

Earth's external processes

- ❖ **Weathering** – the disintegration and decomposition of material at or near the surface
- ❖ Mass wasting – the transfer of rock material downslope under the influence of gravity
- ❖ Erosion – the incorporation and transportation of material by a mobile agent, usually water, wind, or ice

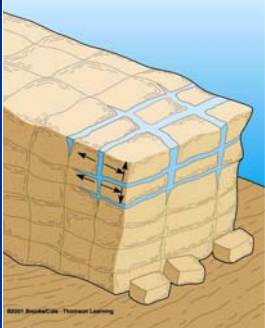
How are Earth Materials Altered?

- Differential weathering and erosion
- Structural and chemical differences in rock can produce spectacular formations
- Mechanical weathering
- Chemical weathering





How are Earth Materials Altered?

- **Mechanical Weathering**
 - Physical forces break rocks into smaller pieces that retain the chemical composition of the parent material
 - Frost action
 - Pressure release
 - Thermal expansion/contraction
 - Salt crystal growth
 - Organic activity



Physical Weathering

How are Earth Materials Altered?

- Pressure release
 - Exfoliation domes result from the expansion of plutons that formed under great pressure, but have been exposed by uplift and erosion

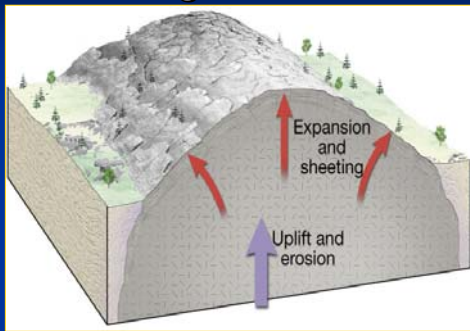


Exfoliation in Granite



Figure 13.11

Unloading and exfoliation of igneous rocks



Weathering

Chemical weathering

- Alters the internal structures of minerals by removing or adding elements
- Most important agent is water
 - Oxygen dissolved in water oxidizes materials
 - Carbon dioxide (CO₂) dissolved in water forms carbonic acid and alters the material

How are Earth Materials Altered?

- Chemical Weathering
 - Decomposition of parent material to produce new minerals and ions. Agents include atmospheric gases, water, and acids.
 - Other processes:
 - Solution
 - Oxidation
 - Hydrolysis

Chemical Weathering

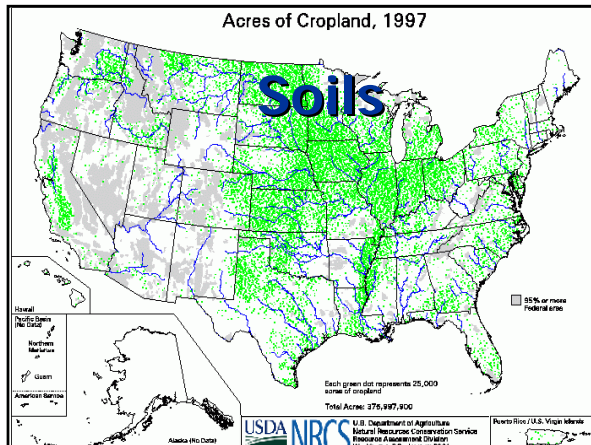
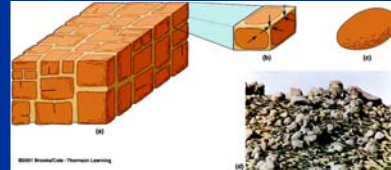




Physical weathering on Mt. Whitney in background
Chemical weathering on Alabama Hills in foreground

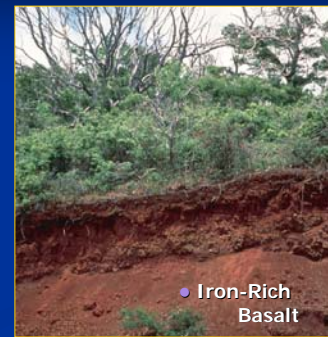
Rates of weathering

- ❖ Advanced mechanical weathering aids chemical weathering by increasing the surface area
- Factors controlling the rate of chemical weathering
 - Stability of minerals is opposite their order of crystallization
 - Mechanical weathering increases the surface area of parent rock, enabling chemical processes to act more effectively
 - Presence of fractures, particle size, climate, parent material



Overview

- Soil Formation
- Chemical and Physical Properties of Soils
- Soils and Human Activities



What is Soil and How Does it Form?

