International Space Station



- ❑ Folded Mountains in Death Valley

Subduction

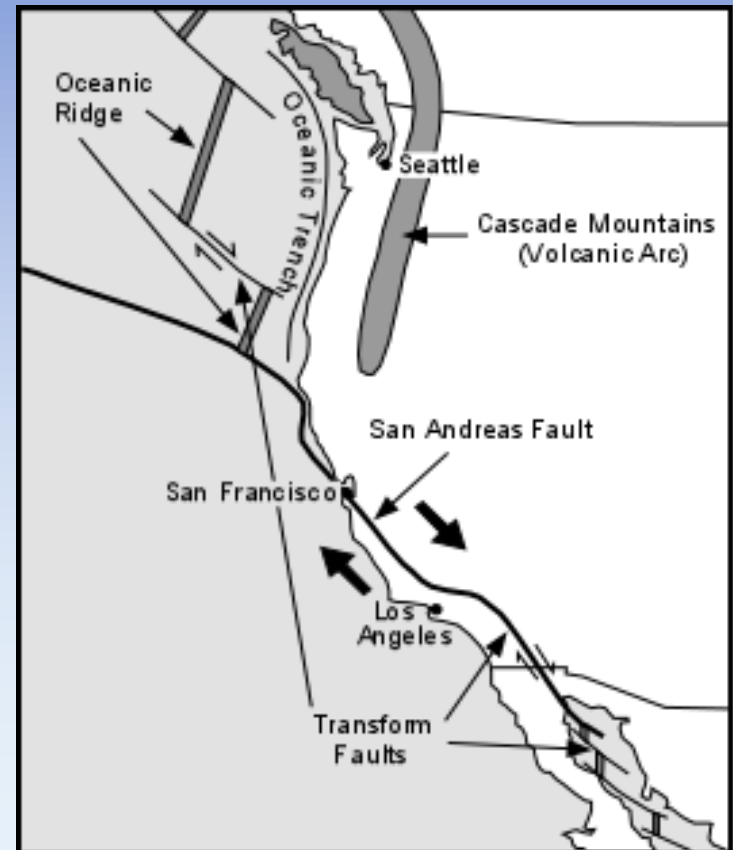
- ❑ Movement convergent, when plates move towards each other
- ❑ Result is volcanoes (edge of continental crust), crust destroyed, BIG Earthquakes



Transform Boundaries

Strike Slip Fault

- ▣ Movement is lateral
- ▣ Result is earthquakes, ex San Andreas Fault



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.



Figure 8.10
Environmental Science
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Ring of Fire

Active Volcanoes, Plate Tectonics, and the "Ring of Fire"



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.
 - ↖ Ex: freezing and thawing ice



Weathering and Erosion

- ▣ Chemical weathering- the breakdown of rocks and minerals by chemical reactions.
 - Ex: acid rain



Erosion

- Erosion- the physical removal of rock fragments from a landscape or ecosystem. Wind, water, ice transport and living organisms can erode materials.
- Deposition- the accumulation or depositing of eroded material such as sediment, rock fragments or soil.



Figure 8.18
Environmental Science
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A plant growing on a rock and slowly splitting it apart is an example of

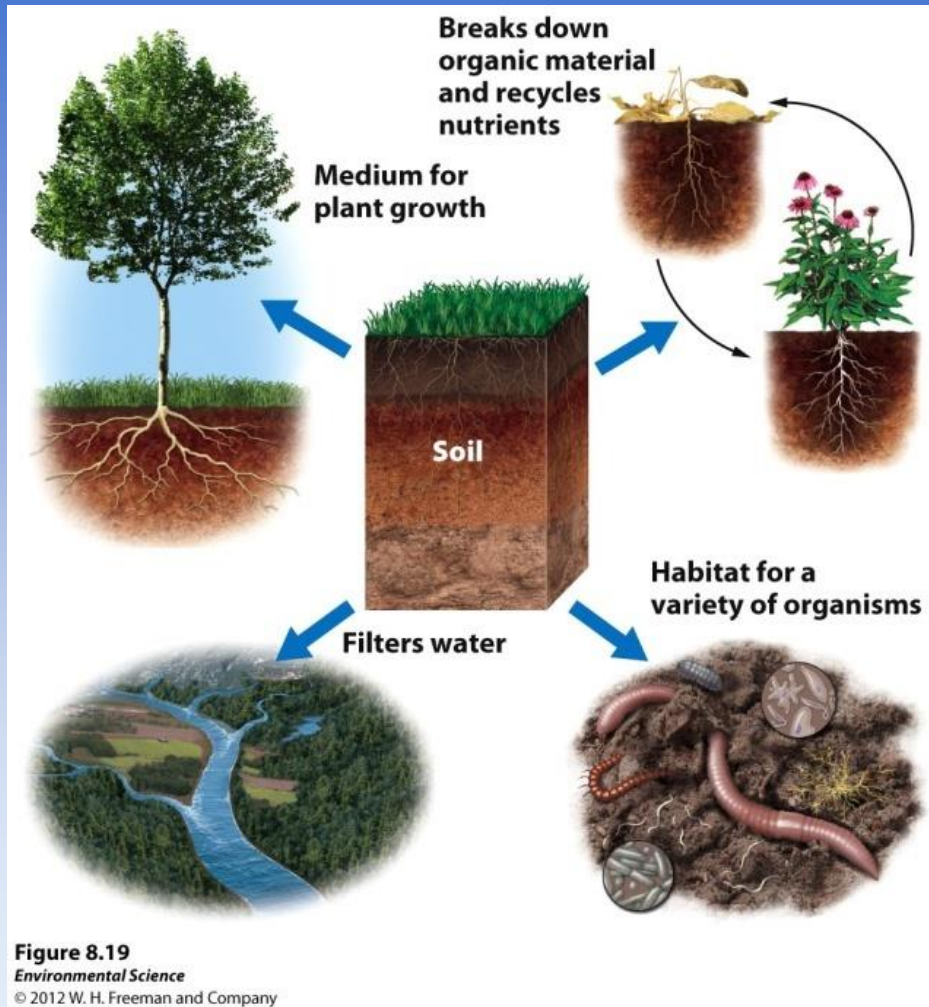
- ▣ A. Physical Weathering
- ▣ B. Chemical Weathering
- ▣ C. Erosion
- ▣ D. Neither physical nor chemical weathering
- ▣ E. None of the above

SMART Response Qu

To set the properties right click and select
SMARTResponse Question Object->Properties...

