Moving Rocks

SUBJECT: Science

GRADES: 3-8

ACTIVITY SUMMARY: Students will physically manipulate clay models to demonstrate changes in the Earth's crust.

DURATION: 30-40 minutes

OBJECTIVES:
Students will learn to:

1. Recognize that the Earth's crust is constantly changing.
2. Recognize that sedimentary rocks have layers.
3. Demonstrate how anticlines and synclines form.
4. Explain how a lower layer of rock (e.g. limestone) can become exposed at the Earth's surface.
5. Recall examples of physical and chemical weathering and how caves may form in limestone areas.

TEKS ADDRESSED:

3rd grade
1A-demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including observing a schoolyard habitat.
2B-collect data by observing and measuring using the metric system and recognize differences between observed and measured data.
2F-communicate valid conclusions supported by data in writing, by drawing pictures, and through verbal discussion.
3C-represent the natural world using models such as volcanoes or Sun, Earth and Moon systems and identify their limitations, including size, properties, and materials.
7B-investigate rapid changes in Earth's surface such as volcanic eruptions, earthquakes, and landslides.
7C-identify and compare different landforms, including mountains, hills, valleys, and plains.

4th grade
1A-demonstrate safe practices and the use of safety equipment as described in the Texas Safety Standards during classroom and outdoor investigations.
2B-collect and record data by observing and measuring, using the metric system, and using descriptive words and numerals such as labeled drawings, writing, and concept maps.
2D-analyze data and interpret patterns to construct reasonable explanations from data that can be observed and measured.
2F-communicate valid, oral, and written results supported by data.
3C-represent the natural world using models such as rivers, stream tables, or fossils and identify their limitations, including accuracy and size.
7B-observe and identify slow changes to Earth's surface caused by weathering, erosion, and deposition from water, wind, and ice.

5th grade
1A-demonstrate safe practices and the use of safety equipment as described in the Texas Safety Standards during classroom and outdoor investigations.
2C-collect information by detailed observations and accurate measuring.
2F-communicate valid conclusions in both written and verbal forms.
7A-explore the processes that led to the formation of sedimentary rocks and fossil fuels.
7B-recognize how landforms such as deltas, canyons, and sand dunes are the result of changes to Earth's surface by wind, water, and ice.

6th grade
1A-demonstrate safe practices during laboratory and field investigations as outlined in the Texas Safety Standards.
2E-analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
3B-use models to represent aspects of the natural world such as a model of Earth's layers.
3C-identify advantages and limitations of models such as size, scale, properties, and materials.
10D-describe how plate tectonics causes major geological events such as ocean basins, earthquakes, volcanic eruptions, and mountain building.

7th grade
1A-demonstrate safe practices during laboratory and field investigations as outlined in the Texas Safety Standards.
2E-analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
3B-use models to represent aspects of the natural world such as human body systems and plant and animal cells.
3C-identify advantages and limitations of models such as size, scale, properties, and materials.
8B-analyze the effects of weathering, erosion, and deposition on the environment in ecoregions of Texas.

8th grade
1A-demonstrate safe practices during laboratory and field investigations as outlined in the Texas Safety Standards.
2E-analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
3B-use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature.
3C-identify advantages and limitations of models such as size, scale, properties, and materials.
9B-relate plate tectonics to the formation of crustal features.

Natural Bridge Caverns, Inc.
26495 Natural Bridge Caverns Rd
San Antonio, TX 78266
210-651-6101
www.naturalbridgecaverns.com

Lesson plan adapted from *Project Underground.*

NATIONAL SCIENCE STANDARDS:

Content Standard D: Earth and Space Science

Grades K-4

Changes in Earth and Sky

- The surface of the earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

Grades 5-8

Structure of the Earth System

- Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.
- The solid earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core.
- Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.

VOCABULARY: strata, sedimentary, limestone, weathering, erosion, anticline, syncline, bedrock

MATERIALS:

For each student:

- 3-4 different colors of clay or similar material
- Piece of fishing wire
- Sheet of wax paper

BACKGROUND:

Over the last 600 million years, much of the area that is now the United States was intermittently covered with warm, shallow seas. Much of the algae and many of the sea creatures that lived in these seas had skeletons made of calcium carbonate. When they died, their remains were deposited in layers, or strata, on the sea floor. After a long time, these layered deposits became hardened and compacted into limestone. Often fossils of ancient marine creatures can be observed in the limestone as visual evidence that the rocks were once part of an ocean floor.

At varying times and locations around the globe, the crustal plates of the Earth's surface have collided, forming mountain ranges. During these collisions, termed orogenies, sedimentary strata including thick limestone layers were deformed (bent and broken) and lifted high above sea level. These upheavals also produced fractures, faults, and folds in the rocks. The upward folds are called anticlines, while the downward folds are synclines. Weathering and erosional processes at the earth's surface work continually to expose the underlying rock. Resistant rock layers stand out to form peaks while the more easily eroded rock layers, either softer or more soluble, form valleys.