- Soil is a mixture of weathered rock material, water, air, and organic matter
 - Sand, silt, and clay - weathered rock fragments
 - Humus - carbon rich decayed organic material
 - Residual soils - develop on parent rock
 - Transported soils - eroded and transported to another location where soil develops

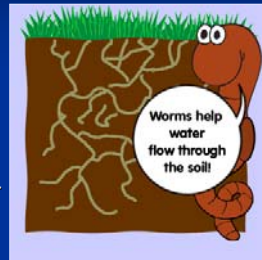
Soil

- ❖ Controls of soil formation
 - Parent material – weathered bedrock
 - Residual soil – parent material is the bedrock
 - Transported soil – parent material has been carried from elsewhere and deposited
 - Time
 - Important in all geologic processes
 - Amount of time to evolve varies for different soils
 - Approximately 80 – 400 years for soil-forming processes to create 1 cm of topsoil.

Soil

❖ Controls of soil formation

- Climate
- Plants and animals
 - Organisms influence the soil's physical and chemical properties
 - Furnish organic matter to soil



Soil

❖ Controls of soil formation

- Slope
 - Angle
 - Steep slopes often have poorly developed soils
 - Optimum is a flat-to-undulating upland surface
 - Orientation (direction the slope is facing) influences
 - Soil temperature
 - Moisture

Soil

❖ Soil types

- Hundreds of soil types worldwide
- Three very generic types
 - Pedalfer
 - Accumulation of iron oxides and Al-rich clays in the B-horizon
 - Best developed under forest vegetation

Soil

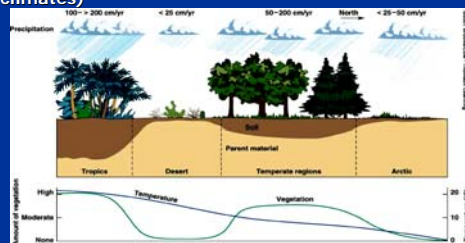
❖ Soil types

- Three very generic types
 - Pedocal
 - Accumulate calcium carbonate
 - Associated with drier grasslands
 - Laterite
 - Hot, wet, tropical climates
 - Intense chemical weathering

What is Soil and How Does it Form?

■ Factors Controlling Soil Formation

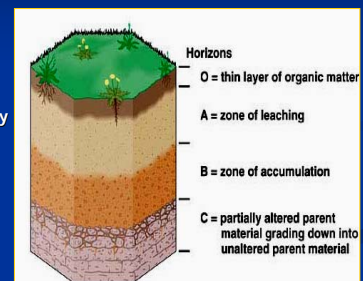
- Climate, relief, slope angle
- Three major soil types are recognized: pedalfer (humid climates), pedocals (arid climates), laterites (tropical climates)



What is Soil and How Does it Form?

■ The Soil Profile

- O horizon
 - organic matter
- A horizon
 - top soil, intense biological activity
- B horizon
 - subsoil, zone of accumulation
- C horizon
 - little organic matter, partially altered parent rock



Soil

❖ Soil Profile

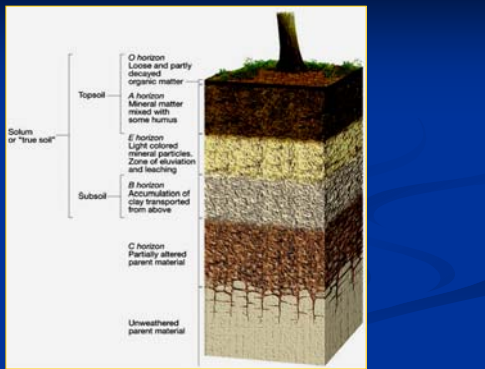
- Soil forming processes operate from the surface downward
- Horizons – zones or layers of soil
- Horizons in temperate regions
 - O – organic matter
 - A – organic and mineral matter
 - E – little organic matter

Soil

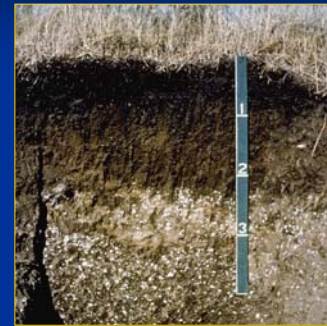
❖ Soil Profile

- Horizons in temperate regions
 - B – zone of accumulation
 - C – partially altered parent material
- O and A together called topsoil
- O, A, E, and B together called solum, or "true soil"

An idealized soil profile



A soil profile showing different horizons



Chemical and Physical Properties of Soils

- Color, Texture, and Structure of Soils
- Soil Classification

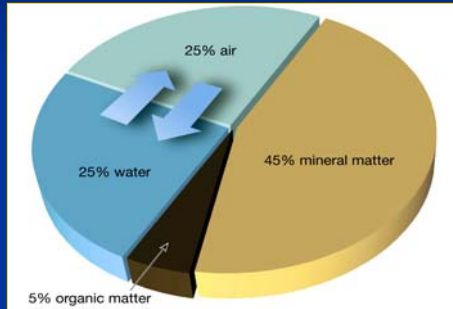
SOIL ORDER:

A group of soils in the broadest category of the the USDA "Soil Taxonomy." The Soil Taxonomy is a basic system of soil classification for making and interpreting soil surveys. There are 12 orders, differentiated by the presence or absence of diagnostic horizons: Alfisols, Andisols, Aridisols, Entisols, Gelisols, Histosols, Inceptisols, Mollisols, Oxisols, Spodosols, Ultisols, and Vertisols. Orders are divided into Suborders and the Suborders are farther divided into Great Groups.

