LEARNING SET 2 INTRODUCTION

Learning Set 2

*5 class periods** u

What Is Causing the Changes You Observe in the Region of Your Earth Structure?

Groups construct models and review models of what is inside Earth and consider what is causing the changes of Earth's structures based on those models.

Overview

Students create a model of Earth's crust and interior. Students consider other models, look at the strengths and weaknesses of models, create their models, and revise their models. The models help students to illustrate what is moving, how it is moving, and why there are earthquakes and volcanoes near the Earth structures that are changing. Students will later use these models to build explanations of the processes changing the crust in the region of their Earth structure. Students will also build a Picture Dictionary of key terms.

*A class period is considered to be one 40 to 50 minute class.

Targeted Concepts, Skills, and Nature of Science	Section
Scientists often work together and then share their findings. Sharing findings makes new information available and helps scientists refine their ideas and build on others' ideas. When another person's or group's idea is used, credit needs to be given.	2.1, 2.2, 2.3
Scientists must keep clear, accurate, and descriptive records of what they do so they can share their work with others and consider what they did, why they did it, and what they want to do next.	2.1, 2.2, 2.3
Identifying factors that lead to variation is an important part of scientific investigation.	2.3
Scientists make claims (conclusions) based on evidence obtained (trends in data) from reliable investigations.	2.3
Scientists use models to simulate processes that happen too fast, too slow, on a scale that cannot be observed directly (either too small or too large), or that are too dangerous.	2.1, 2.2, 2.3

Targeted Concepts, Skills, and Nature of Science	Section
Scientists use models and tools such as *Geographic Information Systems,* and a variety of maps to develop claims and explanations from evidence in the data.	2.2, 2.3
Earth is a system made up of different layers, each with a distinctive composition and set of characteristics. These layers interact, driving the processes that shape Earth.	2.3
Earth's crust is constantly changing. These changes are usually a very slow process that is not immediately observable. Some changes are very rapid and are observable.	2.1, 2.3
Earthquake activity, volcanic activity, and topography are all evidence that Earth's crust is moving and changing.	2.1, 2.2, 2.3
Interactions between Earth's crustal plates can result in mountain-building, rift valleys, and geologic activity such as earthquakes and volcanoes. Underwater volcanic activity may form underwater mountains, which can thrust above the ocean's surface to become islands.	2.3

Students' Initial Conceptions and Capabilities

Students may think that the world was always as it is now, or that any changes that have occurred must have been sudden and comprehensive. (Freyberg, 1985.)

Some students may have difficulty constructing explanations about the causes of volcanoes and earthquakes. (Duschl, Smith, Kesidou, Gitomer, & Schauble, 1992.)

Some students may have heard of the plates and the super continent Pangaea. Some may believe that only the continents are plate. Some students believe that the continents drift around the Earth or float. Others may believe that the continents do not move at all. (Phillips, W.C., 1991.)

Some students may believe that volcanic island chains result from a hot spot moving beneath them.

Some students believe that mountains are created quickly. (Phillips, W.C., 1991).

Some students may believe that Earth is liquid rock except for its crust. (Phillips, W.C., 1991.) Some may think the mantle is fluid like magma or lava and sloshes around under the dirt and that everywhere there are rivers of this lava flowing under the surface just waiting to open up and swallow a car, like in the movies. The mantle is pliable and stretches and folds under pressure. The crust is brittle and cool and breaks and crumbles under pressure.

Understanding for Teachers

Earth's Crust and Interior

Scientists are not sure of the interior structure of Earth but they have evidence that there are three main layers, the crust, mantle (upper and lower), and core (inner and outer). Scientists study the layers of Earth by considering the travel time and paths of reflected and refracted seismic waves produced by earthquakes, studies of minerals in laboratories involving pressure and temperature, Earth's motion, its gravitational and magnetic fields, and how heat flows from its interior. The average radius of Earth is about 6375 km.

Scientists have made direct measurements of Earth's crust and have measured mineral grains dating back to 4.4 billion years ago, which indicates that Earth's crust has been solid for at least 4.4 billion years. Many of the rocks currently making up Earth's crust became part of the crust less then 100 million years ago. Earth's crust is between 0-35 km or 0-22 miles thick. It consists of plates that move slowly and interact with each other. The interaction of plates is what causes earthquakes and volcanoes at plate boundaries.

The mantle is about 2900 km thick and consists of semi-solid and liquid rock. The upper part of the mantle is cooler than the lower part of the mantle. The rock in the upper mantle is near its melting point and is where lava originates. The mantle is made up of silicate rocks that are higher in magnesium and iron, and lower in silicon and aluminum than the crust. It is believed that the crust formed from melted mantle that allowed less dense materials to rise to the top and solidify (freeze). The temperatures of the mantle are high enough that the material in the upper mantle is easily reshaped and can flow however, it flows very, very slowly. The pressure of the mantle increases as you go deeper into it and the lower mantle flows less easily than the upper mantle. The temperature gradient of the mantle causes convection to occur in the mantle. This process leads to motion in the upper mantle, which causes the motion of the plates that form Earth's crust.