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

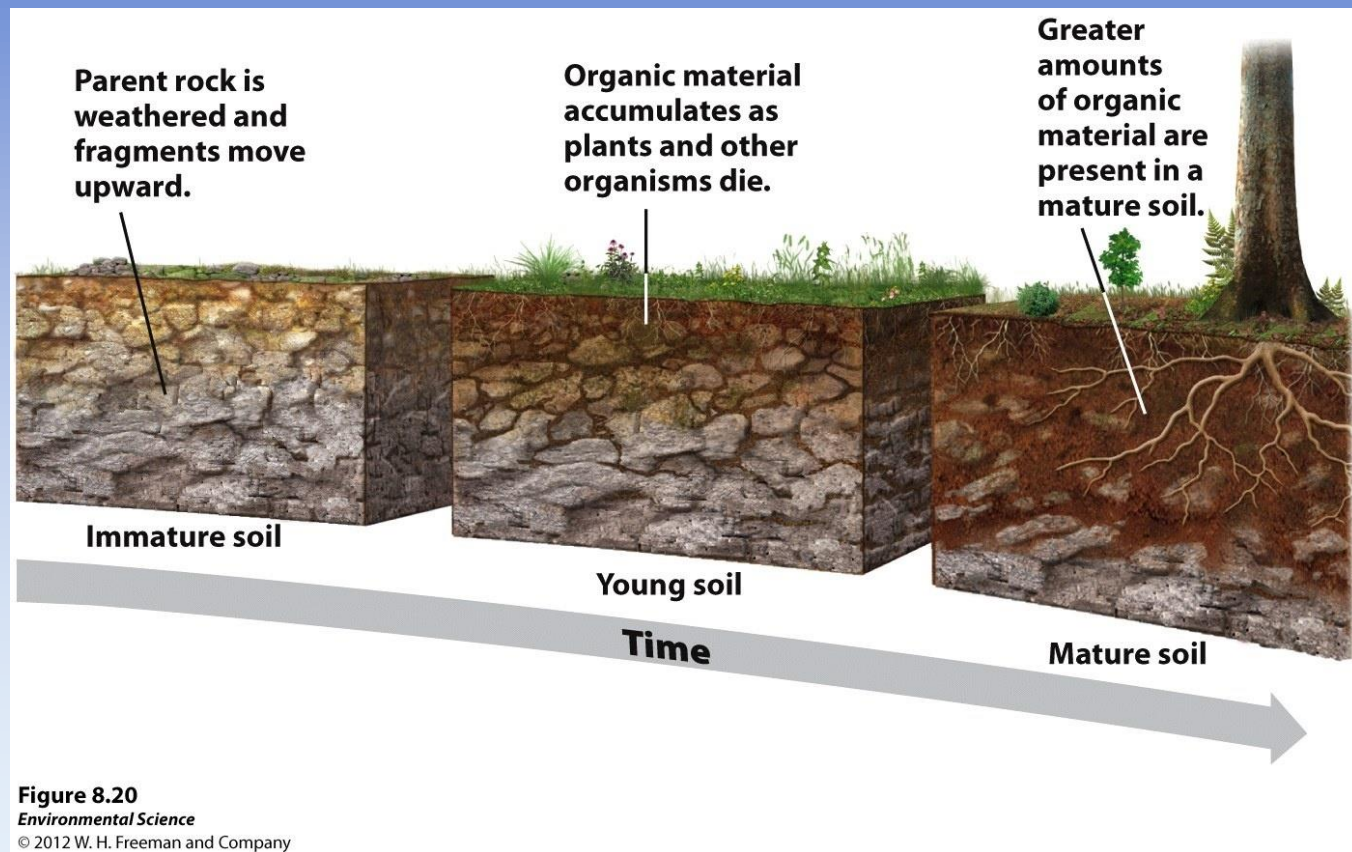


The Formation of Soil

- ▣ Factors that determine 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

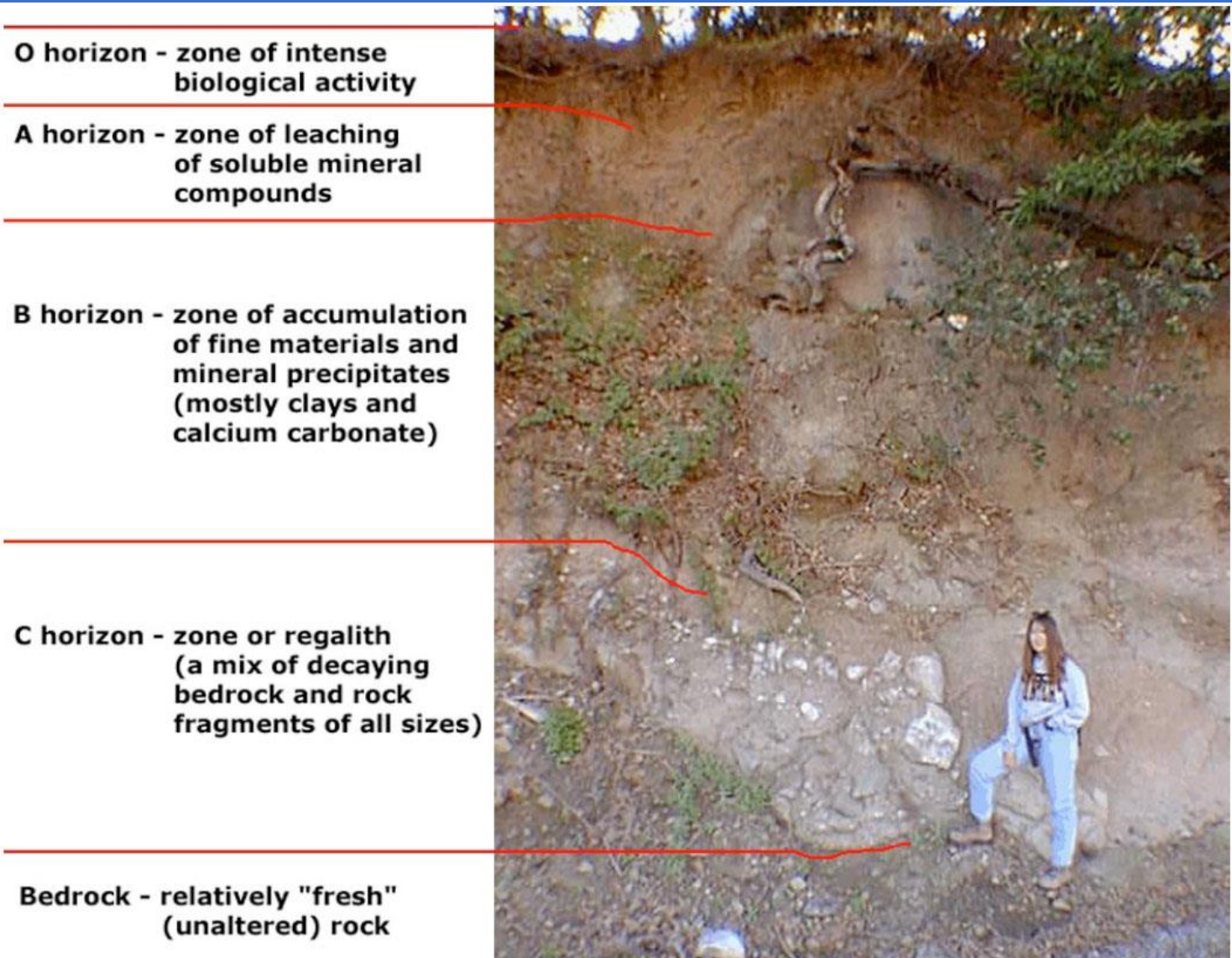
- Parent Material- the rock material from which soil is derived.



