

# What is Soil?

**Grade Level: 4-8**

## Lesson Overview

What is in the soil below our feet, our plants, our roads, and our buildings? Students will explore what soil is composed of, as well as the textures of soil. They will act out how water moves through various types of soil.

## Student Objectives

1. Recognize that soil is made up of specific components, including mineral matter (sand, silt and clay), water, air and organic matter.
2. Recognize that soil is made up of different-sized particles that define its texture.
3. Relate the effect of the different-sized particles on the properties of soil.
4. Explain why different soil particles form layers.
5. Use appropriate increments to measure soil layer thickness.

## Materials

- ✓ Each group will need:
  - 3-sectioned paper plates
  - 1 set of sand, silt and clay samples (can be purchased from <https://agclassroomstore.com/soil-samples-soil-texture/>)
  - medicine dropper or pipette
  - magnifying lens
  - ¼ cup of water
- ✓ Each student will need:
  - Paper towels (1 per student)
  - Sand, Silt and Clay Student Checklist & Data Table
  - Sand, Silt and Clay Worksheet
- ✓ 3 teaspoons
- ✓ Relative Sizes of Sand, Silt, and Clay Particles
- ✓ Sand, Silt and Clay Answer Key
- ✓ 2 quart jars with lids
- ✓ masking tape, to label jars
- ✓ dishwashing liquid
- ✓ plastic rulers
- ✓ water (approximately 4 cups)
- ✓ Soil Slurry Data Table
- ✓ soil sample from garden, flowerbed or field, completely dry
- ✓ soil sample from roadside, gravel pit or housing development, completely dry

## Vocabulary

- **clay** - smallest of the three soil particles; when wet, feels sticky or greasy; when dry, hard, and brick-like.
- **organic matter** - partially decomposed plant and animal matter.
- **sand** - very tiny rock fragments; largest and heaviest of soil particles; feels gritty.
- **silt** - medium-sized soil particles; feels like flour.
- **soil** - the outer portion of the earth's surface. Soil is the foundation of every living thing.
- **soil texture** - the way a soil feels.

## Background Information

- Soil is composed of air, water, mineral matter, and organic matter.
- Soil color varies due to the amount of organic matter in the soil and parent material it came from.

### Soil Layers

- Topsoil is the soil horizon layer where plant roots are generally found. Farmers must do their best to protect the valuable topsoil from wind or water erosion, as it takes 500 years to form one inch of topsoil. This is where most organisms and earthworms are found.
- Soil is considered a nonrenewable resource because it takes so long to form.
- Topsoils range from several feet deep in grasslands to 12 inches or less in many Western states.
- Subsoil is lighter in color, less productive, and contains very little organic matter.
- Soil is formed by parent material, small pieces of rock that are broken down by being naturally rubbed together, water or roots moving through cracks in the rock and dislodging pieces. These cracks can become larger as the water freezes and thaws.
- Bedrock is the deepest layer.

### Soil Textures

- There are three sizes of soil particles – sand, silt, and clay, all with varying textures and abilities for water to move through it.
- A mixture of all three soil particle sizes is best for growing crops. Farmers need to know their soil type so they can best manage the soil and determine

the crops that will grow well in a field and whether or not irrigation may be needed.

- Sand is the largest particle size, measuring 2 – 0.05 mm. It feels gritty. Sand dries out quickly because of the speed the water moves through it.
- Silt is the mid-sized particle, measuring 0.05 – 0.002 mm. It feels smooth to the touch, similar to flour.
- Clay is the smallest, measuring less than 0.002 mm. It feels sticky and can stain fingers when touched. It holds water and nutrients more than the others, but plant roots may have a more difficult time moving through clay.
- Loam is a mixture of all three soil particles in close to equal amounts.
- Soil texture cannot be determined simply by color.

## Procedure

**Particle Parade** – As an interest approach, complete the following activity if space and time allow.

Discuss the makeup of soil and the differences between clay, sand and silt particles. To allow students a visual view of the different particle sizes and water movement through each, perform the following demonstration.