The core was discovered in 1906 by figuring the overall mass of the planet based on astronomical calculations, and by means of studying the reflection and refraction of seismic waves. The core is the densest part of the planet. The seismic measurements show that the core has two sections—a solid inner core and a liquid outer core. The inner core is about 1220 km thick. The outer core is about 2180 km thick. Scientists believe that the inner core is composed mainly of iron and some nickel. It is believed that Earth's magnetic field is caused by the convection in the outer core and the relative motion caused by Earth's rotation about its axis. The solid inner core is believed to be too hot to hold a permanent magnetic field. Recent (2005)

evidence suggests that the inner core is rotating slightly faster than the rest of the planet.

The reason for the different sections of Earth being solid or liquid has to do with the melting points of the materials making the different layers and the pressure and temperature of the different layers. The melting point of a material changes depending upon pressure. The crust is solid because the melting point is well below the temperature at the surface. The upper mantle is mainly a malleable solid with regions of localized liquid. It is hot and under little pressure and has low viscosity relatively speaking, so it moves or flows but very, very slowly. This flow causes Earth's plates to move about 5 cm per year. The inner mantle is under very high pressure and hence has a higher viscosity. The outer core is liquid even though it is under a very high pressure and this is because its melting point is lower than that of the mantle. The inner core is solid because the pressure is higher than that of the outer core. The highest pressure is in the inner core.

Geologists continue to study and update their understanding of Earth's interior.

References

http://pubs.usgs.gov/gip/dynamic/inside.html

http://pubs.usgs.gov/gip/interior/

For more information search the Internet using the following key words: *Earth's interior*

NOTES

Learning Set 2

What Is Causing the Changes You Observe in the Region of Your Earth Structure?

10 min.

Introduce the Learning Set *to the class.*

LEARNING SET 2 IMPLEMENTATION

Learning Set 2

What Is Causing the Changes You Observe in the Region of Your Earth Structure?

The next question for you to think about is *What is causing the changes you observe in the region of your Earth structure?* You know that earthquakes and volcanoes have occurred or are still occurring around the earth structures your class is studying. You have evidence that earthquakes and volcanoes can change the size and shape of the land in the regions around them. You may have already added a question or two about them to your *Project Board*. It is very likely that you already know about earthquakes and volcanoes, but you may not know what causes them. You are going to learn what is moving and creating the changes you observe at your Earth structure.

You know where on a world map your Earth structure is located. You also know where the Earth structures assigned to other groups are located. By looking at the patterns of where these movements and changes occur, you may learn a great deal about why they occur. In this *Learning Set,* you will be introduced to Earth's crust and interior layers. You will learn how Earth's crust, that does not appear to change, can buckle and crumple or split apart under the right conditions.

All of this information will provide the evidence you need to pursue the answer to the *Big Question: How can you explain the changes happening around the regions of your Earth structures?*

The Appalachian Mountains were built up as a result of collisions between continents.

Engage

Begin by eliciting from students the changes occurring in the region of their Earth structure and their ideas about what causes these changes.

TEACHER TALK

"What changes are occurring in the region of your Earth structure and why do you think they are occurring? Why do you think Earth's crust seems so solid but can crumple or split under the right conditions such as an earthquake? What causes that?"

△ Guide

Then ask a few students what they have learned so far. Review previous work done using the class's *Project Board,* making sure students discuss how the volcanoes and earthquakes change Earth's structure.

Next, let students know that they will be learning what is moving and creating the changes observed in their Earth structures, and that later in the Unit they will be looking at the patterns of where these movements and changes occur. Then focus them on this *Learning Set,* which introduces Earth's crust and interior layers and discusses how the crust appears so solid but can crumple or split under the right conditions. Let students know that this will help them to answer the Unit's *Big Question: How can you explain the changes happening in the regions around certain Earth structures?*

TEACHER TALK

"You have evidence that your Earth structures are changing. Look at the examples of changes in the images in the student text. In this Unit you will learn what is moving and creating those observed changes in the Earth structures. Eventually you will be looking at patterns of where these movements and changes occur. First though we need to find out more about Earth, how the structures are changing, and what it to change. In this *Learning Set* you will be become more familiar with Earth's exterior or crust and be introduced to Earth's interior. This information will help you to answer the Unit's *Big Question: How can you explain the changes happening in the regions around certain Earth structures?*"

META NOTES

The Appalachian Mountains have a lengthy geologic history. These mountains were born around 300 million years ago in a series of 3 mountain building events. When the Appalachian Mountains were done rising, they were higher than today's Himalayan Mountains (which includes Mt. Everest the highest mountain (8,850 m) on Earth today). The Appalachian Mountains then began wearing down through weathering and erosion, resulting in their current height. The highest peak in the Appalachians is Mt. Mitchell at 2,037 m (6,684 ft).

These mountains began forming when two tectonic plates began to collide. Students will learn about tectonic plates in *Section 2.3.*

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