Soil Horizons

- ❑ O horizon- (organic layer) composed of the leaves, needles, twigs and animal bodies on the surface. This is what is missing in commercial farming.
- ❑ 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.

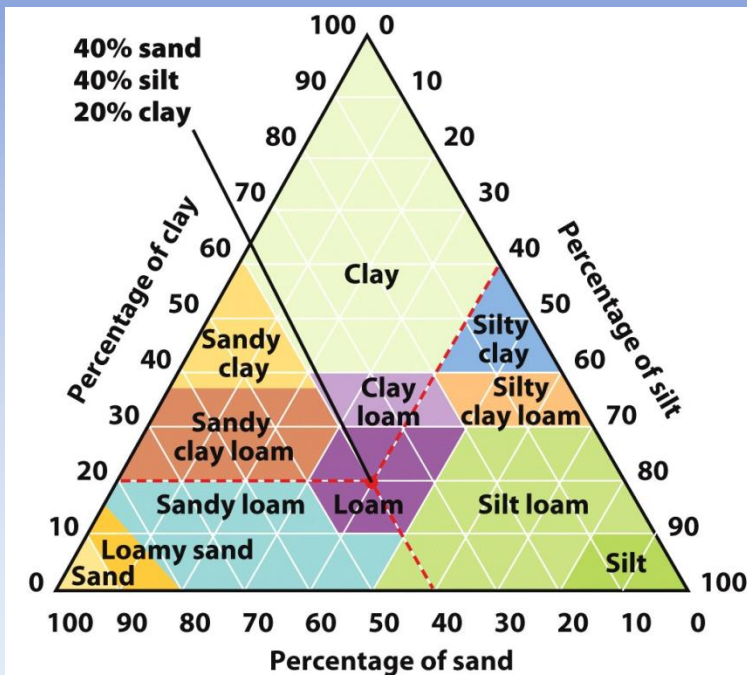
Soil Profile



A complete soil profile exposed by wave erosion along the shore of Calero Reservoir in Santa Clara County.

Physical Properties of Soil

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



Soil texture chart

Figure 8.22a
Environmental Science
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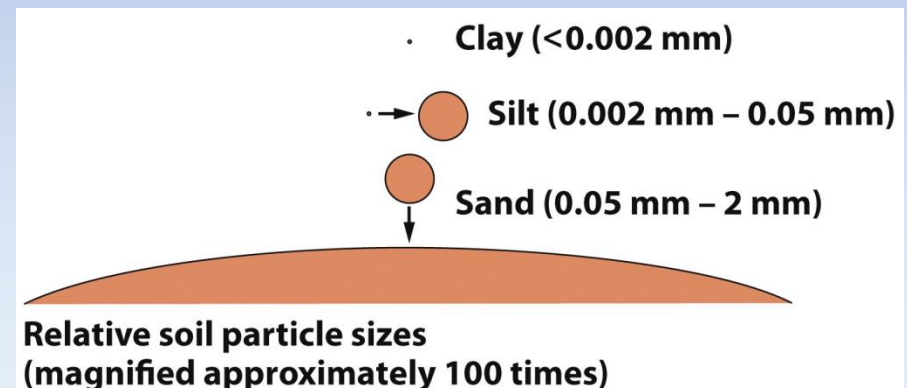
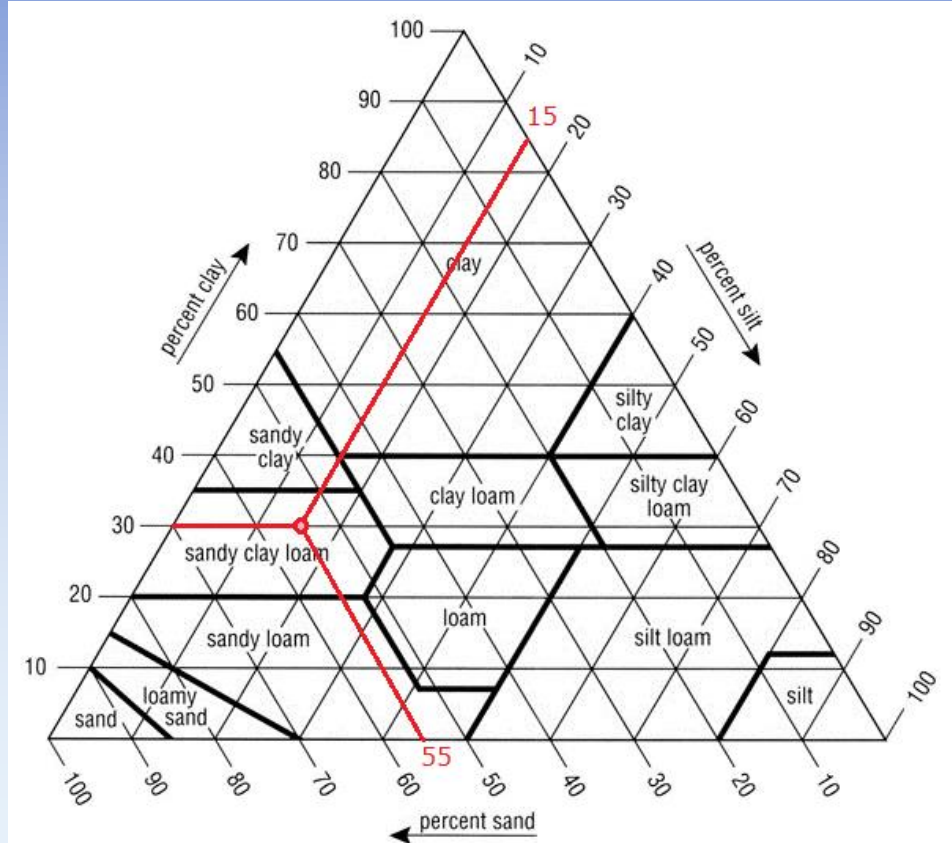


