Plate Tectonics and Mountain Building

Summary

The Theory of Plate Tectonics is explored through the use of the Landform kit from the Utah Geological Survey. Students visualize the plates covering our earth by studying a map called the "Dynamic Planet". This map illustrates that earthquakes, volcanoes, and mountain building occurs predominantly at plate boundaries. By learning about the three types of plate boundaries, students model the four types of mountain building.

Time Frame

3 class periods of 45 minutes each

Group Size

Small Groups

Materials

- Student questions PDF
- Pictures of Mountains PDF
- Label Tectonic Plates PDF
- Label Tectonic Plates Answers PDF

Reserve the Landform kit from the Utah Geological Survey by calling: 801- 537-3300, http://geology.utah.gov/teacher/teachkits.htm The loan is for two weeks with a 50$ deposit that is refunded when the kit is returned to UGS. If you are setting up the lab as stations it is helpful to ask them for a second copy of the "Dynamic Planet" Map.
index cards
tubes of toothpaste, one per table, cheap toothpaste works just fine
dried grass cut up into approximately 1" pieces
Plaster of Paris
small Ziploc baggies
measuring spoons

Alternatives if the Landform kit is not available in your area: The Dynamic Planet map can be viewed and ordered from the website: http://store.usgs.gov" Any US relief map with the mountain regions highlighted can be used. Fault blocks can be purchased from multiple sources and there are multiple sites on the Internet to even make your own fault blocks.

Background for Teachers

The earth is a changing planet. The Theory of Plate Tectonics attributes earthquakes, volcanoes, the mountain-building process, and other movement to the interaction of the rigid plates forming the Earth's crust. The crust is composed of about 35 different large slabs of rock that move over the surface of hot, liquid magma (mantle) under the crust of our earth. These plates form puzzle pieces over the magma and interact with each other. Along the boundaries of these plates, interactions occur that create the Earth's seismic, mountain building, and volcanic activities. The interactions may form a divergent plate boundary, a convergent plate boundary, or a transforming plate boundary.
A divergent plate boundary occurs when two plates move away from each other. The magma under the earth oozes up between the plates and hardens to become new crust. Many volcanoes are found along plates that are spreading apart. Most of this crust formation occurs under the ocean along the Mid Atlantic Ridge. There are few earthquakes along plates that are spreading apart. Volcanoes in Iceland are formed from the North American and Eurasian Plate spreading apart.

A convergent plate boundary occurs when two plates push against each other. When the plates collide the less dense plate overrides the denser plate, this is called subduction. The crust on the plate that is pushed under is subjected to the high temperatures of the mantle below and the crust melts. As the old crust melts, volcanoes form. Plate edges are rough and two edges can get stuck together while the rest of the plate keeps moving. Finally, when the plate has moved far enough, the edges unstick and an earthquake occurs. 3/4 of all earthquakes occur at convergent boundaries. Many mountain ranges occur along these lines because when one plate doesn't completely move under the other, the earth crumbles and this uplifts the crust into mountains. In Europe, the Alps are formed from the African and Eurasian plate bumping into each other.
A transform plate boundary occurs when two plates slide past each other. Where the crust is rough, the two plates build up tension as they slide. When one plate overrides another plate the tension is released in the form of an earthquake. This occurs along the San Andreas Fault in California. Because the plates are merely moving past each other no new crust is formed or lost at this boundary.

Intended Learning Outcomes

1a. Observe simple objects, patterns, and events and report their observations.
1d. Compare things, processes, and events.
3a. Know and explain science information specified for the grade level.
4b. Describe or explain observations carefully and report with pictures, sentences, and models.
5a. Cite examples of how science affects life.

Instructional Procedures

Pre-lab discussion:
Ask the students what major disaster happened in March of 2011. Remind them that it was the earthquake in Japan. Discuss with them some statistics from the earthquake: magnitude 9.0, occurred in the ocean 43 miles from shore, triggered tsunamis up to 130 feet high, 16,000 deaths, one of the 5 most powerful earthquakes to hit the world since 1900, and it occurred where the Pacific Plate is being pushed under another smaller plate and moved that smaller plate 8 feet to the east. After discussing this earthquake explain the theory of plate tectonics and go over the notes from the background information section.
Instructional procedure: This lab works well as stations because the "Dynamic Planet" map, fault blocks, and US relief map need to be shared.
Activity 1: The Earth's Major Tectonic Plates

- Look at the large map titled the, 'Dynamic Planet' found in the kit.
- Identify the continents and review that this is a flat map and the world is round. Notice how Europe and Asia are found on the right and left sides of the map.
- Point out the boundaries for the Earth's major plates. Have the students label their map. Again, notice that plates 3 and 4 occur on both sides of the map. Explain to the students that their map labels 9 of the larger tectonic plates but there are 7 major plates and about 18 minor plates (under discussion how many actual plates there are).
- Have the students identify the symbols for volcanoes and earthquakes on the key for the map. Look at the plate boundaries and observe that the volcanoes and earthquakes are predominantly found along the plate boundaries. Why? Remember, where plates are pushing against each other or pulling apart - landforms change.
- Identify the boundary between the Indian and Eurasian plates. These plates are bumping into each other (convergent boundary) and this process forms the highest mountain ranges on Earth, the Himalayas.

