

APES Ch 10 Outline: Geology: Processes, Hazards & Soils

10-1 Geologic Processes

A. *Geology is the study of dynamic processes occurring on the earth's surface and in its interior.*

1. The surface of the earth is composed of a series of gigantic plates that move very slowly across the earth's surface.
2. The surface features of the earth change due to the effects of water and earth movements.
3. Earthquakes and volcanic action are violent and disruptive actions of the earth.

B. *Three major zones of the earth are the core, mantle, and crust.*

1. The crust is soil and rock that floats on a mantle of partly melted and solid rock.
2. The core is intensely hot. It has a solid inner part surrounded by a liquid core of molten or semisolid material.
3. The mantle is a thick, solid zone. It is mostly solid rock, but an area called the asthenosphere is very hot, partly melted rock about the consistency of soft plastic.
4. The crust is thin and is divided into the continental crust and the oceanic crust.

10-2 Internal and External Geologic Processes

A. *Geologic changes from the earth's interior generally build up the earth's surface. Heat and gravity play a role in these processes.*

1. Heat from the core causes much of the mantle to deform and flow slowly like heated plastic.
2. Two kinds of movement seem to occur in the mantle. Convection currents move large volumes of rock and heat in loops within the mantle. Mantle plumes flow slowly upward, and when it reaches the top of the plume, it radiates out like the top of an open umbrella.

B. *About 15 rigid tectonic plates move across the surface of the mantle very slowly. The plates are about 60 miles thick and compose the lithosphere.*

1. The plates move at different rates. Some move about 1 centimeter per year, and others at the sea floor move as much as 18 centimeters (7 inches) per year.
2. The theory of plate tectonics became widely accepted in the 1960s and was developed from the idea of continental drift.
3. The movement of these plates produces mountains on land and trenches on the ocean floor.
4. Volcanoes and earthquakes are likely to be found at the plate boundaries.
5. The plate tectonic theory also helps to explain how certain patterns of biological evolution occurred.

C. *There are three types of boundaries for lithospheric plates.*

1. divergent plate boundaries: plates move apart in opposite directions
2. convergent plate boundaries: plates are pushed together by internal forces and one plate rides up over the other. A trench generally occurs at the subduction zone.
3. transform fault and occurs where plates slide/grind past one another.

D. *External geologic processes such as changes based on the sun and gravity wear down the earth's surface and produce land forms based on eroded sediment buildup.*

1. Erosion is a major external process of wind, water, and human activities.
2. Weathering is physical, chemical, and biological processes that break down rocks and minerals into smaller pieces.

10-3 Minerals, Rocks, and the Rock Cycle

A. *The earth's crust is composed of minerals and rocks.*

1. The crust is the source of the nonrenewable resources we use as well as the source of soil.
2. A mineral is an element or inorganic compound that is solid with a regular internal crystalline structure.
3. Rock is a solid combination of one or more minerals.

B. *The earth's crust contains igneous, sedimentary, and metamorphic rocks that are recycled by the rock cycle.*

1. Igneous rock is formed below or on the earth's surface when molten rock wells up and hardens. They form the bulk of the earth's crust.
2. Sedimentary rock is formed from small, eroded pieces of rock that are carried to downhill sites. Layers accumulate over time and an increase of weight and pressure plus dissolved minerals bind the sediment particles together to form sedimentary rock.
3. Metamorphic rock is produced from preexisting rock that is subjected to high temperatures, high pressures, chemically active fluids, or some combination of these.
4. The rock cycle is the interaction of physical and chemical processes that change rock from one type to another. It is the slowest of the earth's cyclic processes.

C. *Mineral resources are nonrenewable materials that we can extract from the earth's crust.*

1. We can find and extract over 100 minerals from the earth such as metallic mineral resources, nonmetallic mineral resources, and energy resources.
2. Ore is rock containing one or more metallic minerals to be mined profitably.
3. The U.S. Geological Survey divides nonrenewable mineral resources into four major categories:
 - a. identified resources with a known location, quantity, and quality
 - b. reserves, which are identified resources that can be extracted profitably at current prices,
 - c. undiscovered reserves, which are potential supplies of a mineral resource assumed to exist, and
 - d. other resources, which are undiscovered resources and identified resources not classified as reserves.

