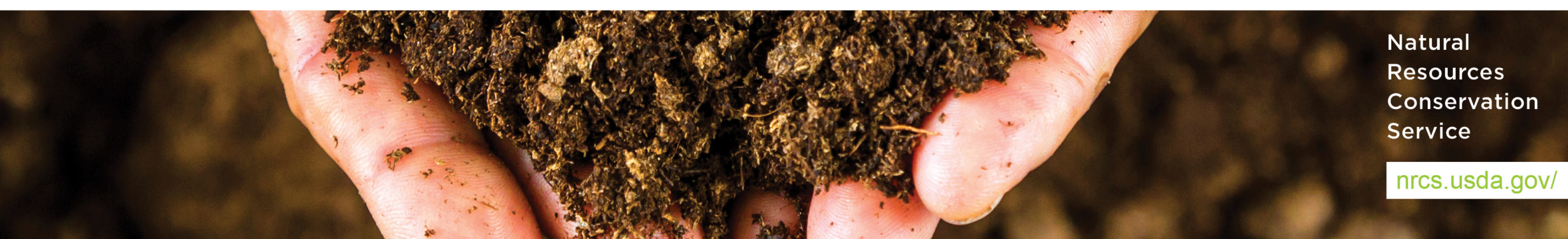
USDA

United States Department of Agriculture

USDA Natural Resources Conservation Service & Fairbanks Soil and Water Conservation District

Soils & Soil Survey



Natural Resources Conservation Service

nrcs.usda.gov/

What is Soil?

Naturally occurring unconsolidated material on the earth's surface that has been influenced by parent material, climate, organisms and topography acting over time

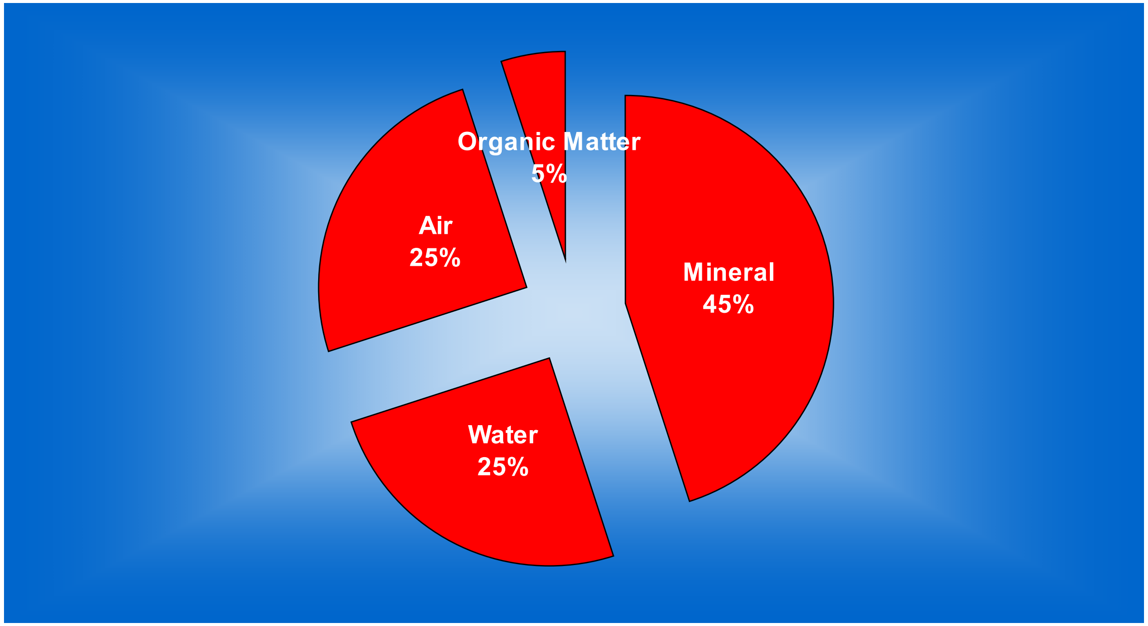
The dynamic biogeochemical interface between the atmosphere, hydrosphere, biosphere, and lithosphere

Soil Composition

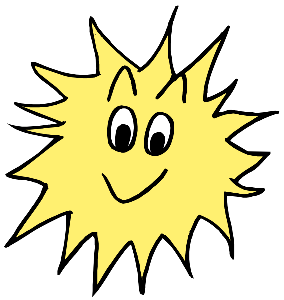
Soils are composed of 3 main ingredients

- Clay to boulder sized mineral material
- Organic materials from the remains of dead plants and animals
- Pore space that can be filled with gas or liquid