Find Iceland and notice all the volcanoes there. The volcanoes are due to the North American and Eurasian plates spreading apart (divergent boundary). As the plates spread apart, rifts occur in the ground on Iceland, these rifts allow the crust to bubble up through a volcano.

Find the San Andreas Fault along the coast of California. Notice all the earthquake activity found there. This fault line is due to the North American Plate sliding south while the Pacific Plate is sliding north (transform boundary). As these plates bump into each other tensions builds until an earthquake occurs.

Find the Hawaiian Islands. These islands are found in the center of the Pacific Plate not at the edge. These islands formed over a hot spot in the ocean floor where magma rose upward until it bubbled up and formed the islands.

Notice all the mountain ranges along the plate boundaries.

Activity 2: Mountain Building

A. Fold Mountains -- form at convergent boundaries, or within a plate between convergent boundaries.

Find a student with a long sleeved shirt. Using one of their arms, place your hands on their sleeve (one below the elbow and one at the wrist) and with your lower hand slowly push the material up their arm towards the elbow.

Observe how wrinkles (mountains and valleys) are formed. This happens on the earth where the crust is being compressed or pushed together. Look at the US relief map found in the kit. The Appalachian Mountains are a folded mountain range. See how the mountains and valleys form in wrinkles on the map. The Alps and the Himalayas are other examples of fold mountains. Look at the picture taken from space over the Zagros Mountains in Iran.

B. Fault-block Mountains -- form at divergent boundaries where two plates are moving and pulling apart. Many times this occurs along a fault line, which is a crack in the earth's surface.

Use the fault blocks. Show the students that the yellow and blue layers represent rock layers under the ground's surface. Hold the blocks with the valley piece in the middle in the shape of a V. Look at the fault lines.

Line up the three blocks and hold them above the table. Starting with the blocks level, slightly pull apart the outer blocks and see how the valley block drops down below the other blocks. Notice also that the two outer blocks are rising slightly. This process forms mountains and valleys.

This is how our Salt Lake valley was formed. The Wasatch Mountains and the Sierra Nevada Mountains in California are being pulled apart. This dropped our valley down below the mountains. Look at these mountain ranges and our valley on the US relief map found in the kit. Look at the picture of the Wasatch Mountains and Salt Lake Valley.

C. Dome Mountains -- form from uplifting of a tectonic plate, not at a boundary. Magma under the earth rises and pushes up the crust to form a mountain without the eruption of the magma. The magma instead cools under the crust and forms the basis for the mountain.

Have students punch a hole in an index card with a pencil. Cover the surface of the index card with dried grass cut into about 1 inch pieces. Hold a tube of toothpaste under the hole in the card and push the top of the tube up through the pencil hole. Slowly squeeze the toothpaste under the grass. The toothpaste should only push the grass up and not seep out of the grass. This is how a dome mountain is formed. The toothpaste represents magma and the dried grass represents rock.

In Utah, Navajo Mountain is an example of a dome mountain. These mountains occur alone rather than in a long chain. Look at the picture of the Showa Shin-Zan dome mountain that formed in Japan over only 18 months.

D. Volcanic Mountains -- usually form at convergent plates when a volcano puts out a series of eruptions over many years. The successive layers of lava that erupted out of the volcano form a

mountain.

Students should put 1 Tablespoon of Plaster of Paris and 2 tsp. of water in a small Ziploc bag. Have students punch a hole in an index card with a pencil. Cut a SMALL hole into the corner of the bag. Place the cut baggie under the hole in the card and slowly squeeze a small amount of the plaster up through the hole. This represents one eruption of magma out of a volcano. When this eruption begins to cool and harden, repeat the lava eruption again. Notice how each lava flow builds on the other. This cycling of eruption and hardening of lava builds up the walls of the volcano and mountain. Mount St. Helens in Washington State is a volcanic mountain. Have students look at the picture of Mt. Vesuvius, an active volcanic mountain in Italy.

Bibliography

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