The activity of the ancient seas produced a variety of sedimentary rock layers in addition to limestone. One example is black shale, which generally formed from very fine-grained particles of materials deposited in very deep water. This layer of hardened clay will not readily transmit water unless broken. However, the clay minerals are very soft, and shale exposed at the surface tends to form valleys. Another common sedimentary rock, sandstone, is formed by sand grains deposited by ancient rivers and along ancient coastlines being cemented together by minerals deposited from ancient groundwater. Sandstone can vary dramatically in its resistance to erosion. In many areas of the United States, sandstone is made up of quartz sand cemented together by microscopic quartz crystals. Called orthoquartzite, this rock is very resistant to erosion, and when exposed at the surface, forms mountaintops.

Rock which has not been significantly eroded and is still connected to the underlying strata is called bedrock. The decomposition of bedrock by the forces of weathering produces a zone of weathered rocks and soil. This layer has been most affected by the forces of weathering (breaking up of rocks, both chemically and physically) and erosion (removal of the weathered materials). Wind, water, and freezing and thawing are constant contributors to the weathering and erosion processes and explain the varying sizes and shapes of sediments found within this top layer. This fairly porous layer has a relatively flat rate of water permeability when compared to the underlying bedrock.

Chemical weathering changes the minerals within the rock, typically softening and weakening them. Rainwater dissolves carbon dioxide in the air and in the soil, where it is produced by organisms and during the decay of organic material. This forms a weak acidic solution of carbonic acid that moves through the ground toward the water table. Some minerals react with the acid to make new minerals and release chemicals into solution. The best examples of this are the feldspars, a group of minerals commonly found in granites and some sandstone. Other minerals are soluble—they dissolve completely into the acidic water but at varying rates. These soluble materials include halite (table salt), gypsum, calcite, and dolomite, in order of decreasing solubility. Because halite is highly soluble, it dissolves completely when exposed at the surface except in the driest of deserts. Gypsum, calcite, and

dolomite dissolve more slowly, and produce a characteristic landscape (called karst) when exposed at the earth's surface. Because limestone (dominantly calcite) and dolostone (dominantly dolomite) are much more common than rock gypsum, most of the world's karst topography forms where these rocks are exposed at the earth's surface. A notable exception is the Guadalupe Mountains of New Mexico, which have karst topography developed dominantly in gypsum.

PREPARATION:
Younger students may benefit from a model prepared ahead of time as a visual aid.

PROCEDURE:

1. Tell students they will be making a model of the earth's bedrock. This will be done in three layers of different colored dough representing different layers, or beds, of sedimentary rocks. Have students soften and flatten the dough to make 3 patties about the size of their hands. Place the layers on top of each other to form a stack.
2. Have students place the stack on a sheet of wax paper so the layers will not stick to the table.
3. If there is a model prepared, have students note the mountains and valleys. Explain that one way a mountain can be formed is through the slow movement of the earth's crustal plates and the resulting pressure. Have students demonstrate this by gently squeezing their layers from the sides, allowing their earth's crust to slowly fold into a new shape. Note the profile, commenting on the anticlines and synclines.
4. Have students use a piece of fishing wire to slice through the dough to reveal a cross-section of the rock layers. Students should be able to see how the rock layers form the mountains and valleys.
5. Take one of the cross-sections and use the fishing wire to cut it in half, perpendicular to the original cut. Have the students hold the pieces together again with the pieces off line from each other. This illustrates a fault.
6. Ask how natural weathering processes may affect the land. Look for examples of physical weathering such as erosion. Then ask how this might affect the peaks. Would the weathering and erosion, over millions of years, remove the soil (which includes broken up rocks)? Consider that valleys may be filled in or be deepened with additional erosion. Have students demonstrate the effect of erosion with the fishing wire. Starting near a peak, have them slowly cut through the layers at an angle, exposing a lower layer, and continuing into the valleys.
7. Ask for discussion of what might happen if there were any breaks or cracks in the ground or the underground rock structures. Remind students that limestone is very soluble. Ask how it may be further weathered and eroded, both through physical and chemical processes. Fill in with background as needed to bring students to the understanding that it is through this process that most passageways and caverns are eroded and dissolved in beds of limestone deposits.

EVALUATION:

1. Name at least three changes that might happen in the earth's crust over millions of years. *(Examples include seas covering an area, depositing of layers of sedimentary rock; formation and erosion of mountains and valleys; further erosion or filling in of valleys; further weathering and erosion within top layer of rocks and soil; formation of passageways and caverns in limestone.)*
2. How might a limestone rock layer become exposed to weathering processes?
3. Why might caves form in beds of limestone?

HELPFUL HINT:
Play-Doh is softer than modeling clay and will be easier for students to manipulate.
Have students draw and label pictures of their layers at each step of the process.