Utah Mining Association

Earth Science Curriculum

Developed by University of Utah Mining Engineering students for the Utah Mining Association

Piloted and refined by Alpine School District teachers

Earth's Structure and Density

Topic: Density and its effect on Earth's layers	Estimated Length (minutes): 30-55 minutes
Standard: 2, Examine the effects of density and particle size on the behavior of materials in mixtures.	**Objective:** 2, Analyze how density affects Earth's structure.

Description:

- Students will examine the densities of the Earth's layers and relate density to positioning of Earth's atmosphere, water, crust, mantle, and core.
- If students have not received instruction on density and its relationship with Earth's materials, see Standard 2: Objective 1 before teaching this lesson.

Resources:

- "Abundance in Earth's crust" link: https://periodictable.com/Properties/A/CrustAbundance.v.log.html

Introduction:

- The Earth's layering is directly related to the density of each layer, which reflects the composition of each layer. The Earth is densest at its core (9.9-13g/cm^3), where gravity has caused iron rich material to be concentrated
- Extending outward from the core is the mantle with a density of 3.3-5.7g/cm^3 composed of rocks containing olivine, magnesium and iron
- The next layer is the crust, which has two different types
  - Oceanic crust consists of cooled iron and magnesium rich rock called basalt. Oceanic crust is thin (5 km) and dense (3.0g/cm^3) when compared to continental crust
  - Continental crust is composed predominantly of granite with a density around 2.7 g/cm^3. It is much thicker than oceanic crust, ranging from 10-75 km in depth
- On top of the crust is the hydrosphere. The layer of the Earth's water with a density of 1g/cm^3
- Further out from the center of the Earth is the atmosphere with a density of 0.001g/cm^3
- Density of some economic elements mined in Utah

Element	Density	Crustal Abundance	Element uses and information
Copper	8.9 g/cm^3	0.00068%	A reddish metallic element that takes on a bright metallic luster and is malleable, ductile, and a good conductor of heat and electricity.
Gold	19.30 g/cm^3	0.00000003%	Very chemically stable precious metal.
Silver	10.50 g/cm^3	0.0036%	Precious metal with high electrical conductivity.
Iron	7.85 g/cm^3	6.3%	A heavy malleable ductile magnetic silver white metallic element, used to make steal.
Tungsten	19.6 g/cm^3	0.000011%	Hard metal with high melting point, used in light bulb filaments and super alloys.
Beryllium	1.8 g/cm^3	0.000019%	A silver-gray metal. 1/3 lighter than aluminum, it is the lightest of all metals. Alloyed with copper for electrical connectors and tools. The world's largest known beryllium resource is in Juab County.
Zinc	7.1 g/cm^3	0.00029%	A bluish white, lustrous metal. Uses include chemical, agricultural, rubber, and paint industries.
Uranium	18.9 g/cm^3	0.000018%	A radioactive, silvery white, metallic element used to power nuclear power plants.

Discussion: (Length: 15 minutes)

- Discuss how density is mass/volume.
    - Discuss everyday items that students are familiar with and invite the students to hypothesize as to their relative densities. (Ex. Brick vs. feathers, oil and water in salad dressing.)
    - Allow students to contrast the weight of similar coins made of different materials--pre-1980 U.S. Lincoln cent (penny) [mostly copper (about 3.1 g)] vs. post-1980 cent [mostly zinc (about 2.5 g)]. With a little practice, many students can distinguish the blindfolded by hefting the two. [The 1943 'steel cent' is the one exception to this composition and was made of zinc-coated steel.]
    - Explain how gravity uses density to naturally sort everything on earth. The most familiar example being the separation of water and air.
    - Confirm student's familiarity with specific gravity and the Earth's structure and layers.
    - Discuss relative amounts of various minerals in the Earth's crust.

Activity: (Length: 10 minutes)

- Invite students to hypothesize as to the relative densities of the layers of the Earth's structure.
- Have students construct a cross section of the Earth including the core, mantle, crust, and atmosphere and list densities of each layer.

Assessment: (Length: 10 minutes)

- Draw incorrect cross sections on the board and invite students to make corrections based solely on density.
- Provide densities of some minerals and metals mined in Utah and ask students where they would most likely be found.

Real World Application: (Length: 5 minutes)

- **Focus on Careers:** Geologists, geophysicist and seismologists
- **What They Do:** Geologists, geophysicist and seismologists use the densities of the Earth's layers to interpret sound waves and help shape the world's knowledge of the earth below us.
- **Where They Work:** They can work for large corporations or doing research and teaching at a university. They varied aspect of a career in geology is a major draw for a lot of people.
- **Education Necessary:** A bachelor's degree is generally required, while post graduate degrees are common in research.
- **How They Use the Concept of Density:** They use the density of materials underground to determine the structure of the Earth. Seismic waves (sound waves that traveling through rock) travel differently through materials with different densities. Monitoring seismic waves, human and naturally created, provides seismologists with information on the contents of the Earths subsurface.