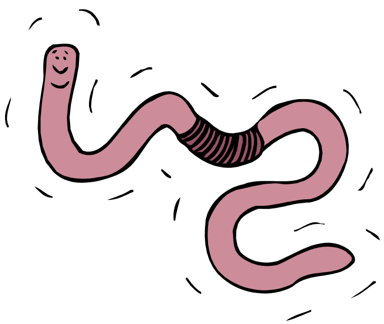
Soil Composition for Optimum Plant Growth

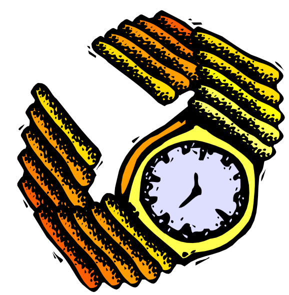


Soil Forming Factors



1. Parent Material
2. Topography
3. Organisms
4. Climate
5. Time





Parent Material

The material from which soil is formed

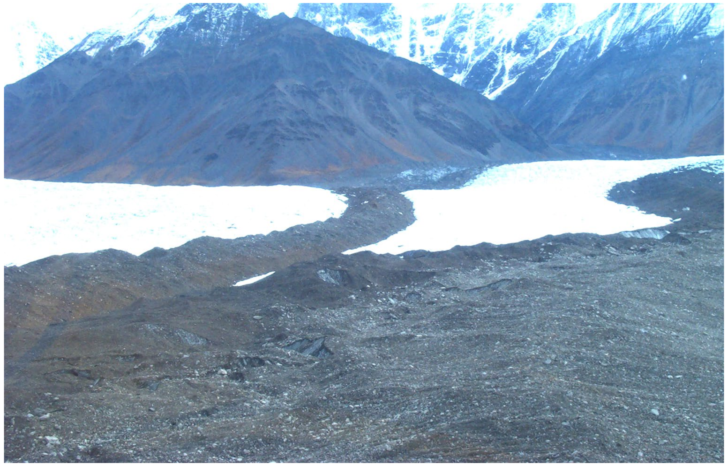
Derived from physical and chemical weathering of rocks

Produced by geologic or biologic process

- **Glacial materials**
- **Volcanic flows and ejecta**
- **Organic matter**
- **Tidal Sediments**

- – ***In place – residuum***
- – ***Moved by gravity - colluvium***
- – ***Moved by wind – loess***
- – ***Moved by water - alluvium***

