Kansas 4-H Geology Leader Notebook

Chapter 1 — Geologic Processes

The Crusty Earth

Geologic Processes — Geology, Level I

What members will learn . . .

About the Project:

- Minerals and rocks in the Earth's crust are in a solid state because they have cooled.
- The Earth's crust floats on the mantle.
- The mantle and core are liquid or semi-liquid material because they are hot.

About Themselves:

- Science concepts are an important part of everyday life.
- Observation skills in their changing environment.

Materials: (2 to 3 members per group)

- 1 bag Plaster of Paris
- 6 tin foil pie pans, 6 paper plates, paper and pencils, or enough for one set per group
- 1 large bowl
- 2 quarts water (do not use soft water)
- 3 ice trays with frozen cubes
- Paper and pencil for each group

Activity Time Needed: 20 minutes

Activity

All matter must be either a solid, liquid, or gas. A solid is hard. Liquid pours, and a gas is generally an invisible vapor. Matter changes from one state to another because of the loss or gain of heat.

Observe the temperature by touching the bottom of the pie plate and lightly touching the top of the plaster. Is it cold, warm, or hot when you touch it? Record this information.

- Give each group a paper plate with an ice cube on it.
- Have each group select someone to record what you observe during this experiment.
- What state is the ice in? Solid, liquid or gas? (*Solid*) Your group recorder should write this information on the paper that was provided. Record date, time and state of ice cube.
- What was the state of Plaster of Paris when you poured it into the pie plate? (*Liquid*) Record date and time, also.

Leader's Notes

Pass out the pie pans to the group, mix the Plaster of Paris in the large bowl by slowly adding water. After mixing, allow each group to get enough plaster to cover the bottom of the pie pan at least one inch deep. To ensure the plaster will set up, do not use soft water. Each group should have a pencil and piece of paper to record data.

Review the following information about the crust, mantle and core while the ice continues to melt and the plaster hardens.

Do some other distance comparisons.

Make this observation at least 10 minutes after pouring the plaster and putting the ice cube on the plate.

The crust, or the outside of the Earth, is solid, because it has cooled. The mantle, which is the section below the crust, and the core, are at much higher temperatures, causing rocks and minerals to be in a liquid or partially liquid stage.

The diameter of the Earth is 12,740 kilometers, or about 7,900 miles. The crust ranges from 0-28 miles deep, or about 0-45 km. The mantle is 28-1,800 miles deep, or 45-2,900 km. 1,800 miles is about the same distance from New York City to Denver, Colorado. The Earth's core ranges from 2,900 to 6,370 km, or 1,800-3,950 miles deep.

Now, let's look at our experiment again. What has happened to the ice? What has happened to the plaster? Have the group recorder write what has happened on your data sheet.

Dialogue for Critical Thinking

Share:

1. What did we do to create this experiment?
2. What happened to the ice as it became warmer?
3. What happened to the plaster when it was mixed with water?

Process:

4. How is the Earth's crust like the plaster?
5. How is the Earth's mantle and core like water?
6. How is the Earth's mantle and core different from this water?

Generalize:

7. Can you think of examples where the Earth's crust is warmer or colder than other areas?
8. When you are conducting experiments like this, why is it important to write down what you see?

Apply:

9. If you could have changed this experiment, what would you have done differently, and why?
10. What have you learned about the Earth's crust that will help you as you think about collecting or identifying rocks and minerals?

Going Further:

1. Build a cross-section model of the Earth to scale and label the parts by name, identifying each state as solid, liquid, or gas.
2. Light a candle and allow the wax to become a liquid or semi-liquid and pour onto wax paper.-As it cools, explain the change from liquid to a solid and also note how the wax is flexible in its semi-liquid stage. The Earth's rocks and minerals react similarly when heated or cooled.

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The Floating Earth

Geologic Processes — Geology, Level I

What members will learn...

About the Project:

- The earth is hotter in the center.
- What causes a volcano to erupt.