1. Ask six students to stand at the front of the room. These students will represent the mineral particles in soil. Ask another student to represent water.
2. Have the six students hold their arms straight out and touch fingertips with the other students. They now represent sand particles. Have them put their arms down and have the student representing water flow between them. Since sand particles are large, it is easy for the water to move freely between the particles.
3. Now have the six students place their hands on their hips with elbows sticking out. They should move in so they are touching the elbows of the other students. They now represent silt particles. Have them put their arms down and ask the student representing water to flow between them. Silt particles are smaller than the sand particles, so it is more difficult for the water to flow through them.
4. Last, have the six students hold their arms at their sides and move in so they are touching shoulders with the other students. They now represent clay particles. Ask the student representing water to try and move through the particles. Since the particles are so small, it is difficult for water to flow through them.

Have the students summarize the size of soil particles and the impact they have on water movement. How might this affect crop production?

## Composition of Average Soil

Discuss with students that soil is made up of 25% water, 25% air, 5% organic matter and 45% mineral matter. Students should consider each component's function in soil.

- **Water** - soil is a storage area for water, which is necessary for plant growth.
- **Air** - the spaces between the soil particles are either filled with air or water. Plants' roots need air to grow.
- **Organic matter** - the decomposing plant and animal material in soil which provides nutrients to the soil.
- **Mineral matter** - provides the structure for a soil, classified into 3 sizes: sand, silt and clay.



*Note: Graphic provide by Illinois Agriculture in the Classroom*

## Sand, Silt and Clay activity

1. Distribute the following items to each group (suggested size 2-4 students):
  - ✓ paper towels (1 per student)
  - ✓ 1 3-sectioned labeled paper plate with a teaspoon each sample of sand, silt and clay that has been appropriately labeled sand, silt and clay
  - ✓ 1 medicine dropper or pipette
  - ✓ 1 magnifying lens
  - ✓ ¼ cup water
  - ✓ Sand, Silt and Clay Student Checklist & Data Table (1 per student)
  - ✓ Sand, Silt and Clay Student Worksheet (1 per student)
2. Instruct groups to look at the three soil particle samples and record the color of each on the Sand Silt and Clay Data Table.
3. Have students look at the samples with and without the magnifying lens. Use small, medium, and large in the "particle size" column of the table. Use each term only once.
4. One by one take a pinch of the soil samples between your thumb and index finger. Put the sample in the palm of your hand and rub with index finger. Use adjectives to describe how it feels in the "Texture - Dry" column of the table.
5. Move a small portion of each soil particle sample to the outer edge of each paper plate.

6. It might be easiest for the teacher to add the water to each group's samples. Add two drops of water to these small portions with the medicine dropper or pipette.
7. Feel the wet portion of each soil sample. Use adjectives to describe how it feels in the "Texture - Wet" column of the table.
8. Have students complete Sand Silt and Clay Student Worksheet.

### **Soil Slurry Activity**

Note: If you are conducting the Soil pH activities, the soil samples collected for that lesson could also be used for this activity.

Please remind students that the samples for Soil Slurry are only topsoil, whereas a soil profile has parent material, subsoil and topsoil.

1. Make sure that all dried soil clumps are crushed and that any rocks, roots and litter are removed from the samples.
2. Label the two jars using the masking tape.
3. Fill the first jar  $\frac{1}{4}$  full of soil sample A.
4. Fill the second jar  $\frac{1}{4}$  full of soil sample B.
5. Add water to the jars until they are about  $\frac{1}{2}$  full.
6. Add 1 teaspoon of dishwashing liquid to each jar.
7. Making sure the lids are on securely, shake them hard for about 3 minutes. Continue shaking until the particles have separated from each other.
8. Set the jars on a table. Observe them closely for 5 minutes. (The sand should settle to the bottom in approximately 1 minute.)
9. Measure any layers and record the data.
10. Observe the jars after 30 minutes. (The silt will settle out in 30 – 60 minutes.)
11. Measure any layers and record the data.
12. Observe the jars after 24 hours. (The clay will take about 1 day to settle.)
13. Measure any layers and record the data.
14. Observe the jars after 48 hours. (The final sample should have a layer of sand on bottom, followed by silt, with the clay at the top. Any floating material should be considered organic matter.)
15. Measure any layers, students will record data on the Soil Slurry Data Table Student Worksheet.