Figure 8.22b
Environmental Science
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Classify a soil sample that is 30% clay, 15% silt, and 55% sand.

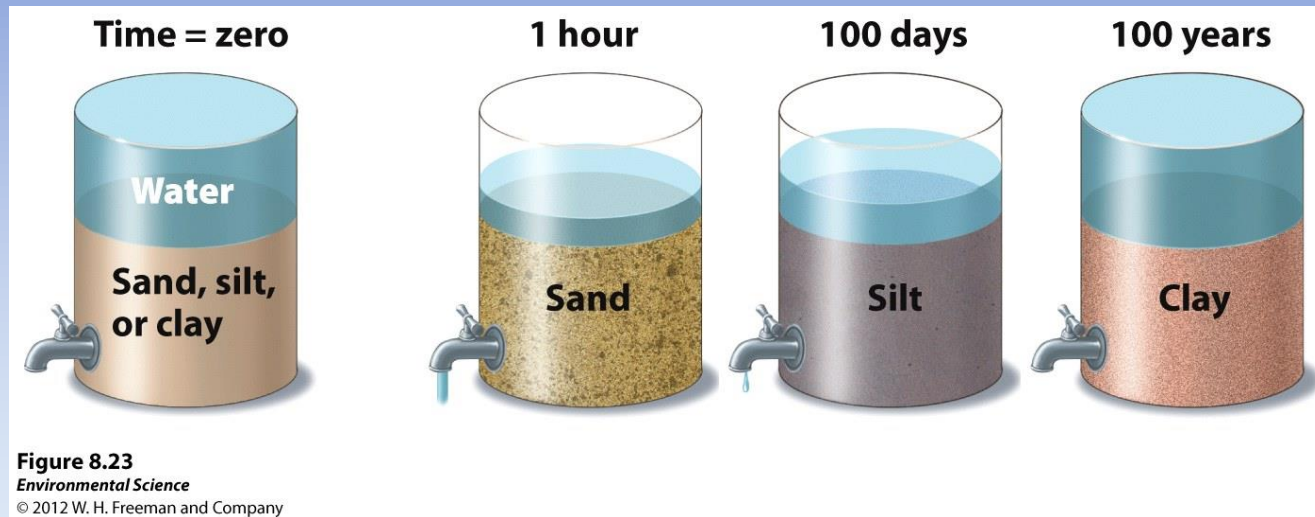
First locate 30% on the clay axis, and draw a line horizontally from left to right. Next, locate 15% on the silt axis, and draw a line going down diagonally to the left. Finally, locate 55% on the sand axis, and draw a line going up diagonally to the left.

The intersection is in a region called Sandy Clay Loam.



Physical Properties of Soil

- ▣ Porosity- how quickly the soil drains (which depends on its texture)



Biological Properties of Soil

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

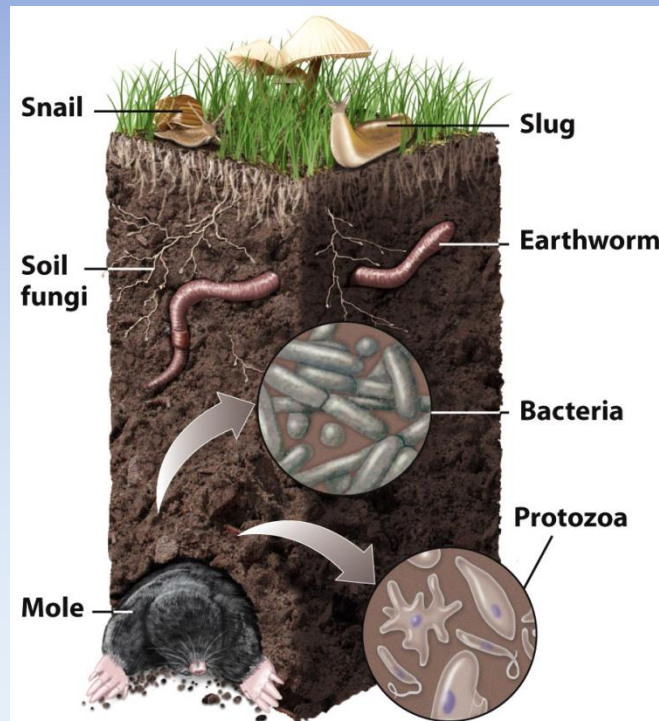


Figure 8.24
Environmental Science
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Productive Soil

- ▣ Good supply of nutrients and nutrient-holding capacity
- ▣ Infiltration, good water-holding capacity, resists evaporative water loss
- ▣ Porous structure for aeration
- ▣ Near-neutral pH
- ▣ Low salt content

Humus makes all the difference...