10-4 Natural Geologic Hazards: Earthquakes and Volcanic Eruptions

A. *An earthquake occurs at a fracture line or causes a fracture and shift in the earth's crust.*

1. Measurement of the magnitude of an earthquake is done using the Richter scale, where each higher number is 10 times greater than the next lower number.
2. Insignificant is less than 4.0 on the Richter scale, minor is 4.0–4.9, damaging is 5.0–5.9, destructive is 6.0–6.9, major is 7.0–7.9, and great is over 8.0.
3. Foreshocks may occur prior to the main shock and aftershocks occur up to several months after the main shock.
4. Primary effects include shaking and temporary to permanent displacement of the ground.
5. Secondary effects include rockslides, fires, and flooding due to subsidence of the land.
6. Examination of an area for faults prior to building can help save lives and destruction of property.

B. *An active volcano releases magma onto the earth's surface. This release may be violent or quiet.*

1. Volcanic activity is generally concentrated in the same areas as seismic activity.
2. Ash and gases may be ejected along with magma.
3. Gases such as sulfur dioxide may remain in the atmosphere and cause acid rain.
4. Particulate matter may remain in the atmosphere for up to 3 years and cause cooling of the atmosphere.
5. Fertile soils are produced from the weathering of lava flows.
6. Scientists are studying phenomena that precede an eruption to better predict their occurrence.

10-5 Soils: Formation, Erosion and Degradation

A. *Soil provides nutrients needed for plant growth; it helps purify water. It is a thin covering that is made of eroded rock, minerals, decaying organic matter, water, air, and billions of living organisms.*

B. *Layers of soil, called soil horizons, vary in number, composition, and thickness.*

1. Soil provides nutrients for plant growth and is the earth's primary filter for cleansing water and for decomposing and recycling biodegradable wastes.
2. Mature soils have developed over a long time, are arranged in soil horizons (series of horizontal layers), and have distinct textures and compositions in these layers that vary among different types of soils.
3. Cross-sectional views of these layers are soil profiles.
4. The layers/horizons of mature soils have at least three parts.
 - a. The top part/layer is the surface litter layer or O horizon. This layer is brown/black and composed of leaves, twigs, crop wastes, animal waste, fungi, and other organic material.
 - b. The topsoil layer or A horizon: composed of decomposed organic matter (humus), as well as some inorganic mineral particles. Thick topsoil layers help hold water & nutrients. These two top layers teem with bacteria, fungi, earthworms, & small insects.
 - 1) Dark-brown/black topsoil is rich in nitrogen and organic matter.
 - 2) Gray, yellow, or red topsoils need nitrogen enrichment.
 - c. The B horizon (subsoil) and the C-horizon (parent material) have most of the soil's inorganic matter — sand, silt, clay, and gravel. The C-horizon rests on bedrock.
5. Air and water fill spaces between soil particles. Plant roots need oxygen for aerobic respiration.
6. Downward movement of water through the spaces in the soil is infiltration. Water moving downward dissolves minerals and organic matter and carries them to lower levels; this process is called leaching.

C. *Soil differences in texture are affected by the size of particles and the space between particles.*

1. To determine a soil's texture, take a small amount of topsoil, moisten, and rub between fingers and thumb:
 - a. A gritty feel means the soil has a lot of sand; this soil is easy to work.
 - b. A sticky feel means the soil has a lot of clay; these retain a lot of water.
 - c. A smooth feel means the soil is silt-laden.
 - d. A crumbly, spongy feel means the soil is heavily loam; these hold water.
2. Soil porosity is affected by soil texture. The average size of spaces or pores in soil determines soil permeability.