Also note that no answer key is included in this lesson, because the answers will vary dependent on soil samples collected.

## Extension Activities

1. Understanding the Soil Triangle is a math lesson that coordinates well with this lesson.
2. The Soil Search, Sample, & Analysis science lesson goes well with this lesson.

## Additional Resources

- Illinois Agriculture in the Classroom Soil Interactive Ag Mag: [http://www.agintheclassroom.org/TeacherResources/AgMags/Soil%20Ag%20Mag\\_2019\\_Online\\_Interactive.pdf](http://www.agintheclassroom.org/TeacherResources/AgMags/Soil%20Ag%20Mag_2019_Online_Interactive.pdf)
- Illinois Agriculture in the Classroom Soil Reader [http://www.agintheclassroom.org/TeacherResources/TerraNova/Soilnews\\_clr.pdf](http://www.agintheclassroom.org/TeacherResources/TerraNova/Soilnews_clr.pdf)
- Properties of Soil video: <https://www.youtube.com/watch?v=Pu8uw5JPLEI&feature=youtu.be>
- Claude's Got the Scoop on Soil: <https://web.extension.illinois.edu/soil/>
- National Resource Conservation Service web site: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/>
- Smithsonian *Dig It* site too <https://forces.si.edu/soils/>
- Soil Science of America soil: <https://www.soils4teachers.org/>
- Interactive Soil Properties Maps: <https://casoilresource.lawr.ucdavis.edu/soil-properties/> under the physical properties you can see the percentage of sand, silt, and clay by state
- Soil Maps by State including soil surveys and soil colors: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcseprd1405236>

## Standards

### ***Illinois Science Standard***

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process

### ***Illinois English Language Arts Standard***

RST1 Cite specific textual evidence to support analysis of science and technical texts.

The **M**ultidisciplinary **A**gricultural Integrated Curriculum (mAGic) was created in 2004 under the leadership of the Illinois State Board of Education (ISBE) and the Facilitating Coordination in Agricultural Education Project (FCAE). Funding was made available through the FCAE grant budget from the agricultural education line item of the ISBE budget. This revision, as printed, was developed in April 2021.



These mAGic lessons are designed to bring agriculture to life in your classroom. They address the Illinois Learning Standards in math, science, English language arts and social studies.

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Name \_\_\_\_\_

## Sand, Silt and Clay Student Checklist & Data Table

Procedure (Check each step as completed and record results in the data table below.)

- \_\_\_\_\_ 1. Look at the three soil particle samples and record the color of each.
- \_\_\_\_\_ 2. Look at the samples with and without the magnifying lens. Use small, medium, and large in the “particle size” column of the table. Use each term only once.
- \_\_\_\_\_ 3. One by one, take a pinch of the soil samples between your thumb and index finger. Put the sample in the palm of your hand and rub with the index finger. Use adjectives to describe how it feels in the “Texture - Dry” column of the table.
- \_\_\_\_\_ 4. Move a small portion of each soil particle sample to the outer edge of each paper plate.
- \_\_\_\_\_ 5. Add two drops of water to these small portions with the medicine dropper or pipette.
- \_\_\_\_\_ 6. Feel the wet portion of each soil sample. Use adjectives to describe how it feels in the “Texture - Wet” column of the table.
- \_\_\_\_\_ 7. Complete the Sand, Silt, and Clay Student Worksheet.

### Data Table

	Color	Particle Size	Texture - Dry	Texture - Wet
Sand				
Silt				
Clay				



Name \_\_\_\_\_

## **Sand, Silt and Clay Worksheet**

1. Which soil particles were the largest?
2. Which soil particles were the smallest?
3. Which soil particles felt sticky when wet?
4. Which soil particles did not feel sticky or gritty?
5. Which soil particles would hold the least amount of water?
6. Which soil particles would blow away in the wind most?
7. Soil contains a combination of all three soil particles (sand, silt and clay), each with its own function. What combination of particles do you think would be best for growing Midwest crops? Why?