Residuum/Colluvium

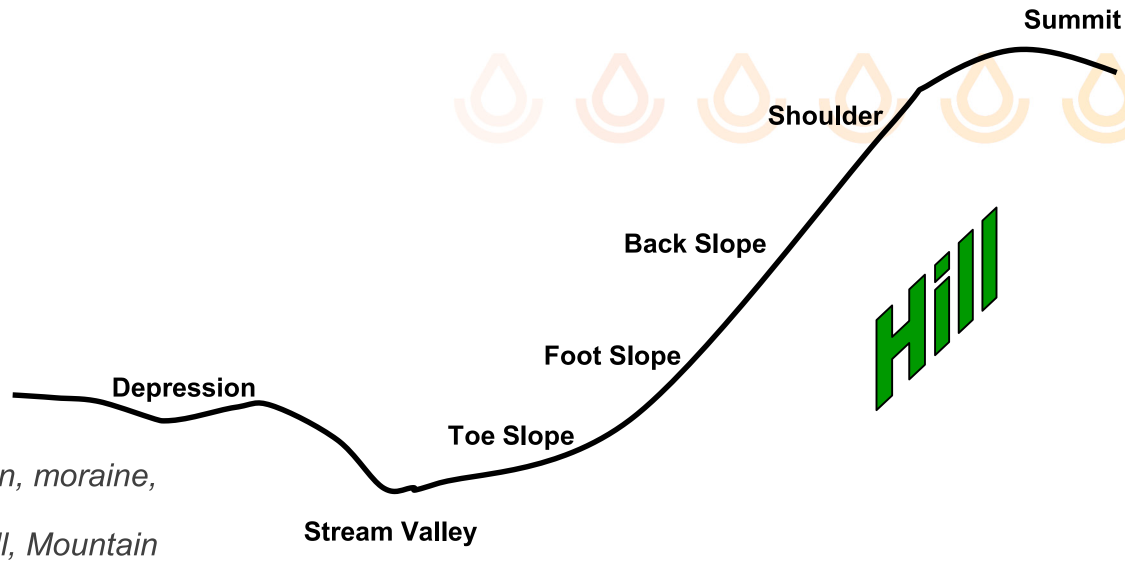


Glacial Materials

Topography

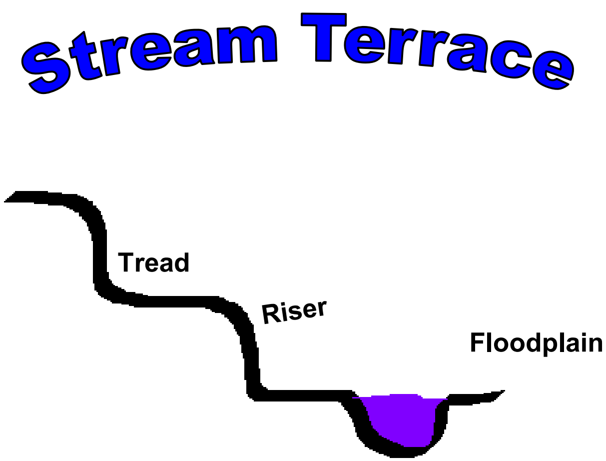
Landscape Position

- Where are you?
  - *Hill*
  - *Stream Terrace*



Landform

- ***Glacial*** *– esker, kame, drumlin, moraine, outwash plain*
- ***Residual*** *– Bedrock cored Hill, Mountain*
- ***Wind*** *– dunes, loess hill*
- ***Water*** *– alluvial fan, floodplain, stream terrace, tidal flat*
- ***Permafrost*** *– thermokarst ponds, ice wedge polygons*
- ***Volcanic*** *– cinder cone, lava flow, volcanic cone*



Shape

- *Concave*
- *Convex*
- *Plane*

Slope

Aspect

Organisms

Plants

- Trees
- Shrubs
- Herbs
- Mosses
- Lichens

Microorganisms

- Fungi
- Bacteria

Animals/Humans

- Excavations
- Organic Matter Decomposition
- Organic Matter Additions

Lichens on Rocks

Squirrel Midden

Climate

The major factor determining the kind of plant and animal life on and in the soil

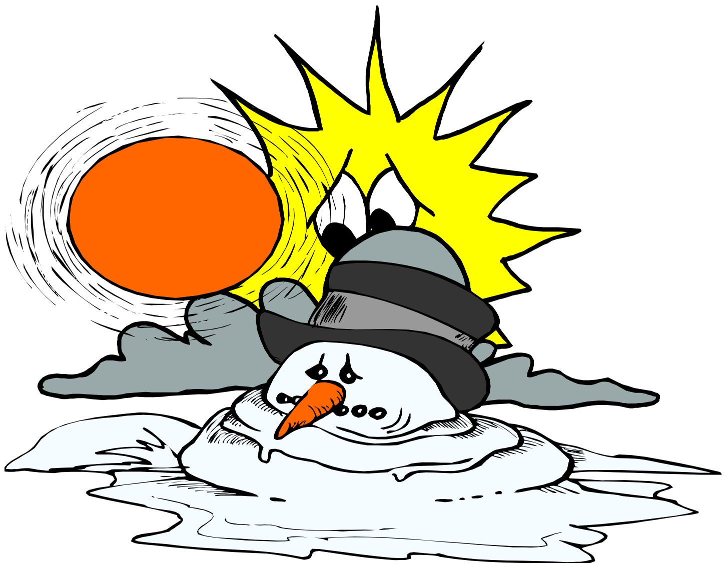
Temperature

- Freezing and thawing
- Rate of chemical activity

Precipitation

- Wetting and drying
- Amount of chemical activity

Temperature and Precipitation fluctuations control the rate of physical and chemical weathering and the break down of parent materials in the soil



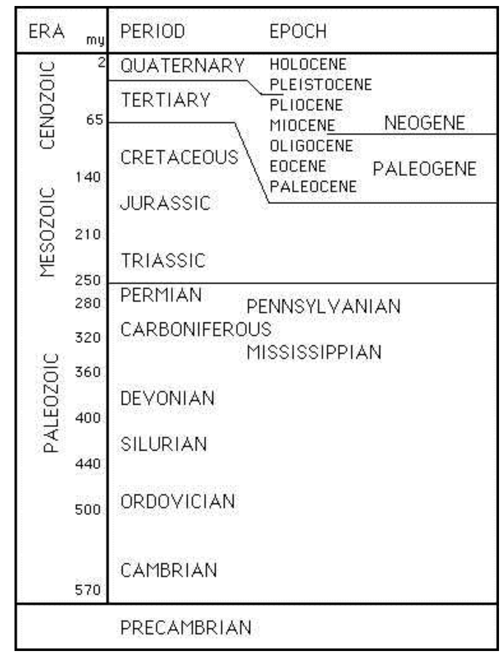
Time

Required for horizon formation

Horizon formation is a slow process

Long term changes happen over hundreds, thousands, or millions of years

Short term changes can be caused by human activity and fire



Geologic Time Scale

Soil Forming Processes

Additions

- Dust
- Loess
- Organic matter
- Manure
- Chemicals

Losses

- Leaching
- Plant uptake
- Gasses

Translocations

- Chemical
  - Osmosis
- Physical
  - Animals
  - Leaching
  - Frost
  - Shrink-Swell Clays