- D. *The ways in which soil particles are organized & clump together is called soil structure.***
1. Loam: hold lots of water, but loosely enough for plant roots to absorb, good for growing crops
 2. Sandy soil: easily worked, but water flows rapidly through. good for irrigated xeric crops.
 3. Clay soil: easily compacted, prone to clumping, decent water holding capacity but low permeability, poor infiltration may lead to waterlogging of crops.
 4. Acidity / alkalinity also important & may need to be adjusted for crops. (lime for raising pH, sulphur to lower pH).
- E. *Soil erosion and degradation affect crop yield and farming success.***
1. Preserving the world's topsoil is of great importance in feeding the world's masses.
 2. Land degradation occurs when the future ability of the land to support crops, livestock, or wild species is decreased.
 3. Water, wind, and people cause soil erosion; soil components are moved from one place to another. Three types of water erosion: Sheet, Rill & Gully
 4. Depletion of plant nutrients in topsoil, through farming, logging, construction, overgrazing, and burning vegetation, leads to loss of soil fertility.
 5. Eroded soil becomes sediment in surface waters where it pollutes water, kills fish, and clogs irrigation ditches, channels, reservoirs, and lakes.
- F. *Soil is a renewable resource unless eroded faster than it can form.***
1. A 1992 joint UN and World Resources Institute report estimated that topsoil is eroding faster than it is replenished on 38% of the world's cropland. Worldwide erosion causes \$375 billion per year.
 2. Soil erosion in the U.S. is being slowed through planting crops without disturbing the soil and government-sponsored soil conservation programs.
 3. The Dust Bowl of the 1930s resulted in Congress passing the Soil Erosion Act in 1935 and established the Soil Conservation Service (a part of the USDA).
- G. *Desertification occurs when production falls by 10% or more through a combination of natural causes (drought) and human activities.***
1. It may be moderate, severe, or very severe; only in extreme cases does it lead to a desert.
 2. Prolonged droughts can't be controlled, but the consequences can be reduced by reducing overgrazing, deforestation, and destructive forms of planting, irrigation, and mining.
 3. Restoration of these areas includes planting trees and grasses to anchor soil and hold water.
- H. *Loss of crop productivity can result from repeated irrigation, which produces salt buildup and water logging of plant crops.***
1. Forty percent of the world's food is produced on twenty percent of the cropland that is irrigated.
 2. Salts left behind when irrigation water is not absorbed into the soil can be left in the topsoil. This is called salinization.
 3. Salinization has reduced yields on 20% of the world's cropland.
 4. Waterlogging occurs when saline water (from irrigation) envelops the deep roots of plants. This saline water accumulates underground and raises the water table.

10-6 Solutions: Soil Conservation

A. Soil conservation seeks ways to reduce soil erosion and restore soil fertility.

B. To reduce soil erosion, farmers must eliminate plowing and tilling and keep the soil covered with vegetation.

1. Conventional-tillage farming means plowing in the fall and leaving the soil bare all winter, making it vulnerable to wind and erosion.
2. Conservation-tillage farming disturbs the soil as little as possible while planting.
3. Minimum-tillage farming allows the soil to rest over the winter. The subsurface soil is broken up and loosened but the topsoil is not turned.
4. No-till farming uses special machines to inject seeds, fertilizers, and herbicides into thin slits in the unplowed soil and, then, cover the slits.
5. About 45% of U.S. farmers used conservation tillage in 2003. The USDA estimates that using it on 80% of cropland would reduce soil erosion by 50% or more.

C. Additional methods to reduce soil erosion include:

1. Terracing converts the land into a series of broad, nearly level terraces that run across the contour of the land. This method holds water for crops and reduces runoff.
2. Contour farming plows and plants crops in rows across the slope of the land, not up and down. Each row acts as a small dam.
3. Strip cropping plants alternating strips of a row crop (corn/cotton) with another crop that completely covers the soil (grass/legume). Runoff is caught by the cover crop.
4. Plant cover crops like rye or alfalfa after harvest.
5. Leave crop residues on the land after harvest.
6. Alley cropping/agroforestry plants several crops together in strips/alleys between trees or shrubs, which may provide fruit or fuelwood.
 - a. The shade of the trees/shrubs reduces evaporation and helps retain soil moisture.
 - b. Fruit, fuelwood, and trimming can be used as mulch.
7. Windbreaks or shelterbelts of trees reduce wind erosion, help retain soil moisture, provide fuelwood, and support bird and insect habitats.

D. Soil fertility can be maintained best through soil conservation. The next best thing is to restore some of the nutrients by the use of fertilizer.

1. Organic fertilizer can be used to restore lost plant nutrients.
 - a. Animal manure improves soil structure, adds nitrogen, and stimulates soil bacteria and fungi.
 - b. The U.S. Department of Agriculture researchers are evaluating the value of burnt chicken wastes that are rich in phosphorus as an organic fertilizer.
 - c. Green manure plows freshly cut or growing green vegetation into the soil to increase organic matter and humus.
 - d. Microorganisms in the soil break down organic matter in leaves, food wastes, paper, and wood to form compost.
2. Crop rotation plants different crops to replenish the soil, especially if a previous crop has depleted the soil of certain nutrients.
3. Inorganic fertilizers, used with organic fertilizers, can restore soil fertility. Commercial inorganic fertilizers contain nitrogen, phosphorus, and potassium. There are advantages and disadvantages to the use of inorganic fertilizers.