## **Sand, Silt and Clay ANSWER KEY**

1. Which soil particles were the largest? **Sand**
2. Which soil particles were the smallest? **Clay**
3. Which soil particles felt sticky when wet? **Clay**
4. Which soil particles did not feel sticky or gritty? **Silt**
5. Which soil particles would hold the least amount of water? **Sand**
6. Which soil particles would blow away in the wind most? **Clay**
7. Soil contains a combination of all three soil particles (sand, silt and clay), each with its own function. What combination of particles do you think would be best for growing Midwest crops? Why?

**Dependent upon plant type, but generally a 25% sand, 50% silt and 25% clay combination is good for crop growing.**

Name \_\_\_\_\_

### Soil Slurry Data Table

	Sample A	Sample B
<b># of layers (5 minutes)</b>		
<b>Layer Measurements (5 minutes)</b>		
<b># of layers (30 minutes)</b>		
<b>Layer Measurements (30 minutes)</b>		
<b># of layers (24 hours)</b>		
<b>Layer Measurements (24 hours)</b>		
<b># of layers (48 hours)</b>		
<b>Layer Measurements (48 hours)</b>		

## The Relative Sizes of Sand, Silt and Clay Particles

# Sensational Soil

Try to remember some times when you played in soil. Did it feel soft some times and gritty at other times? Soil can feel different from one time to another depending on what's in it.

