SOIL SCIENCE

The Earth's Layers

The Earth consists of several layers or zones:

The core, which has a radius of 3500 km (2200 mi) is believed to be composed mainly of iron with small amounts of nickel. The inner core (See Figure 1) is thought to be solid, while the outer core is thought to be molten. Although the core is not accessible, its composition is based on indirect evidence. The core is very dense and the densest element found on Earth in any great quantity is iron. Also, the composition of many meteorites that are found on Earth are mainly iron and nickel.

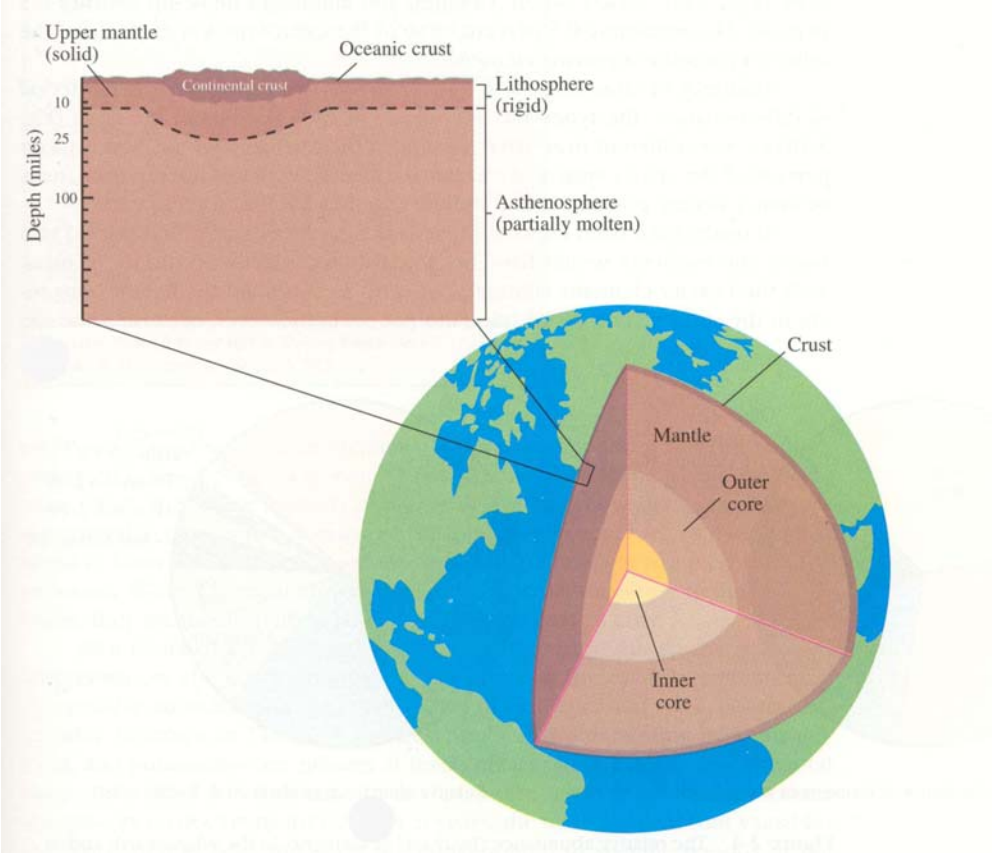

Figure 1. The structure of the Earth showing the layers along with a cut-away section showing the lithosphere and asthenosphere. Source: From Phyllis Buell and James Girard, Chemistry, An Environmental Perspective.

The mantle lies between the core and the crust and is approximately 2900 km (1800 mi) thick.. The asthenosphere, which makes up most of the mantle is an almost solid, thick, viscous liquid that can flow very slowly. The upper mantle is solid.

The crust is the thin layer that forms the outer skin of the Earth. It's thickness ranges from 6 km (4 mi), under the oceans, to 70 km (45 mi) under the mountainous regions of the continents.

Edible Soil Profile

A soil profile is a display of soil horizons. (See Figure 2).

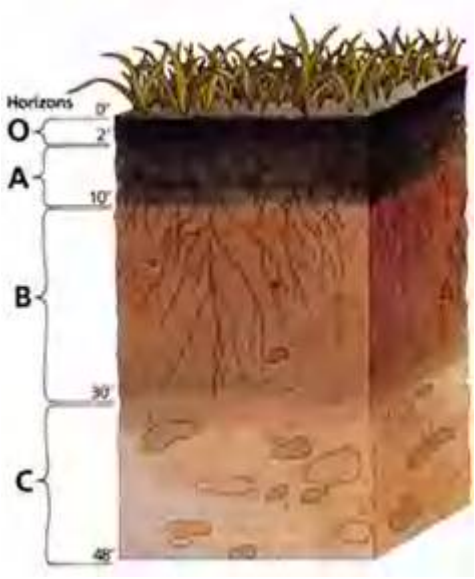

Figure 2. Soil Profile. Source: USDA, Natural Resources Conservation Service

Plants derive nutrients from the soil, but also help to break apart the parent material. Roots and shoots can produce great destructive effects on the bedrock.