Transformations

- Redox state
- Solution
- Decomposition

Soil Features

Soil Profile

- The way a soil looks if you cut a section out of the ground

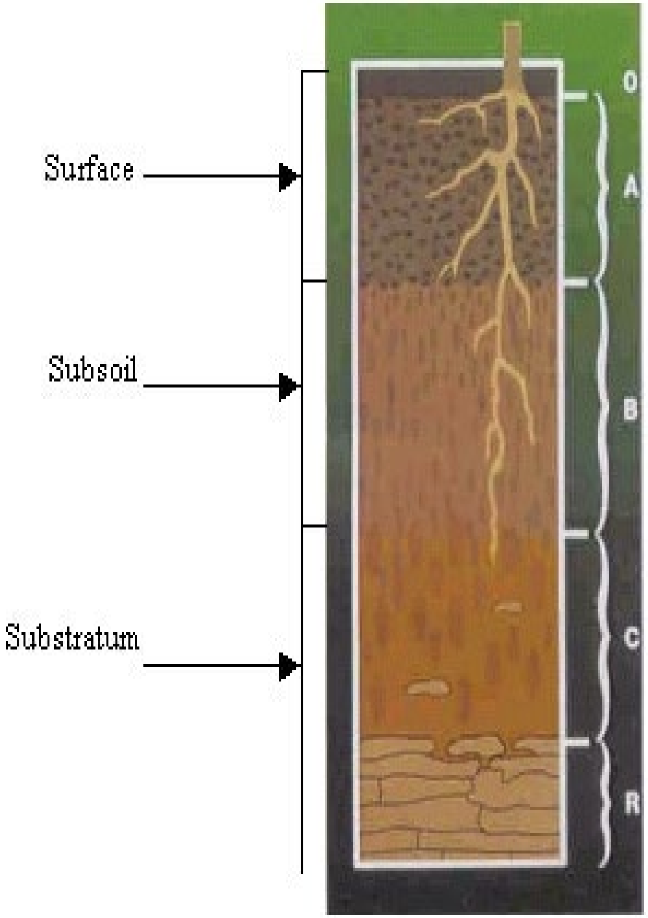
- Tells a story about how the soil was formed
  - Horizons
  - Texture
  - Color
  - pH
  - Structure

USDA United States Department of Agriculture

Soil Profile

Soil Horizons

- Development of soils into layers
  - Surface
  - Subsoil
  - Substratum
- 7 Master Horizons
  - O, A, E, B, C, R, W
  - Type of horizons present is determined by soil forming factors



Natural Resources Conservation Service

nrcs.usda.gov/

Soil Horizons

O horizon

- Organic horizon usually making up the uppermost layer of soil
- Consists of fresh and decaying plant residue from leaves, needles, twigs, moss, and lichens
- Dark in color due to the production of humus

A horizon

- Mainly mineral material
- Darker in color than lower horizons due to varying amount of humus
- Horizon of maximum biological activity and usually most fertile layer

Soil Horizons

E horizon

- Zone of leaching (Fe, Al, organics)
- Usually bleached or whitish in color

B horizon (Subsoil)

- Zone of accumulation (Fe, Al, organics)
- Lighter colored, redder, denser, and lower organic matter content

C horizon (Substratum)

- Weathered sediments
- May contain partially disintegrated parent material

R horizon

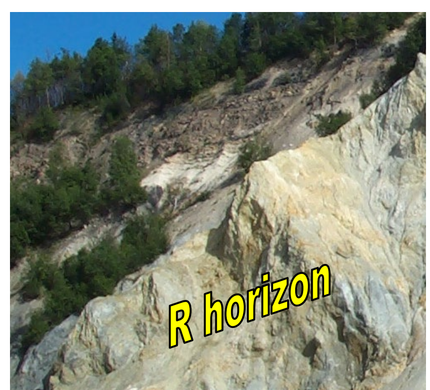
- Bedrock
- Can be within a few centimeters to many meters from surface