Soil

- ❖ An interface in the Earth system
- ❖ Soil is a combination of mineral matter, water, and air – that portion of the regolith (rock and mineral fragments) that supports the growth of plants

Typical components in a soil that yields good plant growth



Soil

- ❖ Soil texture and structure
 - Texture refers to the proportions of different particle sizes
 - Sand (large size)
 - Silt
 - Clay (small size)
 - Loam (a mixture of all three sizes) is best suited for plant life

Soil Texture Triangle

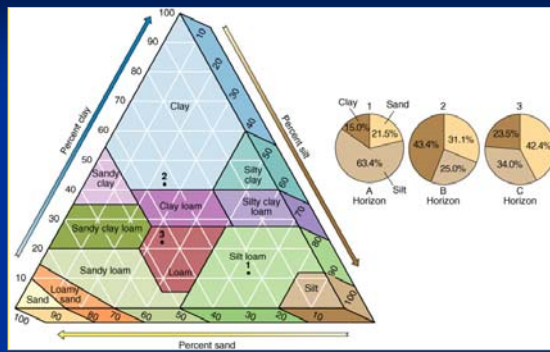


Figure 18.4

Soil Classification

- Soil Taxonomy
- Diagnostic Soil Horizons
- The 12 Soil Orders of the Soil Taxonomy

Soil Taxonomy

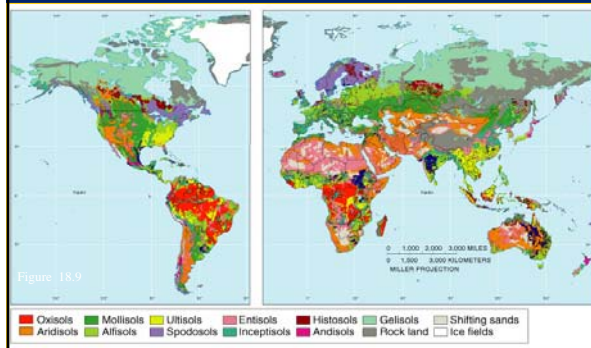


Figure 18.9

Soil

Climate	Temperate humid (>63 cm rainfall)	Temperate dry (<63 cm rainfall)	Tropical (heavy rainfall)	Extreme arctic or desert
Vegetation	Forest	Grass and brush	Grass and trees	Almost none, so no humus develops
Typical Area	Eastern U.S.	Western U.S.		
Soil Type	Pedafers	Pedocal	Laterite	
Topsoil	Sandy, light-colored; acid	Commonly enriched in calcite; whitish color	Enriched in iron (and aluminum) brick-red color	No real soil forms, because there is no organic material. Chemical weathering is very slow.
Subsoil	Enriched in aluminum, iron and clay; brown color	Enriched in calcite; whitish color	All other elements removed by leaching	
Remarks	Extreme development in conifer forests, because abundant humus makes groundwater very acidic. Produces light gray soil because of removal of iron.	Caliche is name applied to the accumulation of calcite.	Apparently bacteria destroy humus, so no acid is available to remove iron.	

Soil

❖ Soil texture and structure

- Structure
 - Soil particles clump together to give a soil its structure
 - Four basic soil structures
 - Platy
 - Prismatic
 - Blocky
 - Spheroidal

Types of Soil Structure

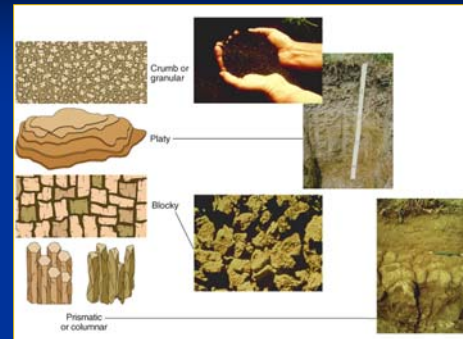


Figure 18.5

Properties of Soils



Munsell Color Book

Soil

❖ Soil erosion

- Recycling of Earth materials
- Natural rates of erosion depend on
 - Soil characteristics
 - Climate
 - Slope
 - Type of vegetation

