

A person with a backpack is seen from behind, walking through a narrow slot canyon. The walls of the canyon are smooth and undulating, with a warm, orange-brown color palette. The lighting creates soft shadows and highlights the textures of the rock. The person is wearing a dark jacket, dark pants, and brown boots. The overall atmosphere is serene and majestic.

Impacts on Earth's Systems

From Rocks to Soil

Grades 4-5

Vetted by Riverside County Office of Education-STEM

UCCE Master Gardener Program of Riverside County



Learning Goals

Students will learn:

- The process of weathering and erosion in the development of soil.
- The importance of the soil's texture and structure for growing plants.
- The four components of ideal growing soil.

Anchor Phenomena: [Soil Formation](#)





Develop a Model To Describe the Phenomena of Soil Formation

Draw a diagram demonstrating the phenomena of soil formation including both observable and unobservable details.

- Label all important parts of the diagram.
- Use arrows to show how all parts interact.
- Write an explanation describing the formation of soil.



Part 1: How Is Soil Formed?



Soil Begins With Rock

Rocks form the Earth's outer solid layer, called the crust and most of its interior.

- Rocks are a naturally occurring solid.
- Rocks are made up of **minerals**.
 - They can be all one kind of mineral, like sandstone which is made of quartz or feldspar.
 - Or they can be made of many different types of minerals like granite.



What Are Minerals?

Minerals are the building blocks of rocks!

- Minerals are a solid material formed by natural events.
- Unlike rocks, minerals have a chemical composition and usually have a crystal structure.
- Minerals can be made from a single [element](#) (like [gold](#) or [copper](#)) or from a combination of elements.



Soil is the Result of Changes To Rocks

Soil forms continuously, but slowly, from the gradual breakdown and movement of rocks through the processes of:

- **Weathering**
- **Erosion**



Physical weathering

The **breakdown** of rocks from the result of a *mechanical action*.

Temperature changes, abrasion (when rocks collide with each other) or frost can all cause rocks to break down.

Chemical weathering

The **breakdown** of rocks through a *change in their chemical makeup*.

This can happen when the minerals within rocks react with water, air or other chemicals.

Biological weathering

The **breakdown** of rocks *by living things*.

Burrowing animals help water and air get into rock, and plant roots can grow into cracks in the rock, making it split.



