



Soil Formation and Horizons



Student Name: _____ Date: _____

What is Soil?

Soil is much more than just dirt! It's a complex mixture of four main components that work together to support plant life and entire ecosystems. Understanding soil composition helps us appreciate why healthy soil is essential for life on Earth.

Four Components of Soil:

- **Weathered Rock (45%):** Tiny mineral particles from broken-down parent rock material
- **Organic Matter (5%):** Decomposed plants and animals (humus) that add nutrients
- **Water (25%):** Moisture in soil pores that helps plants absorb nutrients
- **Air (25%):** Oxygen in soil spaces that supports root respiration and organisms

The Five Soil Formation Factors

Soil doesn't form overnight! It takes hundreds to thousands of years for soil to develop from solid bedrock into the rich, layered material we see today. Five main factors control how soil develops:

Factor	Description	Impact on Soil
Parent Material	The type of bedrock that weathers to form soil (granite, limestone, sandstone, shale)	Determines mineral content and texture of soil
Climate	Temperature and precipitation patterns in the area	Affects weathering rates and biological activity
Time	How long soil has been forming (years to millennia)	Older soils are more developed with distinct layers
Vegetation	Types of plants growing in and on the soil	Plants add organic matter and help break down rock
Topography	The shape and slope of the land surface	Affects water drainage and erosion rates

Understanding Soil Horizons

A **soil profile** is a vertical cross-section of soil that shows distinct layers called **horizons**. Each horizon has unique physical and chemical characteristics. Scientists identify five main horizons, labeled O, A, B, C, and R.

O Horizon (Organic Layer)

Composition: Decomposing leaves, twigs, and organic matter

Color: Dark brown to black

Characteristics: Rich in nutrients from decomposition; supports surface organisms

Typical Depth: 1-5 cm

A Horizon (Topsoil)

Composition: Mixture of humus, minerals, water, and air

Color: Dark brown to black

Characteristics: Most fertile layer; where most plant roots grow; contains earthworms and insects

Typical Depth: 5-30 cm

B Horizon (Subsoil)

Composition: Clay particles, minerals, and some organic matter

Color: Lighter brown, red, or yellow

Characteristics: Accumulation zone for minerals washed down from above; denser than topsoil

Typical Depth: 30-90 cm

C Horizon (Parent Material)

Composition: Partially weathered rock fragments

Color: Light brown to gray

Characteristics: Transition zone between soil and bedrock; little organic matter

Typical Depth: 90-200 cm

R Horizon (Bedrock)

Composition: Solid, unweathered parent rock (granite, limestone, sandstone, etc.)

Color: Varies by rock type

Characteristics: Source material from which all soil layers form through weathering

Typical Depth: 200+ cm

How Soil Forms: Weathering Processes

Soil formation begins when solid bedrock is broken down through **weathering**. There are two main types of weathering that work together to create soil:

Physical (Mechanical) Weathering

Rock is broken into smaller pieces without changing its chemical composition:

- **Freeze-Thaw (Ice Wedging):** Water enters cracks, freezes, expands, and breaks rock apart
- **Plant Roots:** Growing roots push into cracks and break rock apart
- **Abrasion:** Wind, water, or ice scrape and grind rock surfaces
- **Temperature Changes:** Repeated heating and cooling causes rock to crack

Chemical Weathering

Rock's chemical composition is changed, creating new minerals:

- **Oxidation:** Reaction with oxygen (like rusting) breaks down minerals
- **Carbonation:** Carbon dioxide in water creates weak acid that dissolves rock
- **Hydrolysis:** Water reacts with minerals to form new compounds
- **Acid Rain:** Polluted precipitation accelerates chemical breakdown

Why Does Soil Matter?

Healthy soil is one of Earth's most important natural resources. Understanding soil helps us protect and conserve this vital component of our environment.

Three Key Reasons Soil is Essential:

- 1. Agriculture and Food Production:** Healthy soil is essential for growing crops that feed the world's population. Different crops require different soil types to thrive. For example, carrots grow best in sandy soil, while rice grows in clay-rich soil.
- 2. Construction and Engineering:** Engineers must understand soil properties when building roads, bridges, and buildings. The type of soil determines whether foundations will be stable and how much weight structures can support.
- 3. Ecosystems and Biodiversity:** Soil supports countless organisms from bacteria and fungi to earthworms and insects. It's a living ecosystem that provides habitat, filters water, and supports all life above ground!

Reflection Questions

1. Which combination of the five formation factors would likely produce the highest quality soil? Explain your reasoning.

2. Compare how soil formation differs in tropical climates versus arid (desert) climates.

3. Explain why soil on steep slopes tends to be thinner than soil on flat land.

4. Which soil horizon (O, A, B, C, or R) is most important for plant growth? Justify your answer.

5. Given that soil takes hundreds to thousands of years to form, explain why soil conservation is so important.

Key Vocabulary Terms

Term	Definition
Soil Horizon	A distinct layer of soil with characteristic physical and chemical properties
Soil Profile	A vertical cross-section showing all soil horizons from surface to bedrock
Humus	Dark, nutrient-rich organic matter formed from decomposed plant and animal material
Parent Material	The underlying geological material (bedrock) from which soil forms
Weathering	The breakdown of rock into smaller pieces through physical or chemical processes
Topography	The shape and features of the land surface, including slope and elevation
Soil Conservation	Practices that prevent soil erosion and maintain soil quality for future use

NC Science Standard ESS.6.2.3: Use models to explain the rock cycle and its relationship to the formation of soil