About Themselves:

- How daily observation helps them understand scientific principles.

Materials Needed: One set for each 3 members

- 1 empty, clear, 2-liter bottle
- 1 quart jar
- 1 bottle food coloring
- 1 basting tube with 8-inch plastic tube attached
- 1 Tbsp. cooking oil
- Supply of hot and cold water

Activity Time Required: 20 Minutes

Activity

Fill your clear, 2-liter bottle with cold water. Next, place some very hot tap water in the quart jar and add ½ teaspoon of food coloring. What happened?

Now, take the basting tube and draw the hot colored water into it. Place the end of the basting tube in the bottle containing clear water. Gently squeeze the basting tube.

What happened?

Repeat the experiment using the cooking oil instead of the hot, colored water.

What happened?

Now we can see that not only material of a lighter density floats on the top of a more dense material, but that material of the same density when heated will rise to the top of a similar material.

What does this tell us about the Earth? We know that the interior (inside) of the Earth is very hot, so the material (rocks and minerals that compose them) is more dense than those in the crust of the Earth?

Leader's Notes

Explain to the members that the concentrated food coloring is diluted and that the water changed the color because of the dilution.

Heated material (air, water, etc.) of the same type will rise in a similar material.

Material of lighter density will rise or float in a more dense material.

More dense.

Dialogue for Critical Thinking

Share:

1. What did we do?
2. What happened when the hot and cold water were mixed?
3. What happended when the oil was added to the water?

Process:

4. How does this experiment help us understand that the earth's crust floats?
5. How does this explain the temperature of the inside of the earth?

Generalize:

6. What foods or drinks can you think of that react like this experiment?

Apply:

7. Can you think of some examples in your community where heated materials rise? (*Ex.: Hot air ballons, hot air, steam*)
8. On the planet Earth can you think of any evidence that the interior (mantle and core) of the Earth is warmer than the outside (crust)?
9. Why do volcanos and geysers erupt?

The Earth's interior is very hot and it heats the fluids and material in the mantle and crust which then turns into gases or less dense material that rises in similar fluids.

Going Further:

Examine several similar rocks or minerals and explain the color variation. Using a large dish pan, fill it with water and let the members place objects into the water and determine which item is the least dense and the most dense. Items you need are a balloon, wood, plastic, and steel.

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The Earth's Makeup

Geologic Processes — Geology, Level I

What members will learn...

About the Project:

- The Earth is not solid.
- The Earth can be divided into three parts.
- The center of the Earth (core) is made of elements which are heavier (more dense) than the elements in the mantle or crust.

About Themselves:

- How observation skills will help to understand their surroundings.

Materials Needed:

- Raw eggs
- Water
- Vegetable oil (¼ cup per 2 or 3 members)
- Pencils and paper
- Clear plastic glasses

Activity Time Needed: 20 Minutes

Activity

The Earth is similar to an egg in that it has a hard outer layer called the crust, a middle inner layer called the mantle which is semi-liquid, and a center layer called the core that is dense liquid.

When you broke the egg in the bowl, why did the yolk go to the bottom and the white and shell go to the top? Was it because the yolk was heavier (more dense)?

Let's do another experiment:

Take ¼ cup of vegetable oil and mix it with one cup of water and let it settle.

The oil floats to the top because it is lighter (less dense) than the water, therefore it floats on top of the water. Similar to the egg shell and egg white above the egg yolk.

A similar reaction occurs in the Earth, the heaviest or most dense minerals are found in the center of the Earth (core). The mantle is made up of less dense minerals and the crust has the lightest minerals.

Leader's Notes

Have the members gather into small groups (2-3). Each group needs a plastic glass and a raw egg. Let the members describe the egg (*shape, color and shell*). Now have the members break the egg into the glass, have the members describe what they see (*shell which is hard, liquid or the egg white and a dense yellow part called the yolk*).

Have the members explain what happens before telling them.