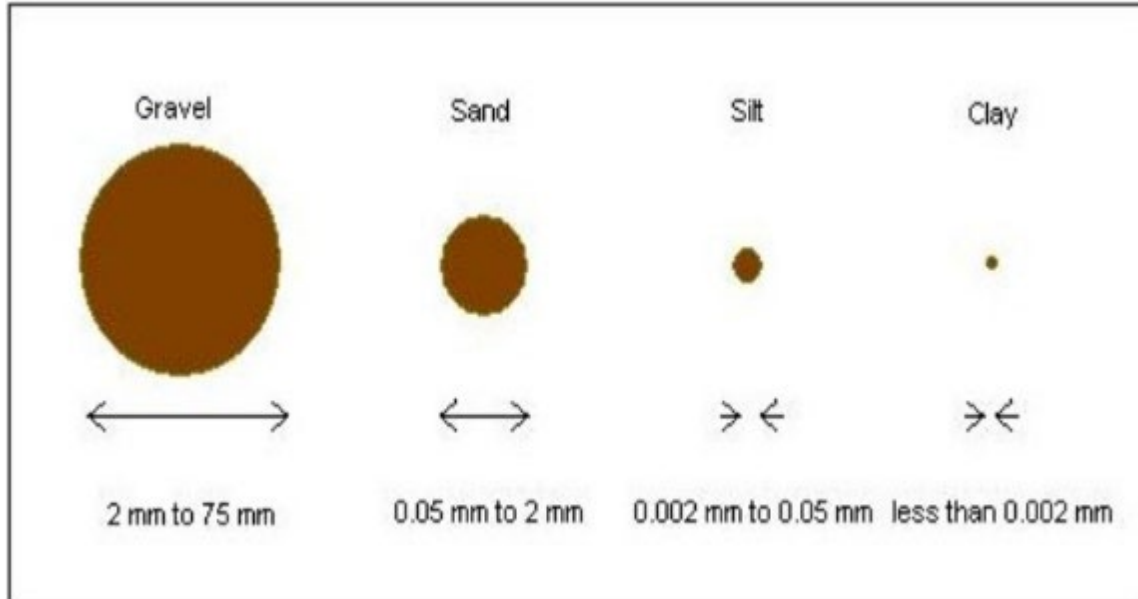
Erosion

Erosion causes rocks, soil and sediment to be **moved** around and deposited elsewhere.

- Wind, water and organisms move the broken-up rock pieces.

What Gives Soil Its Texture and Structure?

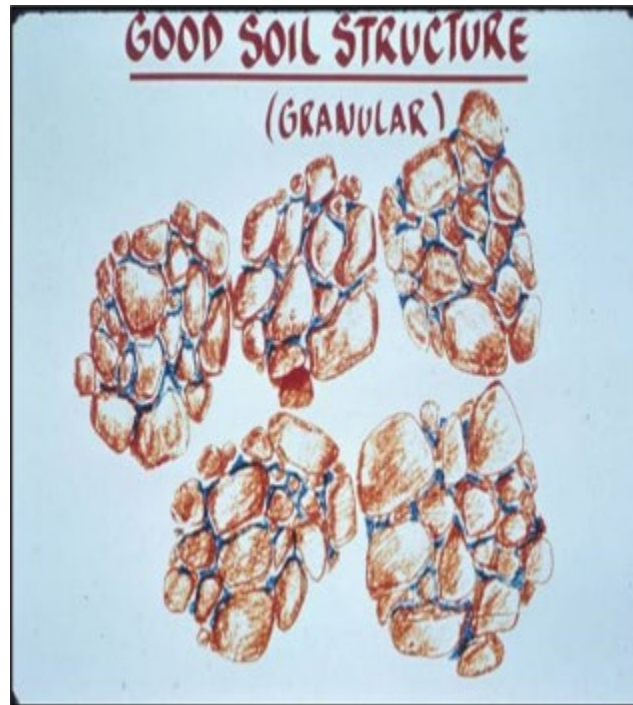
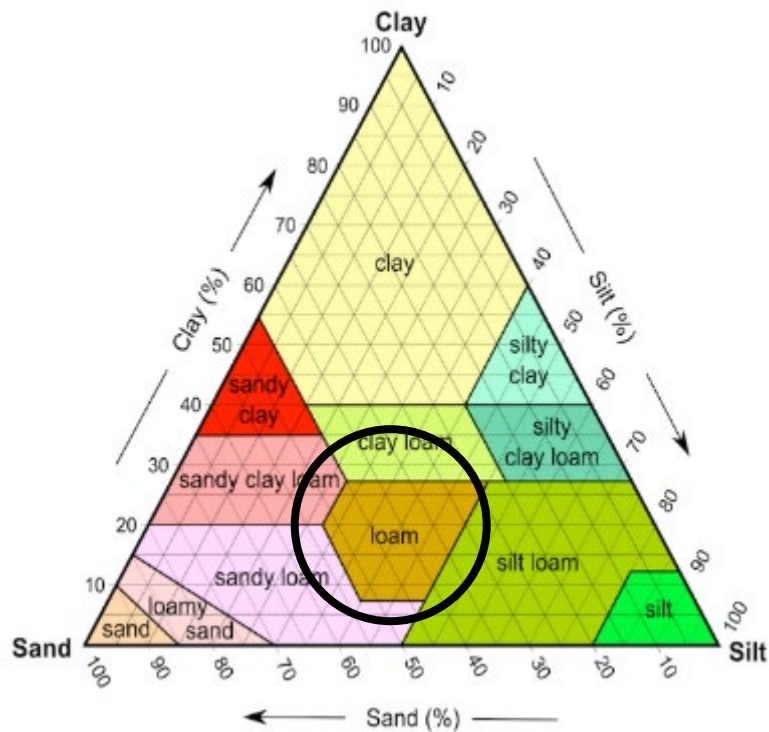
- Overtime, weathering wears rocks down into smaller particles called **granules**. The granules that make up soil are categorized into three groups by size: sand, silt and clay. Most soils are a combination of all three.
- These granules bind together around **organic matter** and are called **aggregates**, clumps of soil particles, which gives soil its structure.



