# How soil forms

Soil is more than crushed rock: it contains mineral particles, organic matter, organisms, water and air. Its development reflects interactions among rock, climate, water and living things over time.

## 1. BREAK DOWN, MOVE, THEN SETTLE

**Weathering**
Rock breaks down or minerals change.

→

**Erosion**
Material is removed and transported.

→

**Deposition**
Transported material settles in a new place.

Soil can develop in material weathered in place or in sediment deposited by rivers, wind or glaciers. Transport is not required for every soil to form.

## 2. WEATHERING SUPPLIES MINERAL MATERIAL

Physical weathering fragments rock without changing its minerals, as when freezing water widens cracks. Chemical weathering alters minerals through reactions with water, acids or oxygen. Organisms contribute too: roots can widen cracks and biological acids can react with minerals.

## 3. FIVE FACTORS WORK TOGETHER

| | |
|---|---|
| **Parent material** | Rock or sediment sets the starting mineral supply. |
| **Climate** | Temperature and moisture affect weathering and decay. |
| **Organisms** | Roots, microbes and animals add, decompose and mix matter. |
| **Topography** | Slope and position affect drainage, erosion and deposition. |
| **Time** | Longer development can produce more distinct horizons. |

Decomposing remains add organic matter; mixing and water movement help develop a soil profile. Formation is slow enough that rapid erosion can outpace replacement.

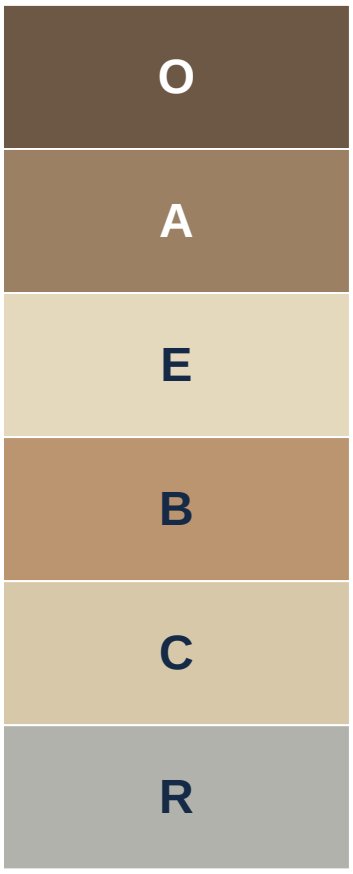
Soil components and formation factors: USDA NRCS, Soil Facts.
Mineral breakdown and alteration: USGS, Environmental Characteristics of Clays.

Scope: College Board AP Environmental Science CED, Topic 4.2, p. 81.

# Read a soil profile

A horizon is a layer distinguished by its composition and other properties. A vertical cross-section shows a profile. The sequence below is idealized: many soils lack one or more of these layers.

## 1. HORIZONS RECORD ADDITIONS, LOSSES AND TRANSFERS




### Organic surface

Litter and decomposing remains; mainly organic material.

### Topsoil

Mineral material mixed with organic matter; often root-rich.

### Zone of loss

Often pale: clay, iron or aluminum have been removed.

### Subsoil

Can accumulate clay, iron or aluminum from above.

### Parent material

Little-altered rock fragments or sediment beneath the soil.

### Bedrock

Consolidated rock beneath the profile; not a soil horizon.

Not to scale. Layer thickness, color and presence vary by soil.

## 2. FOLLOW WATER, NOT JUST THE LETTERS

Downward-moving water can carry dissolved substances and fine particles out of upper horizons. Some material accumulates lower down; some leaves the profile. E is associated with loss and B with accumulation or other soil development. A dark surface often reflects organic matter.

Texture describes sand, silt and clay; horizons are layers. See Topic 4.3.

Horizon identification and typical profile: USDA NRCS, A Soil Profile.
Soil development and variation: USDA NRCS, Soil Facts.

Scope: College Board AP Environmental Science CED, Topic 4.2, p. 81.

# Keep soil in place, protect water

Wind and flowing water remove soil particles. Erosion is natural, but clearing vegetation, overgrazing, tillage and construction can expose soil and accelerate losses.

## 1. CONNECT THE HILLSIDE TO THE STREAM

| | |
|---|---|
| **Bare ground** | Raindrops detach particles; runoff carries them downslope. |
| **Topsoil loss** | Less organic matter and fewer nutrients can lower fertility. |
| **Sediment enters water** | Cloudier water reduces light; deposited sediment can bury habitat. |

Wind can lift dry, exposed particles. Heavy rain and steep, unprotected slopes can increase water erosion; soil cover reduces exposure.

## 2. SOIL CAN FILTER WATER - BUT NOT PERFECTLY

As water infiltrates, soil can trap particles, bind some chemicals and support microbes that transform substances. Erosion can carry sediment-bound nutrients and pollutants into waterways. Conserving soil helps protect water quality, but soil does not remove every dissolved contaminant.

## 3. MATCH A PROTECTION TO ITS MECHANISM

| | |
|---|---|
| **Cover crops / residue** | Shield the surface; roots help hold soil. |
| **Contours / terraces** | Interrupt downhill flow and slow runoff. |
| **Windbreaks** | Reduce wind speed across exposed fields. |
| **Vegetated buffer strips** | Slow runoff and capture sediment before a stream. |

## 4. INVESTIGATE: DOES COVER REDUCE SOIL LOSS?

Compare replicated bare and covered soil trays. Keep soil type, slope, area and simulated rainfall the same. Collect runoff, then dry and weigh its sediment. Compare mean sediment mass lost per tray; lower mass indicates less erosion under those conditions.

Cover and soil protection: USDA NRCS, Cover Crops for Soil Health.
Runoff interception: USDA NRCS, Water Quality Practices.

Scope: College Board AP Environmental Science CED, Topic 4.2, p. 81.