

Nebraska Soil Science Curriculum

Components and Physical Properties of Soil

Approximately 90 minutes

Objectives

By the end of the lesson, students will know or be able to:

- Define: aggregate, the four components of soil (mineral matter, organic matter, air and water), bulk density
- Describe the basic characteristics of the three soil textures – sand, silt and clay
- Create models of seven soil structures – granular, platy, wedge, blocky sub-angular, blocky angular, prismatic, and columnar
- Explain factors that affect aggregate stability
- List and explain factors that affect soil structure
- Differentiate between soil structure and aggregate stability
- Explain what causes soil color

Materials

- Legos (10-15/group of 4 students)
- Canning jar or 24oz pop bottle (cleaned with label removed)
- Soil sample
- About 2 cups of water
- 1 teaspoon of Borax
- Blank paper to spread out soil sample
- Permanent Marker
- “Separating the Components of Soil” Lab Sheet – 1 per student
- Guided Notes sheet – 1 per student
- 3 jars
- Handful of marbles
- Handful of small beads
- Approximately ½ cup of sugar
- Clay or Play-doh
- Pictures of various soils from around the world

Preparatory Work

- Make necessary copies
- Obtain necessary supplies
- Review “Separating the Components of Soil” Lab

Enroll the Participants – Approximately 7 minutes

Students will build a house with Legos. Divide the class into groups of four students and give each group a bag of 10-15 different Legos. Instruct the class to work with their group to build a house with their Legos in 2 minutes. After two minutes, guide the class through a discussion about similarities and differences in the houses. Relate these similarities and differences to soils components and properties. Although each group made a house, they all are made up of different sizes, colors, design and shapes. Explain to your class that soil is just like these houses, it varies in shape, size, design, and color. In this lesson, students will gain and demonstrate an understanding of soils components and physical properties.

Note: You could substitute children's blocks, office supplies, or any variety of materials for the Legos in this activity.

Provide the Experience – Definition and description of soil characteristics and components– Approximately 15 minutes set up, 24 hour wait time, and 10 minute data collection and review

Using the “Separating the Components of Soil Lab”, verbally discuss the steps of the lab. Have students prepare their soil sample and fill their jar. When they finish shaking the jars, place them in an area where they won't be disturbed for at least 24 hours.

After 24 hours, have students carefully observe their samples, record data, and complete the discussion questions.

Note: This lab can be done in small groups rather than individually. Also, it is important that the jars are not disturbed during settling and observing.

Label the Information – Approximately 2 minutes

Instruct students to record the four components of soil and the basic characteristics of soil texture in their guided notes.

Sand: > 2mm
Silt .05-2.0mm
Clay <.05mm

The four components of soil include: mineral matter 45%, organic matter 5%, air 25%, and water 25%. Therefore, soil is 50% solid and 50% pore space.

Demonstrate the Relevance – Approximately 5 minutes

Pass around 3 jars: one containing marbles, another containing small beads, and the third sugar. Use this visual to facilitate discussion on particle size and pore space. Consider using the following discussion points:

- The larger the particle sizes of a soil, the larger the pore space.
- The ration to soil and water will change with the dampness of soil.
- Most soils are a mixture of many different sized particles.
- What impacts particle size during soil formation?

Provide the Experience – Create model of seven soil structures, explain factors that affect aggregate stability and soil structure, and definition of bulk density – Approximately 10 minutes

Show students the slide with the seven soil structure pictures and provide each student with clay. Encourage students to select one type of soil structure and build a model, tell them not to discuss their model during construction. After a few minutes, as students complete their model, guide the class through a gallery walk of the different models. As students identify each other's model, have them discuss each type of aggregate. Keep models intact to use throughout the class today.

Label the Information – Approximately 5 minutes

Encourage students to draw a diagram of each structure on their guided notes sheet.

Share with students the definition for soil structure, aggregates, and bulk density. Refer back to the clay models as appropriate.

- Soil structure is the way in which the individual particles (sand, silt, and clay) are arranged into larger distinct aggregates.
- Soil aggregates are groups of soil particles, often called peds, which bind together more strongly than to neighboring particles and can usually be separated easily.