Why are Soil Texture and Structure Important?

Both affect the amount of nutrition and water a plant gets from soil

Good Texture + Good Structure = Good Soil for Plants



Video: [Types of Soil](#)



Types of Soil

Check For Understanding

- What are the building blocks of rocks?
- Describe one process of soil weathering.
- Describe the process of erosion.
- What is the difference between weathering and erosion?
- Name the three types of granules that make up soil.
- What is an aggregate?



Phenomena in the Garden

What is the particle composition of your soil?

Conduct a simple soil test

- Use a clear, clean, empty pint or quart size jar with a tight lid.
- Fill the jar about half full of garden soil.
- Add water to the jar leaving some room for shaking.
- Shake the jar for several minutes so that all the particles fully mix with the water.
- Set the jar aside for several hours so the particles have a chance to settle.
- They will separate into sand, silt, and clay layers.



Soil Test Continued

- Remember, you filled the jar halfway or 50%. So, the combination of settled particles is 100% of your soil.
- Label the jar with each soil level.
- Visually estimate the percent of each layer.
- To calculate the type of soil texture in your garden use the [USDA Soil Calculator](#)

Instructions: Populate yellow cells. Total Sand, Silt, and Clay must equal 100%. Sand fractions are optional (only used with sands, loamy sands, and sandy loams if known), but if used must equal Total Sand.

Total	Sand (%)	<input type="text"/>
	Clay (%)	<input type="text"/>
	Silt (%)	<input type="text" value="100.00%"/>

Sand Fractions	Very Coarse Sand (%)	<input type="text"/>
	Coarse Sand (%)	<input type="text"/>
	Medium Sand (%)	<input type="text"/>
	Fine Sand (%)	<input type="text"/>
	Very Fine Sand (%)	<input type="text"/>
	Sand Fractions Sum	0.00%

USDA Texture	<input type="text" value="SILT"/>
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Develop a Model To Describe the Phenomena

Revise or draw a new diagram demonstrating what you have learned about the phenomena of soil formation. Include both observable and unobservable details.

- Label all important parts of the diagram.
- Use arrows to show how all parts interact.
- Write an explanation describing the process of soil formation.

Part 2: What Is the Ideal Soil For Growing Plants?





Ideal Soil Contains the Right Mix of Solids and Space

Solids

- **45% Minerals from rocks**
- **5% Organic matter:** Living and decaying organisms, and decaying plant matter.