Humus

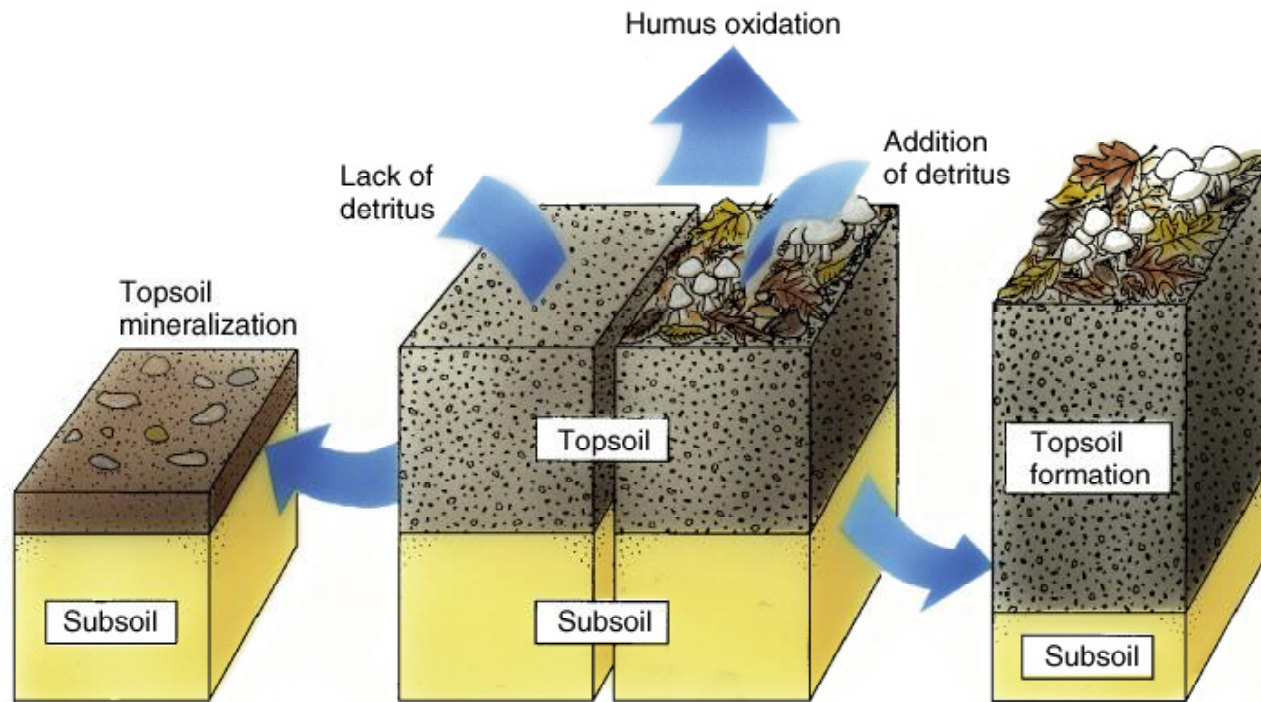
- ▣ Partly decomposed organic matter
- ▣ High capacity for holding water and nutrients
- ▣ Typically found in O horizon

Think, Pair, Share

Why is soil considered a detritus based ecosystem?



The Importance of Humus to



Loss of humus results in topsoil mineralization and consequent loss of:

- Water-holding capacity
- Nutrient-holding capacity
- Water infiltration
- Aeration

Gain of humus results in topsoil formation and consequent gain in:

- Water-holding capacity
- Nutrient-holding capacity
- Water infiltration
- Aeration

Soil Degradation

- ▣ Erosion
- ▣ Drylands and desertification
- ▣ Irrigation and salinization

The Results of Removal of Topsoil: Sand and Gravel





- ❑ If soil is tilled too often the layer of organic matter that keeps the soil moist disappears (blown away) which is why no till agriculture is seen as beneficial.
- ❑ The first inch of no-till soil is two to seven times less vulnerable than that of plowed soil.
- ❑ Keeps water in the soil- more microorganisms

Summary:

- ❑ Earth is overlain by a series of plates that move at rate of a few millimeters per year.
- ❑ Plates can move away from each other (divergent), move toward each other (convergent), or slide past each other (transform).
 - Tectonics processes create mountains, earthquakes and volcanoes
 - Soil properties are determined by: parent material, climate, topography, soil organisms and time
 - Texture determined by: relative abundance of sand, silt and clay

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 in river sediments. Use river water to separate heavier items.

Loss of Habitat



Coal Fires



Burning in Centralia, PA since 1962

The fire, which was started by five members of the volunteer fire company when they were hired by the town council to clean up the landfill, was not properly extinguished and spread to become one of the longest burning coal fires. The landfill was located in an abandoned strip mine pit and as the firemen had in the past, they set the dump on fire, let it burn for a time, and then extinguished the fire, or so they thought.





Degradation of the
natural ecosystem





Erosion
Problems





Loss of
habitat















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Acid Mine Drainage

Pyrite (FeS_2) when exposed to air and water, oxidizes and release large quantities of iron and sulfate. In addition, H^+ ions are liberated producing an acidic solution that readily weathers and releases other trace minerals (i.e. copper and zinc) into solution.

The acidic solution formed, characteristic of high metals and sulfate and low pH, is generally termed acid mine drainage (AMD).

(Contamination of water)



Relatively fresh tailings in an impoundment.

http://www.earth.uwaterloo.ca/services/whaton/s06_amd.html

The same tailings impoundment after 7 years of sulfide oxidation. The white spots are gulls.