Demonstrate the Relevance – Approximately 10 minutes

Discuss factors that affect soil structure and aggregate stability. Students should capture this in their guided notes.

Aggregate stability

- Amount of clay
- Chemical elements
- Organic matter
- Biological activity

Soil structure

- Organic matter
- Soil organisms
- Tillage
- Freezing and thawing
- Water movement

Guide a discussion differentiating between soil structure and aggregate stability. Students should highlight this discussion in their notes using the Venn diagram. Consider using the following information to help facilitate discussion.

- All soil-forming factors, especially climate, influence the type of structure that develops within soil.
- Consider the definition of soil structure and aggregates.
- How are aggregates and soil structure related?
- Use models to demonstrate aggregate stability and soil structure.

Explain that there are many other differences in soil, including color.

Provide the Experience – Explain the causes and indications of soil color
– Approximately 5 minutes

Gather pictures of a variety of soils in several colors from around the world.

Examples: red desert sand in Arizona, gray deserts in Nevada, white sands of New Mexico, black soils of the mid-west, redbeds in Oklahoma, yellow soil of the Yellow River beds in China, or green sands of Hawaii.

Show the students each picture and have them guess where each soil can be found.

With a partner have the students discuss, “What causes color differences in soil?” Have a few students share highlights from their discussion.

Thank students for their thoughts and participation.

Label the Information – Approximately 5 minutes

Instruct students to write the two main causes of color in soil; humus content and iron compounds in their guided note.

Also discuss and record the basic soil color indications:

- Indicator of different soil types
- Indicator of certain physical and chemical characteristics
- Due to humus content and chemical nature of the iron in the soil

Demonstrate the Relevance – Approximately 5 minutes

Show students the Soil Organic Matter Color Chart and explain its use for measuring soil organic matter. Preview the Measuring the Organic Matter Lab in the next lesson. Pass the chart around and encourage students to predict the amount of organic matter in area soils.

Review the Content – Approximately 10 minutes

Instruct students to create a “Top 10 List of Components and Physical Properties of Soil” Students should revisit their guided notes sheet to help them review information. You might consider having students work with partners or in small groups to encourage discussion. Have students share one item from each list.

Celebrate Students Successes – Approximately 2 minutes

Thank students for their contributions to the class and describe how they can make more informed choices about soil management. If you students will participate in the Land Evaluation Competition, explain to them that their knowledge of components and physical properties of soil will help them differentiate soil horizons and determine soil texture and permeability.

Preview the material that will be covered in the next lesson.

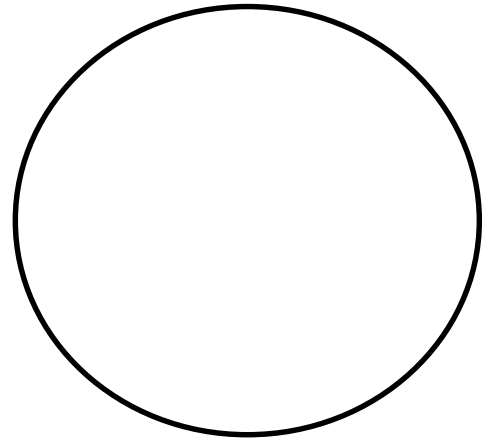
Guided Notes: Components and Physical Properties of Soil

Completed by _____

Components of Soil

Solid portions - _____% of soil volume: mineral and organic matter.

- _____, which accounts for about _____% of the soil, is partially decomposed rock material. It is the sand, silt, and clay that is found in the soil.
- _____, which accounts for about _____% of the soil, is partially decomposed plant and animal matter. Most organic matter is from plant leaves, roots, and stems.

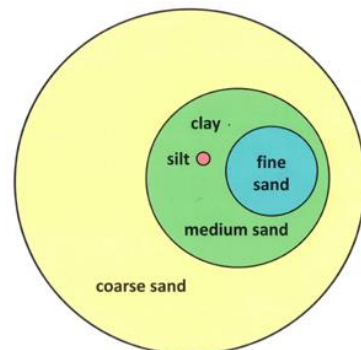


Pore spaces _____% of soil volume: air and water.