Soil

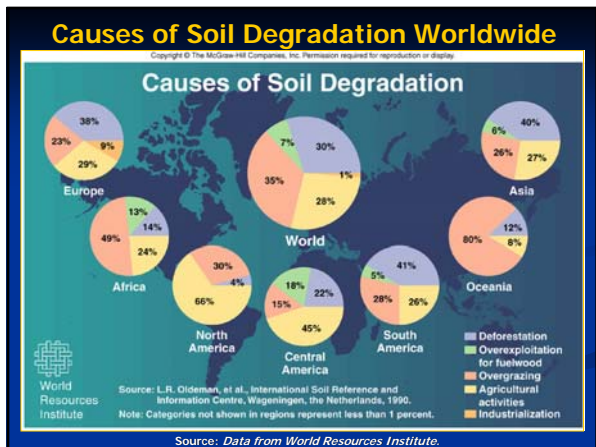
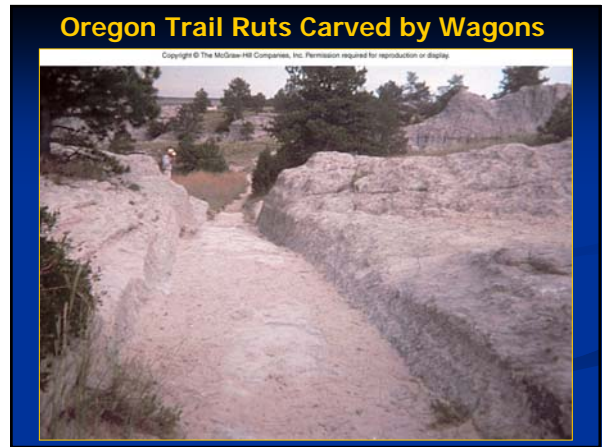
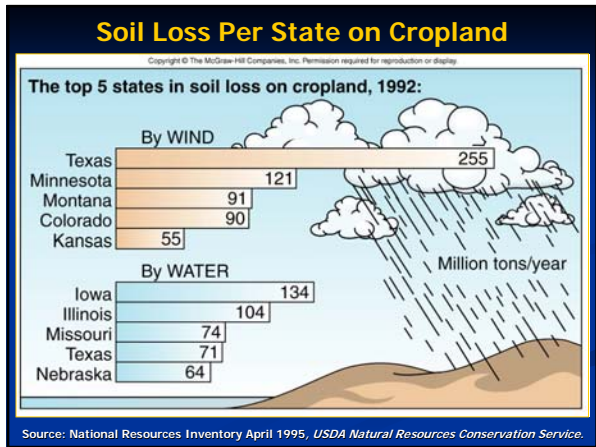
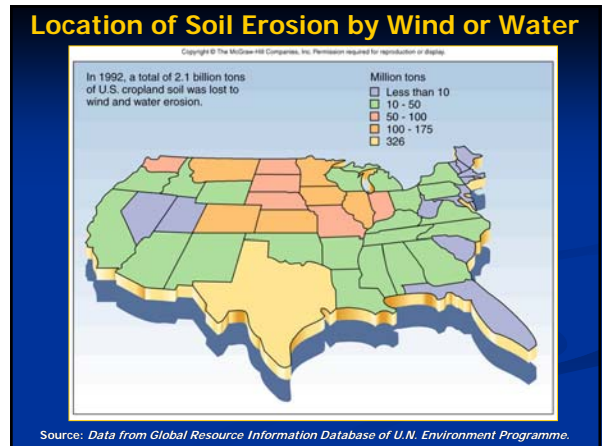
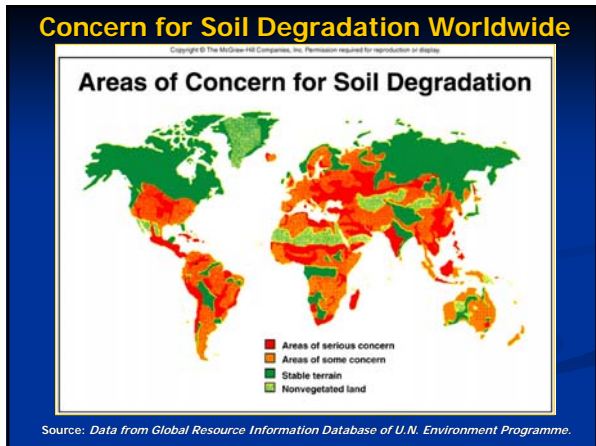
❖ Soil erosion

- Soil erosion and sedimentation can cause
 - Reservoirs to fill with sediment
 - Contamination by pesticides and fertilizers

What is Soil and How Does it Form?

- Soil degradation is a decrease in soil productivity or loss of soil.





EROSION CONTROL

RURAL

- Contour plowing
- Terracing
- Wind Breaks
- Riparian buffers
- Silt ponds

URBAN

- Silt fences
- Storm drain filters
- Detention ponds
- Retention ponds