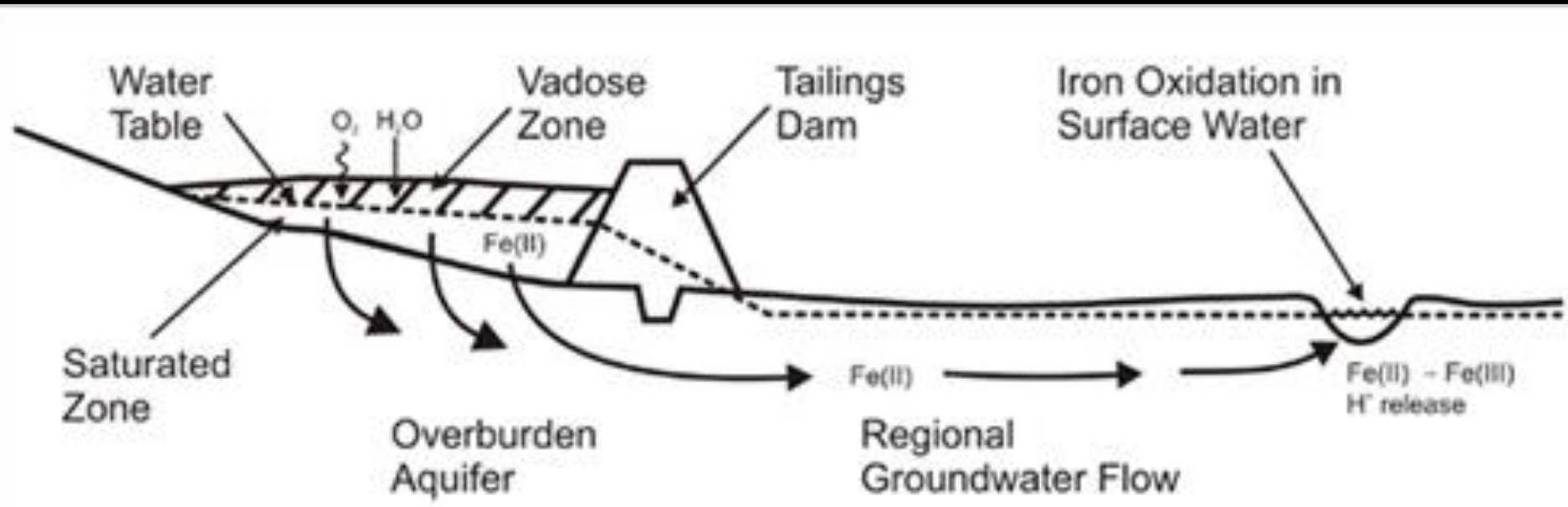


**Mine effluent
discharging
from the
bottom of a
waste rock pile**

**Shoreline of a
pond
receiving
AMD showing
massive
accumulation
of iron
hydroxides
on the pond
bottom**



Groundwater flow through a tailings impoundment and discharging into lakes or streams.