W horizon

- Water

E horizon

C horizon



Soil Texture

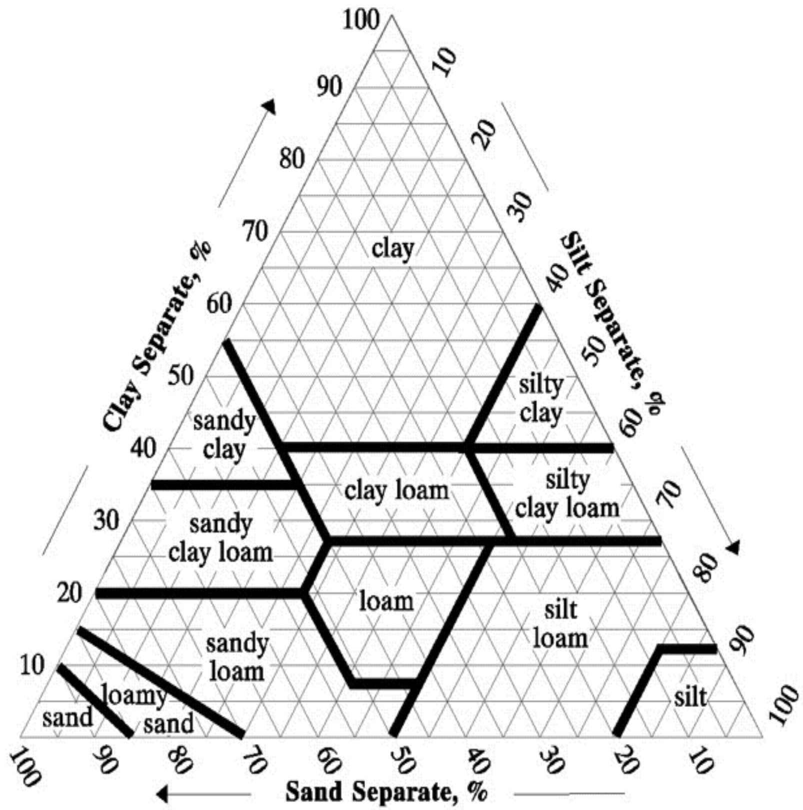
Determined by feel and/or lab analysis

Relative proportion of:

- Sand 2.0mm-0.05mm
- Silt 0.05mm-0.002mm
- Clay <0.002mm

Modified by coarse fragments:

- Gravel >2.0-75mm
- Cobble >75-250mm
- Stone >250-600mm
- Boulder >600mm



Soil Texture Triangle

Soil Color

3 Components that have greatest affect on color

- ***Organic Compounds*** - black or dark brown
- ***Iron Oxides*** - red, orange, yellow
- ***Color of Mineral grains*** – variable

Observed using moist soil and a Munsell Color Book

- Example: 10YR3/3
- Color referred to by:
  - Hue = 10YR
  - Value = 3
  - Chroma = 3

Matrix Color

- Dominant color of soil horizon
- Less dominant colors are recorded as secondary colors
- Mottles (splotches of color) are also recorded
  - Redoximorphic features or relic from parent material

- Redoximorphic (oxidation/reduction) Features
  - Indication that soil is saturated for sometime during the year
  - Redox depletions (reduction) – *low chroma*
    - Fe and Mn have been stripped from soil
  - Redox concentrations (oxidation) – *high chroma*
    - Accumulation of Fe and Mn oxides

Redox Concentrations and Depletions

Soil pH

-The degree of the soils acidic or alkaline state

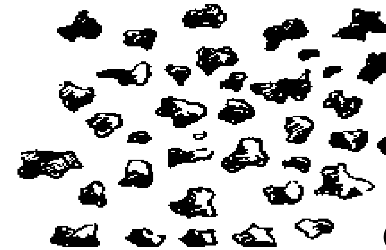
-Measured on a 14 point scale

- 1 = extremely acid
- 7= neutral
- 14 = extremely alkaline (high base)

-Affects availability of nutrients for plant uptake

- Very acid soil – low levels of nitrogen, phosphorus, calcium, and magnesium and high levels of aluminum, iron, and boron
- Very basic soil – low levels of iron, manganese, copper, zinc, boron, and phosphorus and high levels of sodium

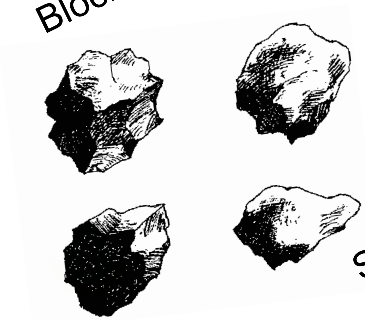
Soil Structure

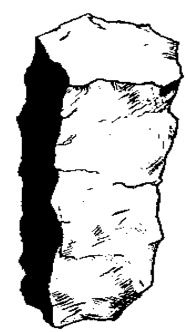


- ***The natural organization of soil particles into aggregates or peds***

- Types of Structure
  - **Granular** – *small and rounded*
  - **Platy** – *flattened*
  - **Angular and Subangular Blocky** – *sharp and rounded edges respectively*
  - **Single Grain** – *falls apart into loose grains (sands)*
  - **Prismatic and Columnar** – *vertically elongated with flat and rounded tops respectively*
  - **Massive –** *does not fall apart naturally into any coherent structure*

- Structure influences
  - » Pore space
  - » Liquid and gas movement
  - » Permeability





Soil Properties

Used to determine suitability of soil for various practices:
agricultural, structural development, roads, etc.