In Spaces/Pores

- **25% Air**
- **25% Water**

45% Minerals in the Soil

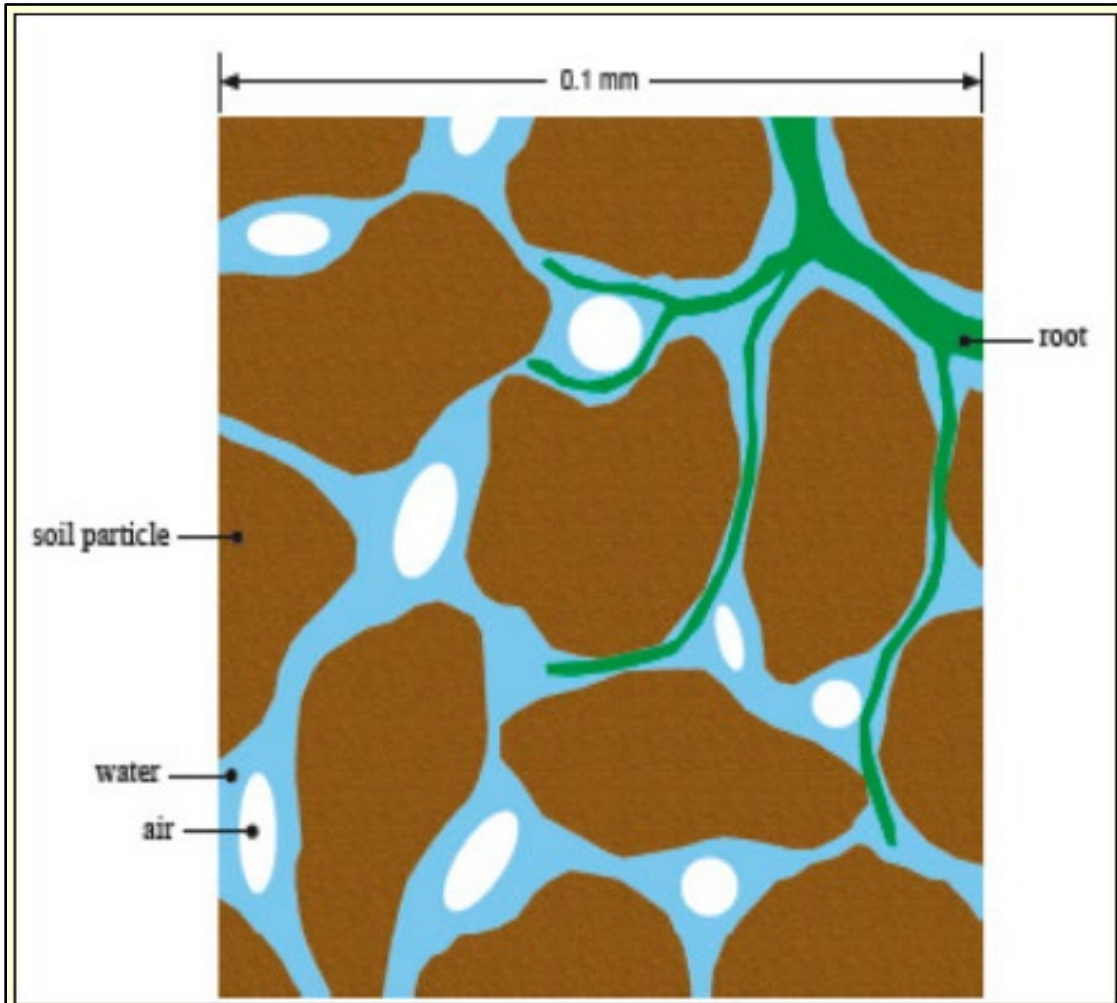
Common minerals in soil are:

- Potassium
- Calcium
- Sodium (salts)
- Iron
- Magnesium

Minerals provide nutrition to plants.

- N = [Nitrogen](#) (proteins)
- P = [Phosphorus](#) ([ATP](#) and the energy cycle)
- K = [Potassium](#) (water regulation)
- Ca = [Calcium](#) (transport of other nutrients)
- Mg = [Magnesium](#) ([enzymes](#))
- S = [Sulfur](#) (some [amino acids](#))
- Si = [Silicon](#) (plant cell walls)

25% Water and 25% Air in the Soil



- **Air** in the soil increases the availability of nutrients to the plants.
- **Water** transports minerals and nutrients from the soil, through the roots to the plants.

5% Organic Matter in the Soil

- Organisms break up soil which increases the amount of air in the soil.
- Organisms leave fertilizer that enriches the soil.
- Plant and animal matter decomposes This process creates dark, organic matter called **humus** which:
 - Binds the soil particles together
 - Helps the soil retain water



What Does Ideal Soil For Growing Plants Look Like ?

