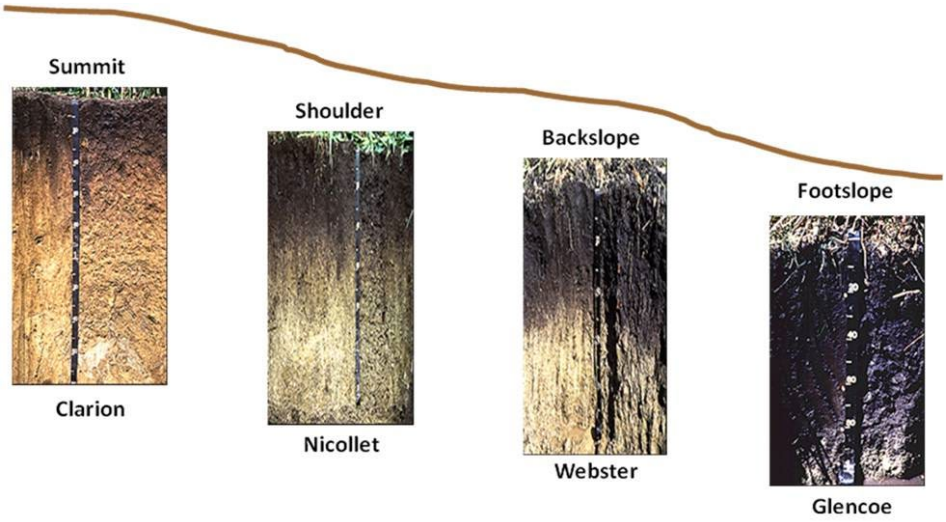
USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

AGI american geosciences institute
connecting earth, science, and people

Earth Science Education Activity

Examining a Soil Catena

Background: Soil surveys help professionals like farmers, engineers, and land managers understand soil properties as they make decisions related to agriculture, construction, and conservation. A key concept in soil variability is the **soil catena**, which is a sequence of soils forming along a slope. Though developed from the same parent material and climate, these soils differ due to their elevation along the slope, and so the soil is affected by variations in drainage, erosion, and deposition.



Soil profiles reveal distinct layers, or horizons, that reflect how soils form and change. Notice the gradient of soil color from oxidizing conditions at the summit (red/brown subsurface colors) to reducing conditions at the toe slope (gray subsurface colors) for representative soil profiles of the Clarion-Nicollet-Webster catena.

Credit: Jay Bell and the University of Minnesota Soil Landscape and Analysis Lab, Creative Commons 3.0

Key Question: How do soil profiles differ across a slope?

STANDARDS

NGSS: MS-ESS2-1, MS-ESS2-2, MS-ESS3-1, HS-ESS2-1, HS-ESS2-5
SDG 2: Zero hunger
SDG 11: Sustainable cities and communities
SDG 15: Life on land

Learn more about the United Nation's Sustainable Development Goals (SDGs) and explore resources for educators from UNESCO.

MATERIALS

- copies of student handouts: Soil Profiles, Data Collection, and a map of the school grounds
- soil sample probe (21" T-style Soil Sampler)
- ruler
- colored pencils (optional)
- camera/phone (optional)

Acknowledgement: This lesson is adapted from an original version developed by Eric Hultgren after attending a Teacher Field Experience with NRCS soil scientists.

The USDA NRCS delivers science-based soil information to help farmers, ranchers, foresters, and other land managers effectively manage, conserve, and appraise their most valuable investment — the soil.

HANDS-ON INVESTIGATION

1. Read the handout on Soil Profiles.

2. Identify four locations along a slope where you will collect soil cores. Mark each location clearly on your map and check with your instructor for approval.

3. With your instructor, collect a soil core at each of your approved locations. For each site:
   - **a.** Take a photo of the soil core.
   - **b.** Sketch the soil profile and label the visible horizons (O, A, B, C) to the best of your ability.
   - **c.** Measure and record the approximate depths of each horizon in the provided data table. Write N/A for any horizon not present in the soil core.
   - **d.** Identify the dominant soil texture (sand, silt, or clay) for each horizon to the best of your ability.

4. Per your instructor's guidelines, place the soil samples in a specific location or place each horizon of the soil samples in its own bag. Label the bags appropriately.

ANALYSIS

1. How do the depth and presence of soil horizons change from the summit to the toe slope?

2. What patterns did you observe in soil color, texture, or horizon thickness at different slope positions?

3. Which horizon (A, B, or C) showed the most variability across the slope? Why might that be?

4. Based on your observations, what slope position had the deepest and most developed soil? Which had the shallowest?

5. Explain why there might be differences in thickness of the layers. Consider surface geologic processes.

6. How would you expect your results to differ if you took samples from a steeper slope? What about an uneven slope?

SYNTHESIS

Based on your observations, make a claim about how topography influences soil development. How did soil characteristics change from the top to the bottom of the slope? Why might these differences occur, and how could they affect land use or management? Support your reasoning with evidence from your investigation and knowledge of erosion and deposition.

EXTENSION

Use the UC Davis California Soil Resource Lab's **SoilWeb** to compare your observations with official soil survey data. Record the soil series name, profile description, and estimated horizon thicknesses. How similar or different are the horizon depths and textures? What factors could explain any differences? Reflect on the accuracy and usefulness of soil survey data for understanding local soils.

