Understanding Soil Formation

MOST OF OUR food supply comes directly or indirectly from crops grown in soil. Soil is clearly one of our greatest resources. How did soil form, and if we lost our soil, could it be replaced?

Objective:

Examine factors involved in soil formation.

Key Terms:

alluvium
bedrock
chemical weathering
climate
glacier
glacial till
loess
native vegetation
organic soils
outwash
parent materials
physical weathering
prairie soil
timber soil
topography

Soil Formation

Soil formation is a complex process that requires time. The process is ongoing. While some soil is being made, other soil is being lost. It may take hundreds to thousands of years to form an inch of soil.

Five primary factors affect the process of soil formation and development. They are parent materials, topography, living organisms, weathering, and climate.

PARENT MATERIALS

Parent materials are formed by the disintegration and decomposition of rock. They are classified according to the way they were moved and scattered.

Glaciers

Many soils have been formed from material originally moved by glaciers. A **glacier** is a large, long-lasting river of ice that is formed on land and moves in response to gravity. For example, two major glaciers, the Illinoisan and the Wisconsinan, had great influence on present-day soils in the Midwest. The Illinoisan glacier occurred thousands of years before the Wisconsinan glacier and covered much of the Midwest. Later, the Wisconsinan glacier covered parts of the Midwest but did not extend as far south as the Illinoisan glacier. As a result, soils in southern Illinois are much older and less productive than those in northern Illinois. Soils of glacial origin are classified as loess, outwash, or glacial till.

FIGURE 1. Glaciers have created and transported soil.

Loess is soil moved and deposited by wind. As glaciers retreated, the exposed land dried. Winds swept across the land, picked up soil particles, and deposited them elsewhere. Some of the best soils in the world, such as those found in much of Illinois, formed from loess. Loess is the most desirable single soil parent material. This is due to its well-balanced mineral content, medium texture, and excellent water-holding capacity.

Outwash formed when the glaciers melted. The waters carried the gravelly materials away to be deposited below the glacial ridges. Sandy outwash was carried farther downstream, and the finer materials—silt and clay—were deposited in lakebeds or streams.

Glacial till often contains soil particles of many sizes. These soil particles have not been layered from the effects of wind or water as have the other two types of glacial soils. Pebbles and various sizes of boulders are common in till.

Alluvium

Sediments deposited by streams as they flood are referred to as **alluvium**. Alluvium is generally a waterborne material deposited on bottomlands, such as deltas and flood plains.

Bedrock

Bedrock is the native consolidated rock. It may consist of shale, sandstone, limestone, granite, or other materials. Often it is buried by loess, glacial till, outwash, or alluvium. However, in unglaciated areas, weathered bedrock has provided soil parent material. The percentage of soils classified as bedrock or thinly covered bedrock varies with the area of the country.

Organic Matter

Organic soils occur where formerly shallow ponds supported swamp vegetation. The wet conditions slowed decay of the dead plants, and organic matter accumulated. The two types of organic soils are referred to as peat and muck. Muck is more decomposed than peat.

TOPOGRAPHY

Topography refers to the slope characteristics of a soil. It includes the degree or steepness, length, shape, and direction of a slope. These factors influence the amount of rainwater that runs off, the amount that enters the soil, and the amount that collects in small depressions on the soil surface. Soils on steep slopes have higher amounts of runoff and erosion than those on more nearly level topography. The amount of moisture in the soil during its development affects the rate of weathering and the development of subsoil colors. Soils in depressions and on nearly level topography are likely to have poor or very poor natural drainage. Soils on moderately sloping to steep topography are usually well drained.