- **Soil Interpretations**
  - » Drainage Class
  - » Depth
  - » Permeability
  - » Slope Class
  - » Erosion and Erosion Potential
  - » Soil Wetness
- **Influenced by:**
  - » Texture
  - » Soil Structure
  - » Pore space
  - » Location/Landscape Position

Drainage Class

6 Drainage Classes

1. **Excessively Well Drained**
   - No redoximorphic features Water moves through soil very rapidly
   - Coarse Textures (sand and loamy sand)
   - Shallow, porous steeply sloped profiles
2. **Well Drained**
   - Good aeration
   - Bright colors in subsoil
   - Water table generally below 150cm
3. **Moderately Well Drained**
   - Water table between 75 and 150cm for part of growing season
   - Redoximorphic features often present between 30 and 150cm
4. **Somewhat Poorly Drained**
   - Water table between 50 and 75 cm for part of growing season
   - Redoximorphic features present between 50 and 75 cm
   - Special management needed for crop production and septic system use
5. **Poorly Drained**
   - Water table between 25 and 50cm for part of growing season
   - Considered a Hydric soil
   - Redoximorphic features between 25 and 50cm or more than 40 cm of organic surface
   - Special management required
6. **Very Poorly Drained**
   - Water table above 25 cm during part of growing season
   - Considered a Hydric soil
   - Redoximorphic features above 25 cm or more than 40 cm of organic surface
   - Water removed extremely slow
   - Located in concave, low-lying areas or depressions

Depth Class

Depth to a layer that limits roots, air, or water

Important for agricultural and nonagricultural practices

- Determines capability and quality of plant growth
  - » Plants on shallow soil may be impacted due to lack of nutrients and water
  - » Certain crops and plants are deep rooted and require deep soils to grow
- Poses restrictions for homes and development
  - » Deep soils are preferred for basements and septic systems
  - » Structures being built on shallow soils may need special designs for foundations and septic systems

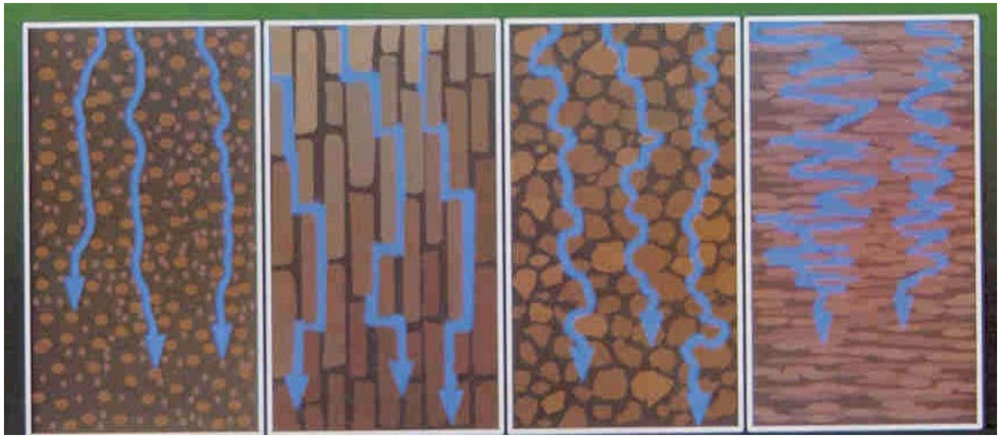
Soil Depth Classes

Very Deep - >1.5m
Deep – 1.0 to 1.5m
Moderately Deep – 0.5-1.0m
Shallow – 0.25-0.5m
Very Shallow - <0.25m

Permeability Class

***Permeability** – the rate that liquid and gas move through the soil*

Influenced by soil structure, bulk density, and texture

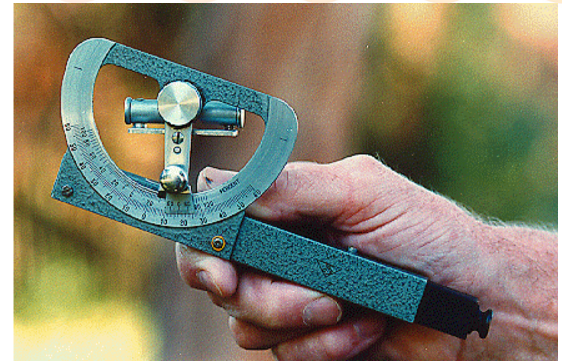


Water movement through granular, prismatic, blocky, and platy structure

Permeability Classes

- Very slow - <0.06 in/hr
- Slow – 0.06-0.02 in/hr
- Moderately Slow – 0.02-0.6 in/hr
- Moderate – 0.6-2.0 in/hr
- Moderately Rapid – 2.0-6.0 in/hr
- Rapid – 6.0-20 in/hr
- Very Rapid - >20 in/hr