Student Handout

SOIL PROFILES

From: Soil Science Society of America. **Soil profiles**. Soils 4 Teachers.

There are different types of soil, each with its own set of characteristics. Dig down deep into any soil, and you'll see that it is made of layers, or horizons (O, A, E, B, C, R). Put the horizons together, and they form a soil profile. Like a biography, each profile tells a story about the life of a soil. Most soils have three major horizons (A, B, C) and some have an organic horizon (O). The horizons are:

O (humus or organic): Mostly organic matter such as decomposing leaves. The O horizon is thin in some soils, thick in others, and not present at all in others.

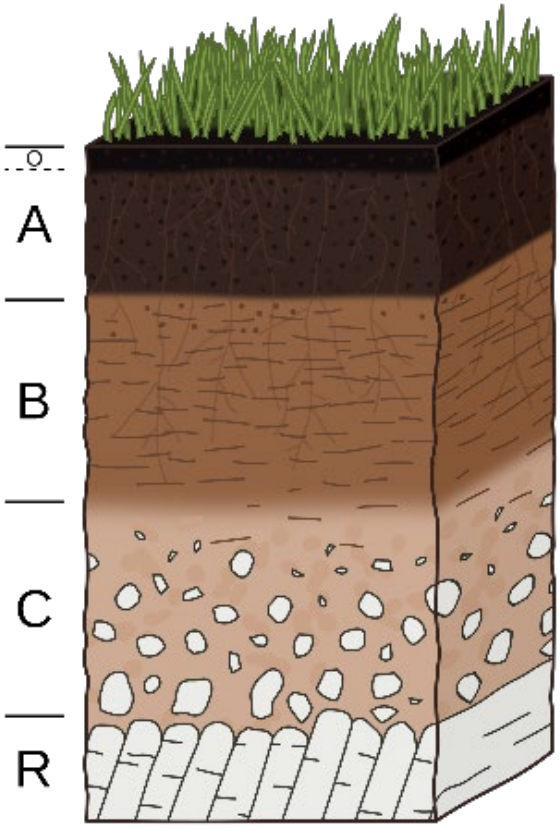
A (topsoil): Mostly minerals from parent material with organic matter incorporated. A good material for supporting life (plants and other organisms).

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. This may include weathered bedrock, but can also include deposited material from another source (e.g., flowing water, wind-blown deposits).

R (bedrock): A mass of rock such as granite, basalt, quartzite, limestone or sandstone that forms the parent material for some soils, if the bedrock is close enough to the surface to weather. This is not soil and is located under the C horizon.

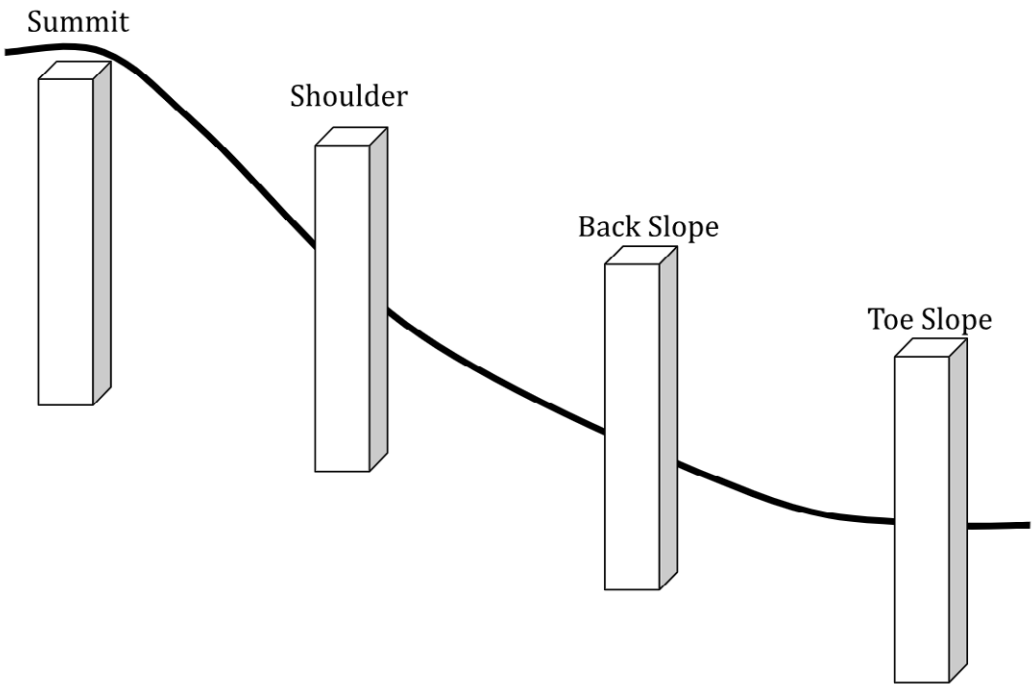


Soil horizons that can occur within a soil profile.

Credit: Tomáš Kebert & umimeto.org, **Creative Commons 4.0**

Student Handout

DATA COLLECTION



	Summit		Shoulder		Back Slope		Toe Slope	
	Thickness (cm)	Color, Texture	Thickness (cm)	Color, Texture	Thickness (cm)	Color, Texture	Thickness (cm)	Color, Texture
O horizon								
A horizon								
B horizon								
C horizon								