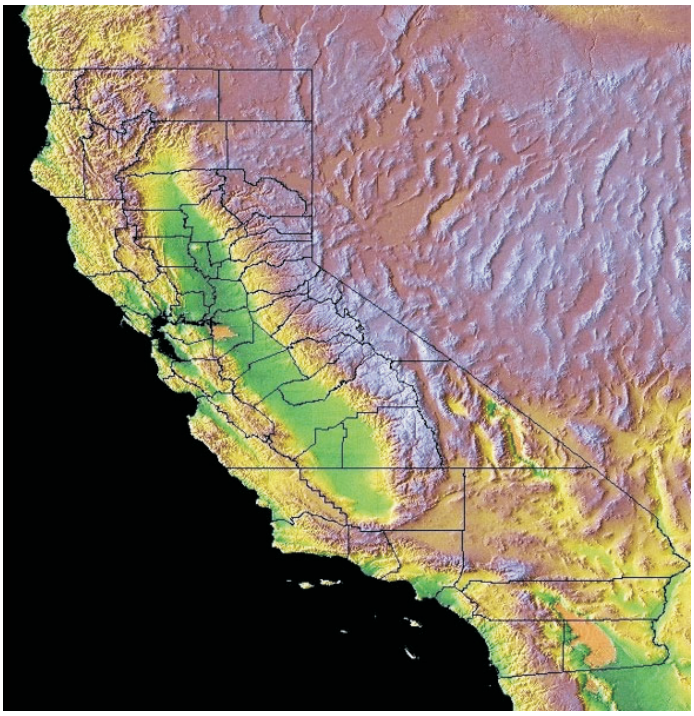

FIGURE 2. Topography of the coastline of California.

LIVING ORGANISMS

Plants, insects, microbes, and other organisms that live in the soil actively affect soil formation. The greatest effect on the development of soil is from plants that once grew in it. These plants are referred to as **native vegetation**. This vegetation determines the kind and amount of organic matter in the soil. Two common types of soils are prairie soils and timber soils.

A **prairie soil** has a dark and deep surface layer. This is because roots from the prairie grass filled the top of the soil to a depth of usually 1 to 2 feet. Partial decay of these roots over a long period gave the soil high organic-matter content.

A **timber soil** tends to have a thin, moderately dark layer. This is due to organic matter accumulating on the surface, where decay occurs more rapidly. When tilled, this dark material is mixed with the soil below to produce a lighter color.

Other living matter that influences the development of soil includes various kinds of animal life. Earthworms, crawfish, insects, ground squirrels and other burrowing animals incorporate organic matter into the soil. They also improve drainage and tilth.

WEATHERING

There are two types of soil weathering. **Physical weathering** is caused by the effects of climatic factors, such as temperature, water, and wind. Freezing and thawing is a major contributor to physical weathering. Rainfall wears rock away a little at a time. Wind also wears rock away. **Chemical weathering** causes changes in the chemical makeup of rock and breaks it down. Rainwater is mildly acidic and can slowly dissolve many soil minerals. Some minerals react with oxygen in the atmosphere. Oxidation further acts to decompose rock.

Weathering causes soil to develop, mature, and age. As soil develops, nutrients are released that plants can absorb, and organic matter accumulates. Soil will develop faster in humid regions than in arid regions. Mature soil reaches a peak level of productivity when a high amount of organic matter accumulates. Over time, water leaches away nutrients, and plant growth starts to decline. This results in less organic matter. As soil ages, minerals continue to break down, and clay is leached into the subsoil. The soil becomes lighter in color as organic-matter content declines.

FIGURE 3. Rainfall, along with the streams it creates, slowly wears down the mountains.

CLIMATE

Climate refers to rainfall, freezing, thawing, wind, and sunlight. These factors are either directly or indirectly responsible for the breakdown of rocks and minerals, the release of plant nutrients, and many other processes affecting the development of soils. Soils in humid regions are subject to more leaching than soils in dry regions.

Summary:

Parent materials, topography, living organisms, weathering, and climate are five primary factors that affect the process of soil formation and development.

Parent materials are formed by the disintegration and decomposition of rock. Soils of glacial origin are classified as loess, outwash, or glacial till. Sediments deposited by streams are referred to as alluvium. Bedrock is the native consolidated rock that provides soil parent material. Organic soils occur where formerly shallow ponds supported swamp vegetation.

Topography refers to the slope characteristics of a soil. Plants, insects, microbes, and other organisms that live in the soil actively affect soil formation. Physical weathering is caused by the effects of climatic factors, such as temperature, water, and wind. Chemical weathering causes changes in the chemical makeup of rock and breaks it down. Climate refers to rainfall, freezing, thawing, wind, and sunlight.

Checking Your Knowledge:

1. What are parent materials?
2. What types of soils have a glacial origin?
3. How does topography affect soil formation?
4. How do living organisms affect soil formation?
5. What influence does weathering have on soil formation?

Expanding Your Knowledge:

Contact your local soil and water conservation agent for information about the soil type in your area. Research the soil. Investigate its age and learn about the forces that formed it.

Web Links:

Soil Formation
http://library.thinkquest.org/J003195F/soil.htm

Soil Formation and Classification
http://soils.usda.gov/education/facts/formation.html

Agricultural Career Profiles
http://www.mycaert.com/career-profiles