Slope Class

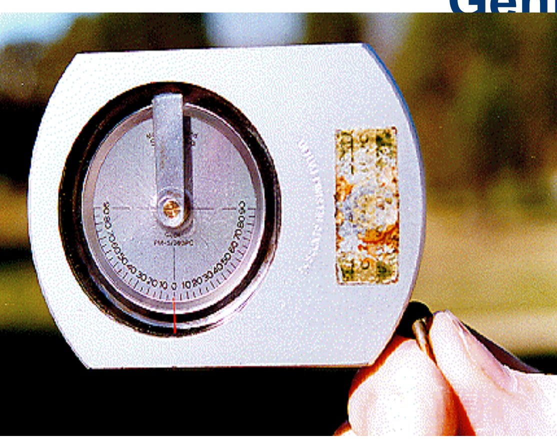


Abney level

Expressed as a percentage
Measured using a clinometer or Abney level

Slope Classes

- Nearly Level 0-3%
- Gently Sloping 3-7%
- ngly Sloping 7-12%
- Moderately Steep 12-20%
- Steep 20-30%
- Very Steep 30-40%
- emely Steep >40%



Clinometer

Erosion and Erosion Potential

Erosion

the detachment and movement of soil or rock by water, wind, ice, or gravity

Accelerated by the removal of native vegetation and/or cultivation

Estimated as a measure of the remaining soil compared to the original depth of the soil

Three types of Water Erosion

- Sheet
- Rill
- Gully

Erosion Potential

soil's susceptibility to erosion

Determined by:

- Steepness of slope
- Length of slope
- Soil texture
- Permeability
- Type of Vegetation

Erosion Classes

Class 1 - <25% of original surface soil lost

Class 2 - 25 to 75% original surface soil lost

Class 3 - >75% original surface soil lost

Class 4 – 100% of original surface soil lost

Soil Wetness

Hydric Soils

Soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part

Field Indicators of Hydric Soils

- Ponding, Flooding, or Saturation
- Hydrophytic Vegetation
- Redoximorphic Features in upper horizons

Wetland Areas

- Have wetland hydrology, hydrophytic vegetation, and hydric soils
- Regulated by the Core of Engineers
- Poor sites for buildings and septic systems
- May be farmed under special management and proper permits

» List of Hydric Soils Provided in Soil Survey

United States Department of Agriculture

Soil Classification

12 Soil Orders (all soils belong to an order)

1. **Entisols** – new soils
2. **Inceptisols** – young soils
3. **Gelisols** – permafrost soils
4. **Spodosols** – conifer forest soils
5. **Andisols** – volcanic soils
6. **Histosols** – organic soils
7. **Mollisols** – prairie soils
8. **Aridisols** – desert soils
9. **Vertisols** – swelling clay soils
10. **Alfisols** – high-nutrient soils
11. **Ultisols** – low-nutrient soils
12. **Oxisols** – tropical forest soils

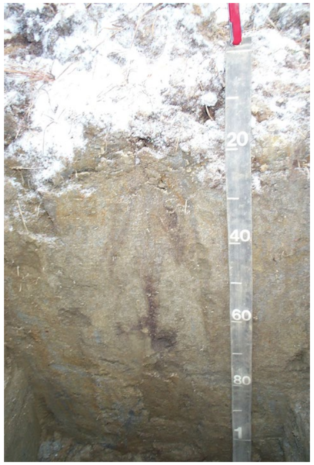
(*The first 7 orders are found in Alaska*)

Orders are divided into suborders, great groups, subgroups, families, and series based on observed soil features

Classification changes as soils weather

Each soil order can have many series and/or families

Fairbanks Silt Loam (Inceptisol)



Tanana Silt Loam (Gelisol)

Natural Resources Conservation Service

nrcs.usda.gov/

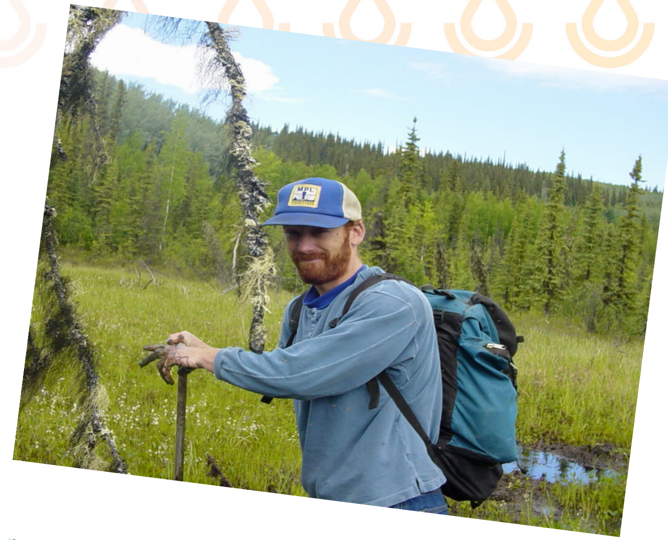
Soil Mapping

Soil Survey Area is divided into polygons based on landforms and soil properties

Soil Scientist traverses the area and digs holes at determined intervals in each polygon