- _____ accounts for about _____% of the soil. When soils are wet the amount of air will be less. When soils are dry the amount of air will be more.
- _____, which accounts for about _____% of the soil, is also part of the pore space in the soil. When it rains water will enter the soil or flow off of the soil's surface.

Soil Particle Size

Soil Particle	Size
	> 2 mm
	.05mm – 2mm
	<.05mm



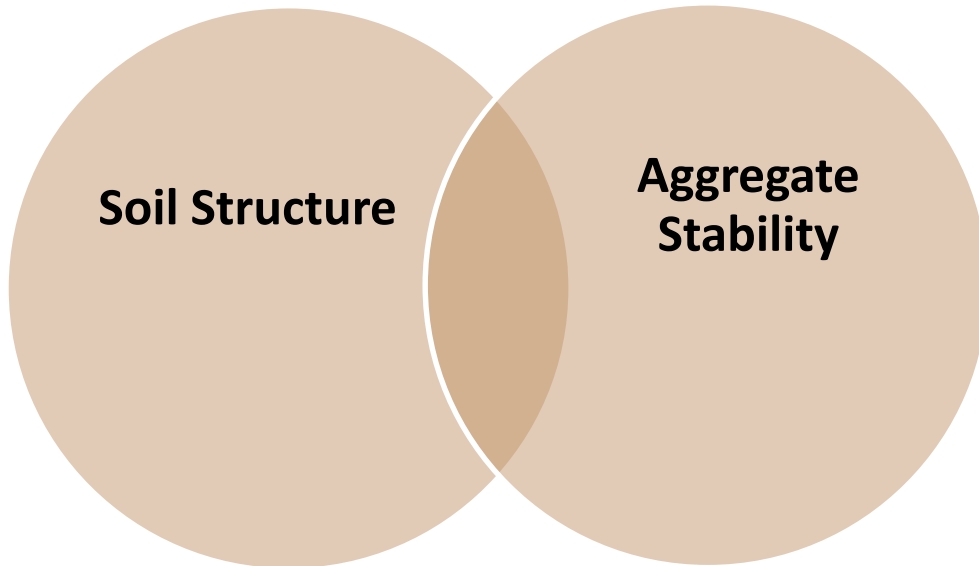
Draw the Soil Structure:

Granular	Platy	Wedge
Blocky Sub-Angular	Blocky Angular	Prismatic
Columnar		

Soil Structure

Soil Aggregates

Bulk Density



Causes of Soil Color

- -
- -

Soil Color Indications

- -
- -
- -
- -

Separating the Components of Soil Lab

Student _____

You will need:

- Canning jar or 24oz pop bottle (cleaned with label removed)
- Soil sample
- About 2 cups of water
- 1 teaspoon of Borax
- Blank paper to spread out soil sample
- Permanent Marker

Follow These Instructions:

1. Spread soil sample on blank paper.
2. Remove large rocks, trash and roots.
3. Break down large pieces of soil.
4. Fill jar or pop bottle $\frac{1}{4}$ full of soil.
5. Add water until the jar is $\frac{3}{4}$ full.
6. Add one teaspoon of borax
7. Tightly put the lid on the jar and label it with the students' name.
8. Shake jar vigorously for about 5 minutes to break apart all soil aggregates.
9. Leave the jar undisturbed for at least 24 hours.
10. After at least 24 hours. Observe the soil in the jar. Be careful not to disturb the soil.
11. Record your findings on the chart below and answer the discussion questions.

Layer	Description/Observation: (Color, texture, size, amount...)
Top	
Middle	
Bottom	

Using your observations answer the following discussion questions:

1. Describe the differences of all three layers.
2. Describe similarities of all three layers.
3. Compare your sample to other samples in the class.
4. Using what you know, what do you think is the makeup of each layer? Why?
Top Layer:

Middle Layer:

Bottom Layer:
5. Why might some samples have more or less than three layers?