Now have the members draw a circle that represents the Earth's crust. In the center of their first circle have the members draw a small circle and color it solid. The members are now ready to label the parts of the Earth that are the crust, mantle and core.

The members should now be instructed to go back to their cross section of the Earth and label the three parts, from lightest to most dense using the following terms: lightest, light and heavy.

Dialogue for Critical Thinking

Share:

1. What happened to the shape of the egg when it was broken?
2. What part of the egg is similar to the vegetable oil? Why?

Process:

3. How are the earth and an egg alike? Different?
4. What are the three main layers of the Earth?
5. Which parts of the Earth are heaviest? Lightest?

Generalize:

6. Where else do you observe layers?
7. What other items have different weights? How do you know?

Apply:

8. How will what you learned help you understand other things in nature?

Going Further:

Gather samples of soil, sand and gravel. Take one cup of each sample and place them into a quart jar, finish filling the jar with water. Gently shake the jar for about two minutes and allow the jar to set on a table for five minutes. What happens?

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Dusty Rocks

Geologic Processes — Geology, Level I

What members will learn...

About the Project:

- How to define mechanical or physical weathering.
- The definition of erosion.
- Erosion and weathering are slow processes.

About Themselves:

- Discoveries through observation
- Value of cooperation

Materials Needed:

- Soft rocks such as limestones, sandstone and chalk. Four or more pieces should be several inches in diameter. The rest should be a cup or more of small pieces.
- Coffee can (will be loud) or plastic jar such as peanut butter jar (preferred).
- Pieces of white paper
- Measuring spoons
- Soil samples of mineral and plant material
- Magnifying glass

Activity Time Needed: 15 Minutes

Activity

Did you ever wonder what rocks become when they break up? Well, today we are going to find out. We are using soft rocks today, so we can see the results faster, but it works the same for hard rocks also. What kind of rock is this? We are going to rub these two rocks together until some pieces break off. I'll show you how to do it and then you can each try it. Here is a sheet of paper to catch the pieces and then we can put all that we rub off together and see if we can make a spoonful. Put your paper on the desk (or table) and hold the rock above it and rub them like this until you see some tiny pieces come off. See how small they are? Now, we'll pass these rocks around while we are talking and you can each rub them and try to get some rock dust.

Now, I am going to start another experiment.

What do I have in this jar? (*A. Some rocks.*) What kind are they? Do you see any dirt or dust? No. As we pass this jar around, I want each of you to shake it a little while. Try not to be too loud so that we can keep on talking. What do you think will happen?

Leader's Notes

Try your rocks ahead of time to see how they work. If they are not soft enough or if you cannot find appropriate natural rocks, you may use chalk. The sidewalk chalk would make a good size. Chalk is a "real" rock.

Hold up a piece of rock.

Set time limits on each person if necessary. Have several sets, if possible.

Predicting is a valuable exercise that improves thinking skills.

Large events often occur in nature, but this lesson focuses on the gradual ones.

Ties into the rock cycle. Learn more about that in the rock section.

Look at it with a magnifying glass.

Every person should get a chance before you finish.

Carefully! If anybody spills, use a piece of paper like a dustpan and collect what you can

What would be rubbing rocks together in nature, if people weren't there? (*A. Wind could be hitting the rocks together. Also water and ice could do that.*)

Would ice break off very much at a time? (*A. Sometimes, but usually it would only break off small pieces.*)

What happens to the little pieces of rock? (*A. Sometimes they get washed into the ocean.*) When rocks are broken apart and moved to a different place, it is called erosion. Sometimes they get squashed or melted back into rocks, called magma, but most of the time, they become part of the dirt or soil. Let's look at this sample of soil that I brought from outside.

What do you see in it? Do you see any little pieces that could be rock? What else do you see? Could some of that be plant materials? All that stuff combines to make soil. The decayed plant materials, called humus, help to hold the water in the soil and to make it loose and easy to work with.

