Introduction to Pedology

Chapter 18: The Geography of Soils
Pedology as a field of Science

- Pedology studies the origin, classification, distribution, and description of soil.
- A pedon is a hexagonal column measuring 1 to 10 m² in top surface area. A pedon is the basic soil sampling unit in soil surveys.
Pedology as a Field Science

(a) An idealized soil profile within a pedon.

(b) Profile of a well-drained soil with till as parental material (a Mollisol) in southeastern South Dakota. Carbonate nodules are visible in the lower B and upper C horizons.
Glacier Creek Prairie Reserve
Soil Horizons

• **O** (humus or organic): Mostly organic matter such as decomposing leaves.
• **A** (topsoil): Mostly minerals from parent material with organic matter incorporated.
• **E** (eluviated): Leached of clay, minerals, and organic matter, leaving a concentration of sand and silt particles of quartz or other resistant materials – missing in some soils but often found in older soils and forest soils.
• **B** (subsoil): Rich in minerals that leached (moved down) from the A or E horizons and accumulated here.
• **C** (parent material): The deposit at Earth’s surface from which the soil developed.
• **R** (bedrock): A mass of rock such as granite, basalt, quartzite, limestone or sandstone that forms the parent material for some soils
Factors that Determine Soil Composition

- Parent Material
- Climate
- Biological Material
- Topography
Classifying Soil

- Soil texture
- Soil color
- Soil structure
- Soil chemistry
- Soil acidity and alkalinity
Classifying Soil - Soil Texture Triangle

• Calculating Soil Texture
  clay% + sand% + silt% = 100%
  silt% = 100% − clay% − sand%
Classifying Soil - Color

Munsell Color Chart
Classifying Soil - Consistency

• Wet soil is sticky and moldable.
• Moist soil is filled to half of field capacity and is loose to friable to firm.
• Dry soil is brittle and rigid and ranges from loose to soft to extremely hard.

<table>
<thead>
<tr>
<th>Resistance-to-crushing class</th>
<th>Method used</th>
<th>Condition of failure of 30 mm test cube or aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very weak</td>
<td>Force applied between extended fingers</td>
<td>Fails under very gentle force</td>
</tr>
<tr>
<td>Weak</td>
<td>Fingertip and thumb either on horizontal faces of cubes as</td>
<td>Fails under gentle force</td>
</tr>
<tr>
<td>Slightly firm</td>
<td>Oriented in profile, or normal to defined aggregate</td>
<td>Fails under moderate force</td>
</tr>
<tr>
<td>Firm</td>
<td>Area, or on defined aggregate faces</td>
<td>Fails under strong force, the maximum that most people can assert</td>
</tr>
<tr>
<td>Very firm</td>
<td>Force applied slowly under foot on hard flat surface or between both hands locked</td>
<td>Fails with gentle force under foot, can be crushed between locked hands of average person</td>
</tr>
<tr>
<td>Hard</td>
<td>Force applied slowly under foot on hard surface</td>
<td>Fails under the force which is applied by full body weight of c. 50 kg applied slowly</td>
</tr>
<tr>
<td>Very hard</td>
<td>Withstands the force applied slowly under foot by average body weight of c. 80 kg.</td>
<td></td>
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Classifying Soil - Structure

- Soil texture describes the size of soil particles.
  - Soil structure refers to their arrangement.
- The smallest natural lump or cluster of particles is a ped.
  - Types of peds from Granular to Massive
Classifying Soil - Chemistry

- Soil Colloids – tiny particles of clay or organic materials
- Soil chemistry helpful in determining types of plants able to grow
  - A soil rich in hydrogen ions (cations) is an acid soil.
  - A soil high in base cations (calcium, sodium) is a basic or alkaline soil.
Soil Taxonomy

- Types of soils classified similar to types of species
- Soil classification system, emphasizes the physical and chemical properties of the soil profile.

<table>
<thead>
<tr>
<th>TABLE 18.1 Soil Orders</th>
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<tbody>
<tr>
<td>Order</td>
</tr>
<tr>
<td>Oxisols</td>
</tr>
<tr>
<td>Aridisols</td>
</tr>
<tr>
<td>Mollisols</td>
</tr>
<tr>
<td>Alfisols</td>
</tr>
<tr>
<td>Ultisols</td>
</tr>
<tr>
<td>Spodosols</td>
</tr>
<tr>
<td>Entisols</td>
</tr>
<tr>
<td>Inceptisols</td>
</tr>
<tr>
<td>Gelisols</td>
</tr>
<tr>
<td>Andisols</td>
</tr>
<tr>
<td>Vertisols</td>
</tr>
<tr>
<td>Histosols</td>
</tr>
</tbody>
</table>
Oxisols

- Less defined layers
  - Typically called “old soils”
- Even layering, even at depth
  - Little horizontal separation
Aridisols

- Also known as “desert soils”
- Pale in color
- Shallow Horizons
- Susceptible to salinization

Global Distribution of Aridisols

~12% of global ice-free land area

(source: USDA-NRCS)
Mollisols

- Primarily found in grasslands
- Thick soft, usually dark brown or black in color
- Great fertility
Alfisols

- Associated with forest ecoregion
- Productivity depends on climate
  - Determines decomposed organic material
Soil Classification by Texture and Slope
from STATSGO Data Base
Sand Hills

- Primarily made up of sediment from Rocky Mountains and washed to Great Plains during Pleistocene Era
  - Primarily sand, stabilized by grasses
  - Very poor for cultivation
Soils of the United States
Ultisols

- Heavily weathered, found in subtropical areas
- Very clayey with large amounts of Iron
  - Low productivity
Spodosols

- Conifer forest soils
- Form from sandy parent materials
- Acid accumulation in the soil

Global Distribution of Spodosols

~4% of global ice-free land area

(source: USDA-NRCS)
Entisols

- Newer soils
  - A catch-all classification for soils with no other order
- Not much vertical development
- Frequent in deposition and mountains
Gelisols

- Defined by presence of permafrost within 2 meters of surface
- Very unproductive
Vertisols

- Contain more than 30% clay
  - Clay swells when wet and shrinks when it dries, creating cracks and destroying foundation.
- Black color is due to specific mineral content rather than organics.
Histosols

- Largely made up of organic materials
- Presence in bogs, much, or peats
  - Poor drainage, slow decomposition
Soil Conservation

- Soil quickly eroding across the world by wind and water
  - 35% of farmland losing soil faster than it can form
  - Estimates of loss of soil by 2120

- Desertification: Land degrading and becoming unproductive
Carbon Sequestering of Prairie Plants
Dust Bowl

Dust storm damage, 1930 - 1940

- Dust Bowl states
- Area with most severe dust storm damage
- Other areas damaged by dust storms
Soil Conservation

• Wind Breaks/Shelter Belts
• Crop Rotation
• No-Till Farming
• Contour Farming