The **O horizon**, located at the top, is primarily composed of organic matter. At the surface is the dead plant and animal material (including waste) which is continually added to the surface layer. These are broken down by various decomposers such as worms, insects, bacteria, fungi, etc. Many of these insects are known as **detritovores** which includes millipedes, many different mite species, beetles, etc. (Most detriovores are harmless to crops.) The decomposed organic material is known as humus and enriches the soil with nutrients (nitrogen, potassium, etc.), aids soil structure by acting to bind particles, and enhances moisture retention.

Beneath the O horizon is the **A horizon**, which is dark due to the organic matter that has been incorporated into the inorganic products of weathering. This is known as the topsoil. The removal of organic and inorganic material in this section is caused by the downward motion of natural water. This leaching of nutrients is known as eluviation.

The lower section of the A horizon is sometimes called the **E horizon.**
This section of the soil often has a high concentration of quartz and contains much of the soluble materials leached from the A horizon. Under coniferous forests, this section may have an ashy-gray appearance.

Next is the **B horizon** where the downward moving fine material is accumulated. This process is known as illuviation. This fine material forms a more dense layer in the soil and contains little organic matter. This may be enriched with calcium carbonate in the form of nodules or as a layer which precipitates out of the downward moving water. In arid climates, the calcium carbonate along with sodium salts may be formed from precipitation due to capillary action of calcium and sodium ions upward through water from lower layers. Other mineral deposits, which may have percolated up from lower levels, may be found in this layer.

The **C horizon** is composed of broken bedrock or parent material. There is essentially no organic material in this section which is just starting to develop into soil.

Below the C horizon is bedrock, referred to as the **R horizon**.

Materials

Broken graham crackers or cookies such as vanilla wafers
Chocolate pudding (sugar free)
Butterscotch pudding (sugar free)
Sprinkles (jimmies)
Green jelly mint leaves
Licorice lace pieces
Gummy worms
Clear plastic drinking cups, 10 ounce
Plastic spoons

Procedure

You are provided with various ingredients to assemble an edible soil profile in a clear plastic drinking cup. Decide which ingredients you must use for each component of the profile and enter the information in the table below. **The components being modeled for this ecosystem are: A horizon, B horizon, C horizon, detritovores, O horizon, producers**. (Note: 2 ingredients will be used to make one of these components.

Component of Soil that is being represented	Ingredient	Why is the ingredient suitable for what it represents?
	Butterscotch pudding	
	Chocolate pudding	
	Graham crackers or cookies	
	Green jelly leaves	
	Gummy worms	
	Licorice laces	
	Sprinkles	

Based on the information you completed in the table above, assemble your soil profile model in the plastic cup.

Mining for Natural Resources

We make great use of many minerals and materials that make up the Earth's supply of natural resources. The most common elements, that are economically useful, found on Earth as listed in Table 1. Except for the precious metals, such as gold, silver, and platinum, most of the elements are found combined as minerals, usually in localized deposits, and must mined. After mining, the elements must be extracted from their ores. In this activity, we will simulate the mining of minerals ores.

Name	Chemical Symbol	Crustal Abundance (percent by Mass)
Aluminum	Al	8.00
Iron	Fe	5.80
Magnesium	Mg	2.77
Potassium	K	1.68
Titanium	Ti	0.86
Hydrogen	H	0.14
Phosphorus	P	0.101
Fluorine	F	0.0460
Sulfur	S	0.030
Chlorine	Cl	0.019
Chromium	Cr	0.0096
Zinc	Zn	0.0082
Nickel	Ni	0.0072
Copper	Cu	0.0058
Cobalt	Co	0.0028
Lead	Pb	0.00010
Arsenic	As	0.00020
Tin	Sn	0.00015
Uranium	U	0.00016
Tungsten	W	0.00010
Silver	Ag	0.000008
Mercury	Hg	0.000002
Platinum	Pt	0.0000005
Gold	Au	0.0000002

Source: From F. Press and R. Siever, *Earth*, 3d ed. (New York: W. H. Freeman, 1982), p. 553.

Table 1. The relative abundance of elements in the earth's crust.

Materials

Chocolate chip cookies
Toothpicks
Paper towels or paper plates

Procedure

Obtain a chocolate chip cookie. Place it on a paper towel of paper plate.

Using the toothpick, remove the chocolate chips from the cookie.

How many chocolate chips are there in the cookie?

What do the chips look like? (Describe their condition.)

What does the remains of the cookie look like?

How does the appearance of the chocolate chips affect the way they taste?

Obtain a new chocolate chip cookie. Place it on a paper towel of paper plate.

How would you modify your extraction process in order to preserve the cookie, as if it was the Earth and the chips were mineral resources?

Using the toothpick, remove the chocolate chips from the cookie.

How did you modify the extraction process?

Were you successful in removing all the chocolate chips?

What do the chips look like?

What does the remains of the cookie look like?

If you were to be rewarded with an extra cookie for having the highest yield of chocolate chips, would you have altered your extraction method?

Assuming there is a next generation that will inherit the cookie. Would you do anything different? What would you tell other cookie owners that have not yet removed their chocolate chips?