What do you think the rock pieces do? (*A. They contribute minerals, or nutrients, that the plant needs to grow.*)

If each of you has had a chance to rub off some rock pieces, let's look at the results. Did anybody get a lot? Well, you all did pretty good, but nobody got a whole lot by themselve. Let's carefully pour it all together on this piece of paper and see if we get a teaspoonful together. (Measure). If each person does a little and puts it all together, then we get enough to make a difference. Weathering works the same way. Each piece isn't much, but all together, over several years, it is enough to make a big difference.

Now let's look at the jar. What do you see? Any dust or dirt yet? Where did that come from? (*A. From the little pieces of rock that have broken up.*)

Dialogue for Critical Thinking

Share:

1. Which created the most dust, rubbing rocks together or shaking the jar? Why?
2. What rocks made the most dust? Why?

Process:

3. What problems did you have making dust? What is this process called? (*Weathering*)
4. What is it called when rocks are broken apart and move to a different place? (*Erosion*)
5. What is soil? (*Rocks and plant material*)

Generalize:

6. How much dust did you make compared to that of the total group? How did cooperation help?
7. What are some other times when you need help (cooperation) to get something done?

Apply:

8. How important is each small part when cooperating on a big job? Why?

Going Further

1. Go for a walk, or on your next field trip, look for examples of weathering and erosion.
2. Compare soil samples from different places. What makes them different?

References:

Schlesener, Norman E., Plant Science, 4-H Curriculum Material, Level IV, Cooperative Extension Service, Kansas State University, Manhattan KS.

VanCleave, Janice, *Earth Science for Every Kid.* 1991, John Wiley & Sons, Inc., New York.

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The Mighty Plates

Geologic Processes — Geology, Level II

What members will learn...

About the Project:

- The members will learn about Pangea (Pan-JEE-uh).
- Continental drift and continental plates.
- Plates are pieces of the Earth's crust, most of which contain a continent.

About Themselves:

- Why change is often slow.

Materials Needed:

- Copies of Activity Sheet 1, *Continental Plates* for each member
- Scissors
- Tape
- Pencils
- Globe or world map

Activity Time Needed: 20 Minutes

Activity

The word Pangea is the name given to the large land mass on the Earth before it began breaking into the continents that we presently recognize. Pangea was subdivided into two smaller continents about 200 million years ago during the Jurassic Period. Laurasia represented the northern hemisphere continent and Gondwanaland was the continent located in the southern hemisphere. Laurasia and Gondwanaland began breaking up into the continents as we recognize them today about 135 million years ago. The heated material from the Earth's core and mantle provide the energy necessary to move the plates on the Earth's crust.

Pass the map of the continents out and have each member carefully cut out each of the continents. Once they have cut out the continents, they are ready to assemble into one large continent that geologists call Pangea. Each large continent is called a continental plate. To assemble them into one large continent, simply move the continental plates around until you have a good fit. When you get a good fit, tape them together. Keep adding continental plates until all are taped together. Now they should fit on the Pangea continent.

Once you have taped all the tectonic plates back together, you can see how the Earth looked 200 million years ago.

Leader's Notes

This was the time the Rocky Mountains were beginning to form.

Does this help explain why there were dinosaurs on all continents?

Distribute Activity Sheet 1, *Continental Plates*.

Dialogue for Critical Thinking

Some possible answers:

2. The holes are present because most of the continents have a continental shelf, which are underwater extensions of the continents.
3. Volcanoes and earthquakes occur.
4. Yes, show them the globe or world map and point the active areas out.
5. Yes, because this is where the rocks are solidifying and forming.
6. Remember how the mantle and core have semi-liquid material present and the crust is a brittle solid; as the material in the mantle worked its way toward the surface it broke up Pangea and began forcing the land masses apart, forming the continents as we know them presently.

Share:

1. How did you feel when you were trying to match the continents to Pangaea?
2. Did all the plates fit together or are there some holes? Why?