**Sandy soil** is made up of mostly sand. Sandy soil feels gritty and allows water and air to move through it.

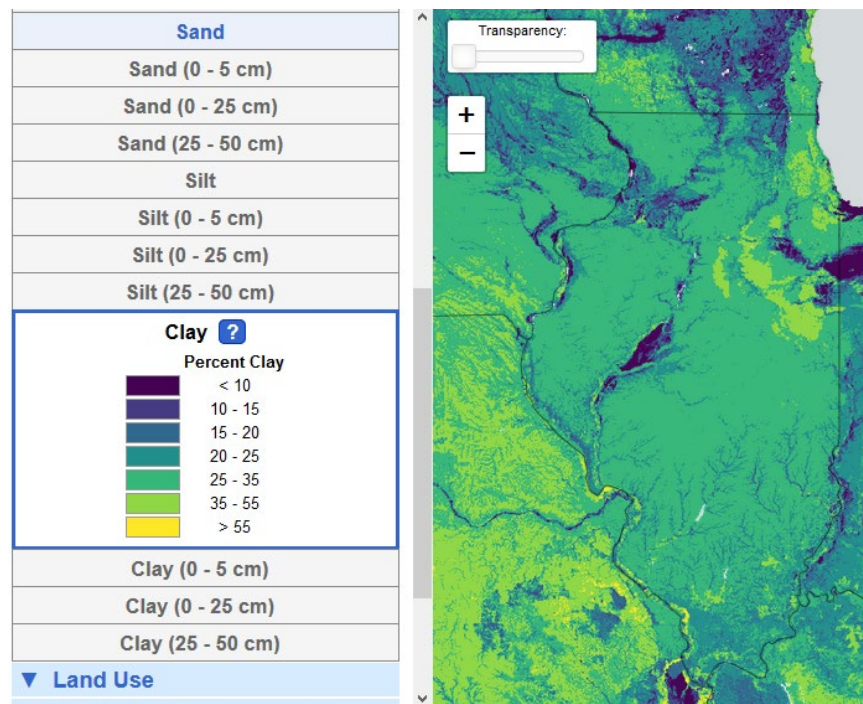
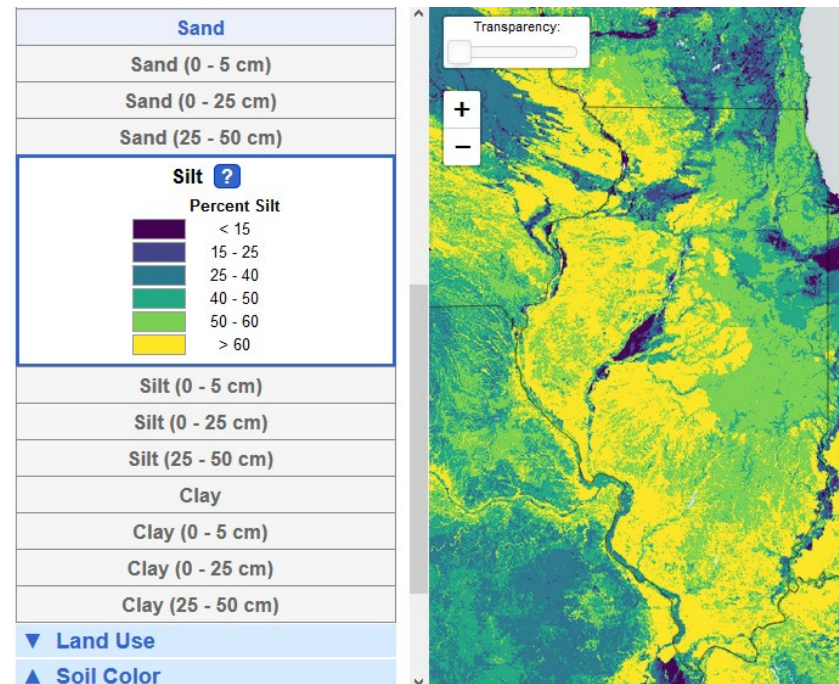
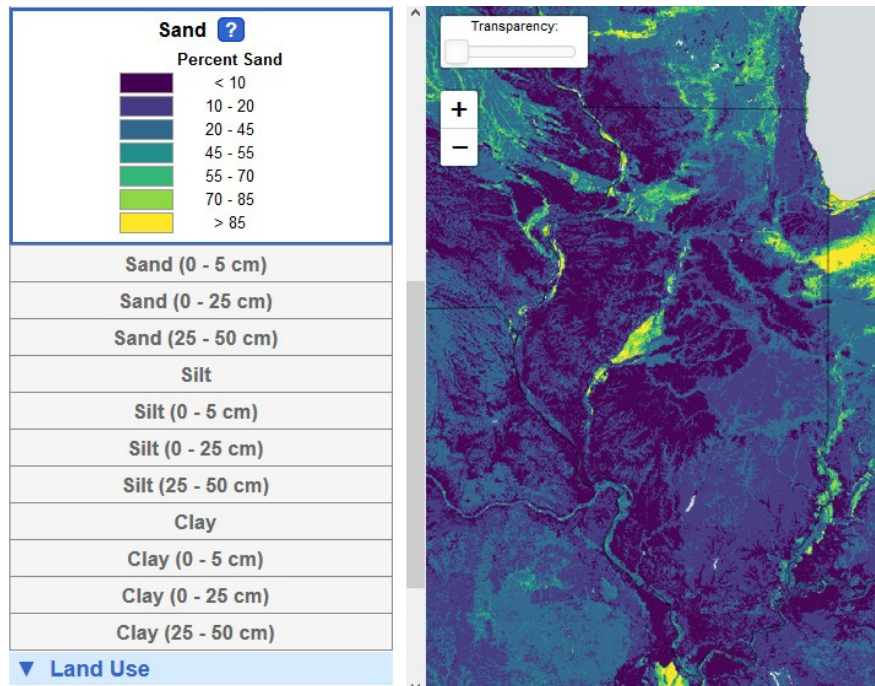
**Silt** feels like flour when dry and is very smooth and soft when moist. Silt particles keep the soil softer and easier to plow than soils with too much clay.

**Clay soil** has mostly clay, some organic matter, silt, and a little sand. Clay particles are very fine and are the smallest of the three types of soil particles. Clay is sticky when wet and hard like bricks when dry.

*Sand, silt, and clay particles are different sizes. Imagine a piece of sand the size of a basketball. That would make silt the size of a baseball and clay smaller than the size of a marble.*



*Note: Graphic provide by Illinois Agriculture in the Classroom*



## Soil Properties

View regional trends for a variety of soil properties

<https://casoilresource.lawr.ucdavis.edu/soil-properties/>

Note: These pictures are screenshots of the percentage of sand, silt, and clay in Illinois. This website has an interactive map in which a person can view many different soil properties for anywhere in the United States.