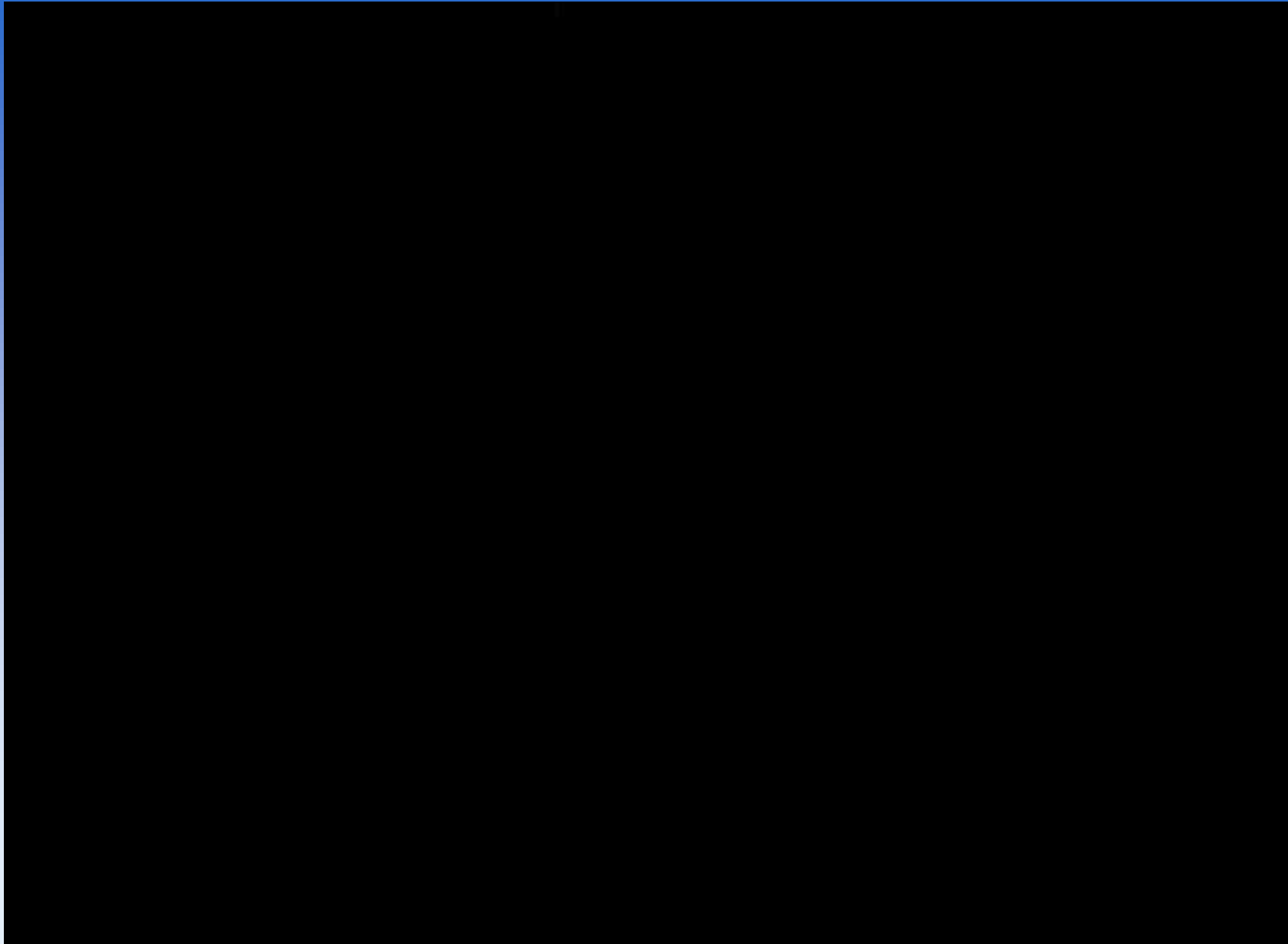


Legislation of Mining

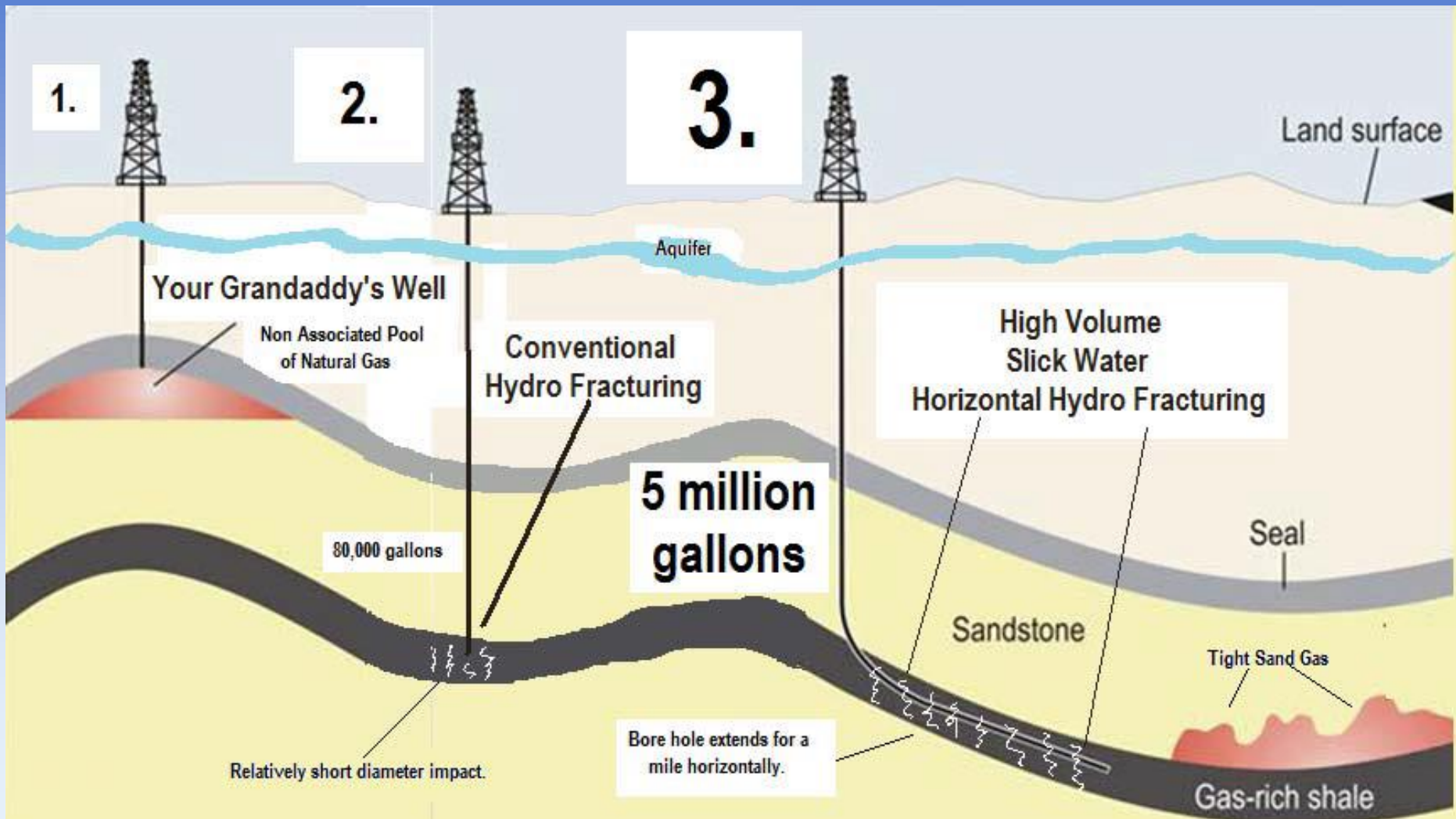
- ▣ The Surface Mining Control and Reclamation Act- regulates surface and subsurface coal mining. Mandates that land be minimally disturbed during the mining process.

What is Fracking?

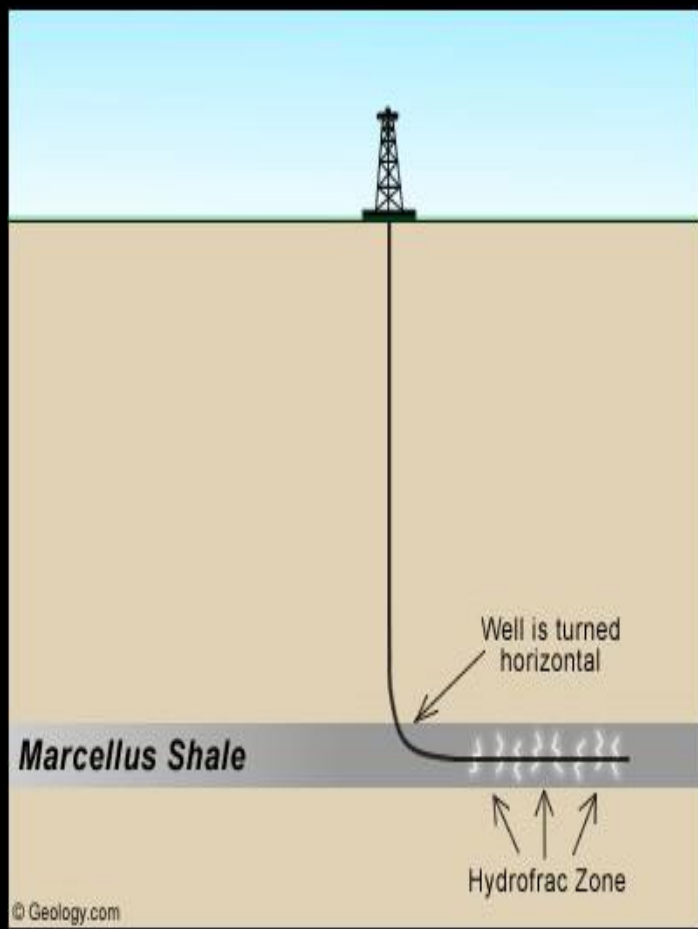
- ▣ **Hydraulic fracturing** is the propagation of fractures in a rock layer, as a result of the action of a pressurized fluid being pumped into the rock. Some hydraulic fractures form naturally. **Induced hydraulic fracturing** or **hydrofracking**, is a technique used to release petroleum, natural gas, or other substances for extraction. This type of fracturing creates fractures from a wellbore drilled into reservoir rock formations.



Drilling for Natural Gas Has Changed



Why is it such a big deal now?