Process:

3. When the hot material of the mantle reached the surface of the Earth, what happened?
4. Are there any areas on the Earth today that have active earthquakes and volcanoes?
5. Why would the crust of the Earth be the youngest and thinnest near the earthquakes and volcanoes?
6. What force might have caused Pangea to break apart?

Generalize:

7. What other things can you think of that have changed shape over time? What caused that change?

Apply:

8. Name or describe some natural or man-made disasters that have changed the face of the earth?
9. What can you do to affect change?

Going Further:

Research Continental Drift and do a project talk on what other evidence supports this theory.

References:

Physical Geology, Fifth Edition, Publisher William C. Brown

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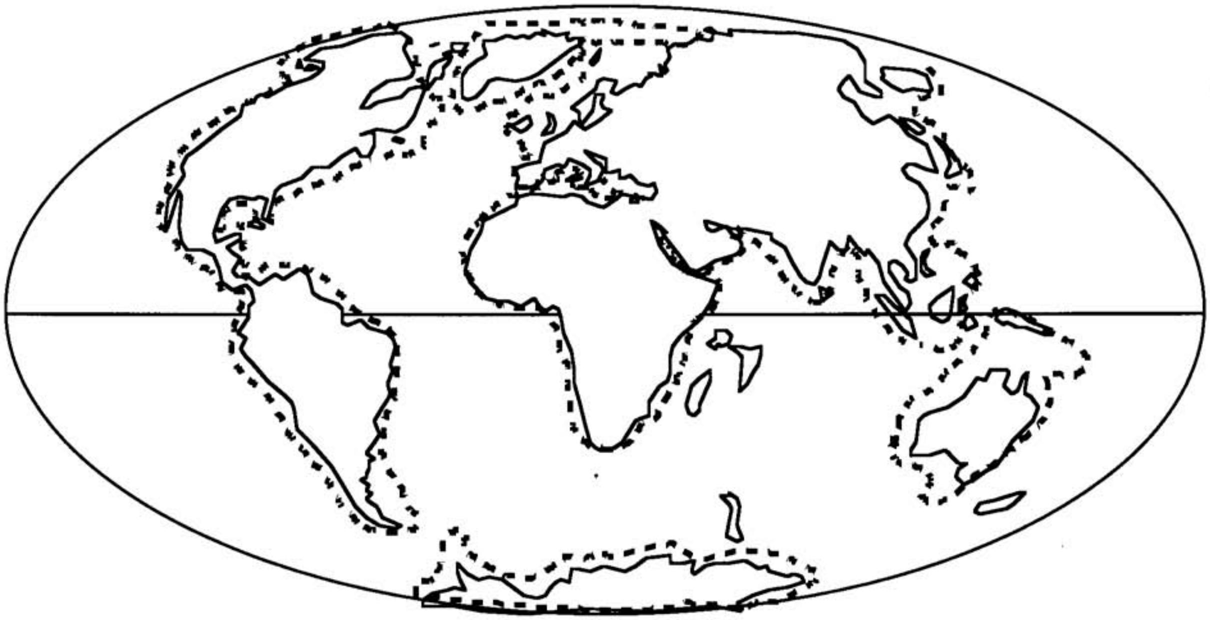
The Mighty Plates