Soil features and characteristics at each stop are recorded on a field data sheet

The data collected is entered into the national soils database for further analysis and is used to produce the soil survey



Soil Survey

Inventory of the soils in a particular area

First Surveys established in 1899 under the guidelines of the National Cooperative Soil Survey

Data is collected and analyzed in the field and the lab by Soil Scientists and then published as technical reports and maps

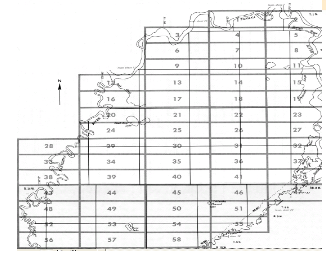
Collection of information useful to farmers, rancher, foresters, wildlife specialists, homeowners, landowners, and developers

Contents of a Soil Survey

- Narrative portion describing the Soils of the area
- Tables containing physical and chemical property data, and interpretive information about the soils
- Aerial photos showing extent of soils and their locations on the landscape

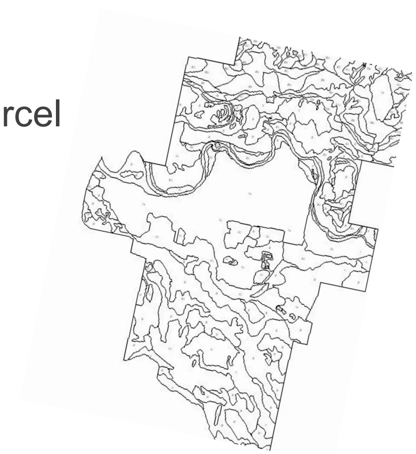
Using a Soil Survey

Index Map



- provided to locate parcel on Aerial Map Sheet
- Legal description or latitude and longitude of area required
    - » Ex. NW1/4, SW1/4, Sec 27, T4S, R3E
- Number listed on Index Sheet is Aerial Map Sheet needed

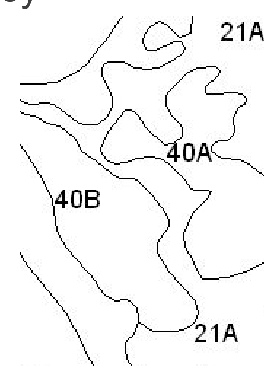
Aerial Map Sheet



- Polygons showing map units observed in area
- Section numbers labeled in center of each section to locate position of parcel
- Parcel may cross between multiple map units

Map Unit

- Represented by a symbol on the aerial map sheet
    - » Old Surveys ex. – GtA – Goldstream Silt Loam nearly level
    - » New Surveys ex. – 21A – Goldstream Silt Loam 0-3% slope
- Can be composed of more than one soil component
    - » Ex. Fairbanks-Steese complex
- Description of soil components each map unit can be found in the front of the Survey



Soil Series

- Name given to soils of a family that are similar in all major profile characteristics
- Usually named after a town, body of water, place, etc
    - » Ex. Tanana Silt Loam

Interpretations from Soil Surveys

Interpretations can be made using information in the tables provided in the soil survey

- Suitability of Soils for various practices
  - Each soil is given a rating based on standards developed for each practice
    - Construction materials
      - Rating of poor, fair, or good
      - Ex. Ester Peat **poor** for Road fill – permafrost, depth to rock, wetness
    - Sanitary Facilities
      - Rating of slight, moderate, or severe
      - Ex. Fairbanks Silt Loam 3-7% slope **moderate** for Septic Tank Absorption field – slope
    - Building Development
      - Rating of slight, moderate, or severe
      - Bohica Silt Loam 3-7% slope **slight** Small Commercial Buildings

➡ If rating is **poor, severe**, **moderate**, or **fair**, reasons are given in order of impact

Local Concerns

problems in an area that should be investigated prior to development
**can be determined using the Soil Survey from the area*

Interior Alaska Examples

Permafrost

- Ice lenses and wedges
- Thermokarsts

Flooding/Ponding

- Rivers
- Depth to water table

Sources of Information

1) The Nature and Properties of Soils - Nyle C. Brady and Ray R. Weil

2) http://faculty.msmary.edu/envirothon/
   - Charts and diagrams

3) www.envirothon.org

4) National Soil Survey Handbook – USDA Ag Handbook 436

5) Soil Survey Manual – United States Department of Agriculture

6) Field book for Describing and Sampling Soils
   - 3, 4, and 5 available online at http://soils.usda.gov