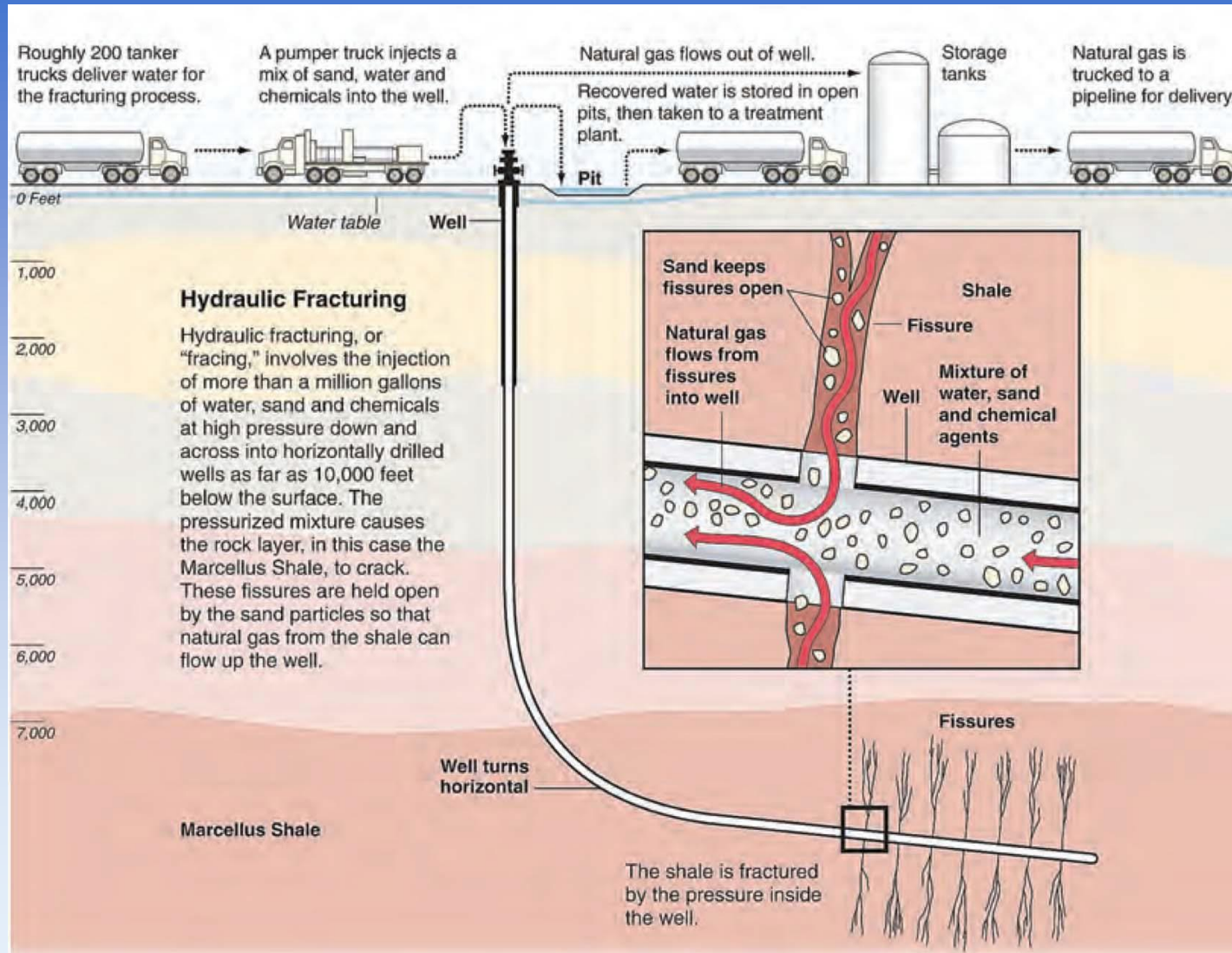
Conventional method

- Drill into porous rock
- Gas comes out
- Small footprint during and after

Hydrofracking

- Drill into solid rock
- Pump millions of gallons of water & chemicals per well
- Apply extreme pressure to fracture rocks
- Chemicals, heavy metals & radioactive substances come up with gas
- This mix can migrate underground

The Frack...



Water Withdrawals

- 5.5 million gals *average* per well per frack
 - ~ 1,600 truck trips per well
 - Deplete fresh water sources
 - Billions of gallons of water contaminated forever
 - Locals pay for damage to country roads
- Each well can be fracked several times,
multiplying the damage



Why, if fracking is safe as the gas industry maintains, did they get the Bush administration in 2005, to make fracking exempt?

**The Oil & Gas Industry is Exempt from
Sections of the Following U.S. Laws**

Clean Water Act

Safe Drinking Water Act

Clean Air Act

Resource Conservation and Recovery Act

CERCLA, also known as the Superfund Law

Do You Think These Should be Regulated?

Toxins Released During Oil and Gas Operations

Pollutants

Arsenic	Cancer.
Hydrogen Sulfide	Headaches, nausea, vomiting, loss of memory, and motor function. Death.
Mercury	Damages brain, kidneys, developing fetus.
Polycyclic Aromatic	Cancer.
Volatile Organic Compounds (VOCs)	
Acetone	Headaches and confusion. Birth defects.
Benzene	Cancer. Leukemia.
Ethylbenzene	Respiratory problems, fatigue, headaches.
Toluene	Birth defects, central nervous system damage.
Xylene	Headaches, problems with balance, memory loss.

Fugitive methane (CH₄): A “greenhouse” concern.

Optical Photography



Infrared photography



← Same Image →

Infrared imaging shows methane emissions coming from tanks not visible with the naked eye.

Flowback is Advertised as Produced “Water”



**VOC: Volatile
Organic
Compound**



Method for moving water into holding ponds using cannon-like transfer method. Fracking operations include water injection methods that shoot toxic brews into the air where they are caught by winds that transport them far from the site.

Fracking Chemical Storage



**Millions of pounds can sit at one pad.
Is this on a floodplain?
What's the evacuation plan?**

Drillers remove the "produced" water

Quick & dirty solution:
dump onto a West Virginia
country road

- "Produced" water can be put down injection wells or abandoned mines
- It can be dumped into waterways
- There's no practical way to treat it