- Soil rich with organic matter will be darker in color and have a granular (round) structure to the particles which allows for better movement of air and water.
- This is soil that has both good texture and good structure.



Video: [The Four Components of Ideal Soil](#)



What's the Dirt on ... Dirt?



Check For Understanding

- What is the total percentage of air and water in ideal soil?
- Describe how air or water (your choice) helps soil.
- What is the percentage of minerals in soil?
- Why are minerals important to plants?
- What is the percentage of organic matter?
- Give an example of organic matter.
- Why is organic matter important for soil?
- What is the name of the nutrient-rich part of the soil discussed in the video?

Phenomena in the Garden:

What Is the Structure of Your Soil?

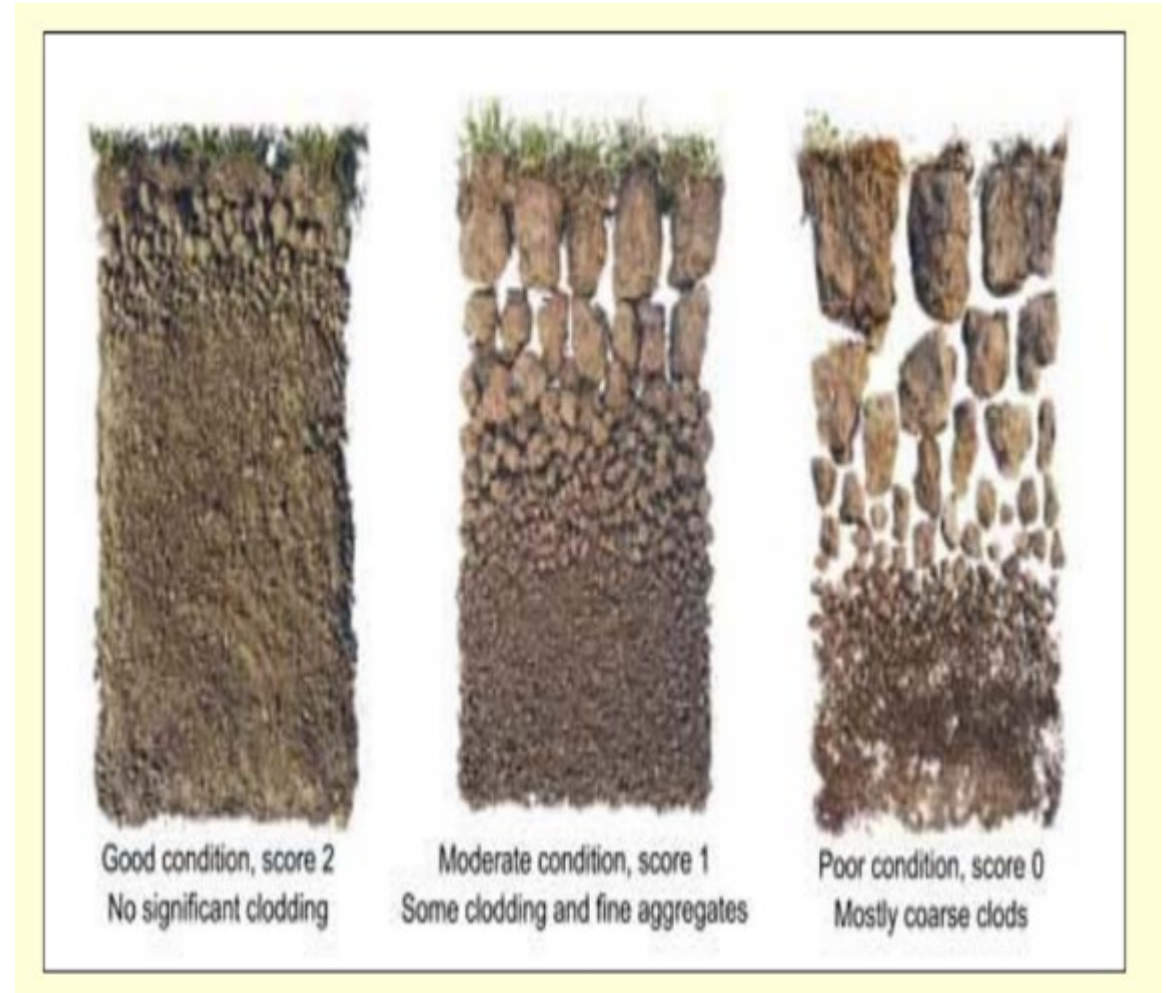
Give your garden area the *Shovel Test*

- This simple test requires only one tool—a full-sized shovel.
- Collect samples from several areas of your garden and/or school grounds.
- Dig to the full depth of the shovel.
- Carefully lay each sample on white butcher paper.
- Label the location site of each sample.



Interpreting the Results of Your Shovel Test

- Soil in good condition has no significant clumps or clods.
- Soil in moderate condition has some clumps and small aggregates.
- Soil in poor condition is mostly coarse clumps or clods.





Develop a Model To Describe the Phenomena

Revise or draw a new diagram demonstrating what you have learned about the phenomena of soil formation. Include both observable and unobservable details.

- Label all important parts of the diagram.
- Use arrows to show how all parts interact.
- Write an explanation describing the process of soil formation.

Extend Your Thinking: *Improve Your Soil's Texture and Structure*

- Learn how to add organic matter to your soil through a process called **composting**.
- [Composting for Kids](#) demonstrates how to create rich organic matter to feed your soil and improve its structure.



Next Generation Science Standards

4th Grade:

- **ESS2.A: Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1)
- **ESS2.E: Biogeology** Living things affect the physical characteristics of their regions. (4-ESS2-1)

5th Grade:

- **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)
