Soil as a Resource

The central concept of Vertisols is that of soils that have a high content of expanding clay. They shrink when drying and swell when they become wetter.

Houston Black Soil Profile
- Surface layer: black clay
- Subsoil upper: black clay with slickensides
- Subsoil lower: black clay with slickensides and calcium carbonate
- Substratum: light olive brown clay

The Houston Black series occurs on about 1.5 million acres in the Blackland Prairie, which extends from north of Dallas south to San Antonio. Because of their highly expansive clays, Houston Black soils are recognized throughout the world as the classic Vertisols, which shrink and swell markedly with changes in moisture content. These soils formed under prairie vegetation and in calcareous clays and marls. Water enters the soils rapidly when they are dry and cracked and very slowly when they are moist.

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
  - 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

Climate, relief, slope angle

Three major soil types are recognized: pedalfers (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 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 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

What is Soil and How Does it Form?
- Soil degradation is a decrease in soil productivity or loss of soil.

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

Chemical and Physical Properties of Soils

Types of Soil Structure

Properties of Soils
Soils and Human Activities

- Lateritic Soil
- Wetland Soils
- Soil Erosion
- Soil Erosion versus Soil Formation
- Strategies for Reducing Erosion
- Irrigation and Soil Chemistry
- The Soil Resource—The Global View

Soil

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

Concern for Soil Degradation Worldwide

Areas of Concern for Soil Degradation

Source: Data from Global Resource Information Database of U.N. Environment Programme.

Location of Soil Erosion by Wind or Water

Source: Data from Global Resource Information Database of U.N. Environment Programme.

Soil Loss Per State on Cropland

The top 5 states in soil loss on cropland, 1992:

- Texas: 255
- Minnesota: 121
- Montana: 91
- Colorado: 90
- Kansas: 56
- Iowa: 134
- Illinois: 104
- Missouri: 74
- Texas: 64
- Nebraska: 64

Source: National Resources Inventory April 1995, USDA Natural Resources Conservation Service.
Oregon Trail Ruts Carved by Wagons

Causes of Soil Degradation Worldwide

Erosion Control
- RURAL
  - Contour plowing
  - Terracing
  - Wind breaks
  - Riparian buffers
  - Silt ponds
- URBAN
  - Silt fences
  - Storm drain filters
  - Detention ponds
  - Retention ponds

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

Soil Taxonomy

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

- **Soil types**
  - Hundreds of soil types worldwide
  - Three very generic types
    - Pedalfers
      - Accumulation of iron oxides and Al-rich clays in the B-horizon
      - Best developed under forest vegetation
  - Pedocals
    - Accumulate calcium carbonate
    - Associated with drier grasslands
  - Laterites
    - Hot, wet, tropical climates
    - Intense chemical weathering

Soil

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Eastern U.S.</th>
<th>Western U.S.</th>
<th>Laterite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
<td>Forest</td>
<td>Grass and brush</td>
<td>Almost none, so no humus develops</td>
</tr>
<tr>
<td>Typical Area</td>
<td>Rainforest</td>
<td>Grasslands</td>
<td>Hot, wet, tropical climates</td>
</tr>
<tr>
<td>Texture</td>
<td>Sandy, light-colored, acid</td>
<td>Clayey, enriched in calcite, dark-colored</td>
<td>Enriched in lime, dark-colored</td>
</tr>
<tr>
<td>Color</td>
<td>Varied colors</td>
<td>Brownish-gray</td>
<td>Brownish-gray</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Low nutrient content</td>
<td>High nutrient content</td>
<td>Low nutrient content</td>
</tr>
<tr>
<td>Remarks</td>
<td>Extreme development in cooler forests, because abundant organic matter</td>
<td>Precipitation tends to be high</td>
<td>Precipitation tends to be high</td>
</tr>
</tbody>
</table>

TABLE 3.2 Summary of Soil Types