- **LS1.C: Organization for Matter and Energy Flow in Organisms**
Plants acquire their material for growth chiefly from air and water.(5-LS1-1)

Next Generation Science Standards

Science and Engineering Practices

- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1)
- Develop a model to describe phenomena. (5-LS-1)

Crosscutting Concepts

- Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1)
- Systems and System Models- A system can be described in terms of its components and their interactions. (5-LS2-1)

Resources

- California Master Gardener Handbook, Second Edition 2015
- [Biological Weathering](#); Geological Society
- [Composting For Kids](#); Robert Richter, County Extension Agent Horticulture, Harris County, Texas Agrilife Extension Service
- [How Soils Form PDF](#); Stockton USD
- *Protecting and Nurturing Soils*, PowerPoint; Chuck Ingels, Farm and Horticulture Advisor UC CE Master Gardeners, Sacramento County
- *Soil 101: A Practical Approach*, PowerPoint; Kevin Marini, UCCE Master Gardeners, Placer/Nevada Counties
- [Soil](#); Kiddle
- [Soil4 Teachers.Org](#)
- [Soils and Plant Nutrients](#); NC State Extension
- [Soil Facts](#); USDA
- Wikipedia

Resources

- **Images:** Creative Commons; Kiddle; Soil Association; Stock; Texas Agrilife Extension Services; UCCE Master Gardeners
- **Videos:** Khoj Museum; Sci Show Kids; news.com.au; AgriLifeStar

Master Gardeners

The University of California Cooperative Extension (UCCE) Master Gardener Program (MGP) is an educational program designed to teach and effectively extend information to address home gardening and non-commercial horticulture needs in California.

UCCE is the outreach arm of UC's division of Agriculture and Natural Resources (ANR). Master Gardener volunteers (MG volunteers) promote the application of basic environmentally appropriate horticultural practices through UCCE-organized educational programs that transfer research-based knowledge and information.



University of California

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UCCE Master Gardener Program

Gardening Questions?

- Email or call the UCCE Master Gardeners of Riverside County
- Email Helpline
 - anrmgriverside@ucanr.edu
- Telephone Helpline
 - 951-683-6491 ext 232, 231
- [Riverside Master Gardeners Website](#)



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