Activity Sheet 1, Continental Plates

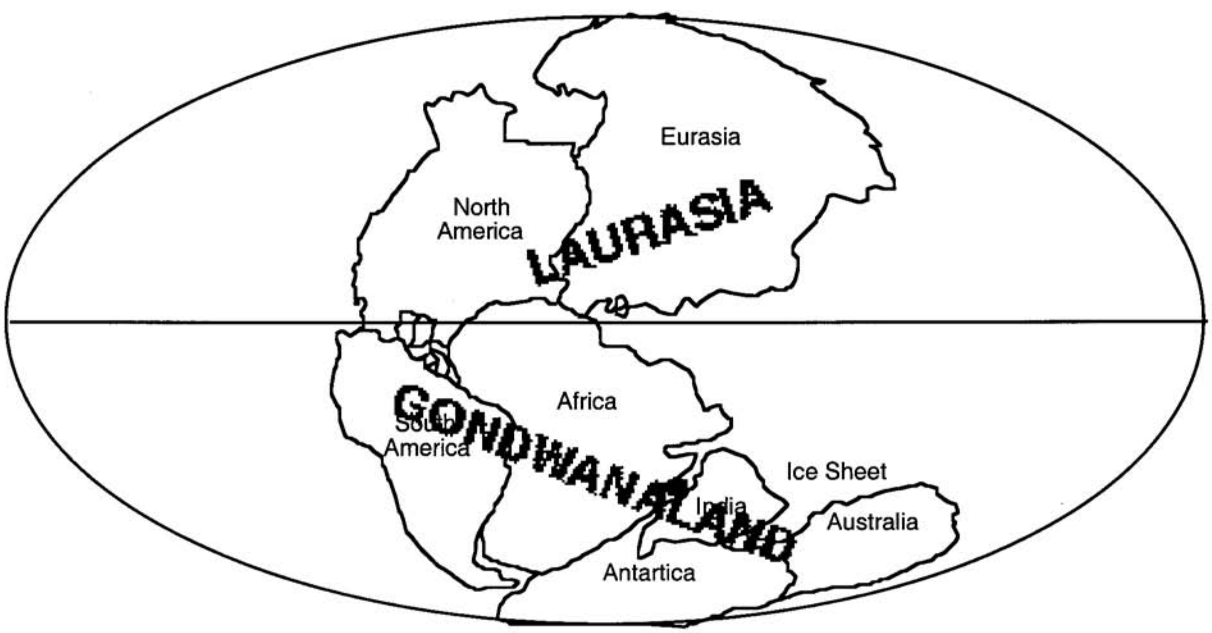
Geological Processes — Geology, Level II

Cut the continental plates around the dashed line.



Pangaea

This is what the earth's landmasses looked like before the breakup of Pangaea.



Making Mountains

Geologic Processes — Geology, Level II

What members will learn...

About the Project:

- Things happen inside the earth that help form mountains.
- New geological terms and processes.

About Themselves:

- Small changes can make big changes over long periods of time.
- Patience is important when working with others.

Materials Needed:

- A sample of igneous, metamorphic, and sedimentary rocks (see Leader Notes)
- Activity Sheet 2, *Major Tectonic Plates of Earth*
- Activity Sheet 3, *Major Tectonic Plates of Earth, Leader's Key*
- Member Handout 1, *Glossary of Geological Terms*

Activity Time Needed: 30 Minutes

Activity

The Earth's crust is made up of large and small pieces called plates that move around on the mantle of the Earth. Sometimes these plates run into each other forming mountains. In some places, one plate is forced under the other and the second plate is forced up and over the first, forming mountains. In other places, the plates collide head on and mountains are erected. A mountain can be defined as any rock body that rises 2,000 feet or more above the surrounding land mass. Kansas is part of the North American Plate.

The North American Plate is moving west at the rate similar to that of your fingernails growing.

Mountains that are formed by plates colliding or large structural uplifts are called structural mountains. Structural mountains are usually very large. One such mountain system runs from Alaska to the tip of South America. It includes the Andes of South America, the Rockies of North America and the Alaskan Mountains. These mountains have a core area made of igneous rocks, which are surrounded by metamorphic rocks and further out by sedimentary rocks. These structural mountains are usually highly folded and faulted.

Another type of mountain is formed by erosion. These mountains have a simple structure in which rock layers are horizontal or folded. These mountains are called dissected mountains. They formed as a result of a river or drainage system that erodes a channel and removes the material or

Leader's Notes

Show your members a piece of granite for an igneous rock, which is commonly found in mountains. A piece of gneiss or schist is a good example of a metamorphic rock found in the mountains. A piece of sandstone, limestone or shale, which is found in the foothills around a mountain range is an example of a sedimentary rock.

Distribute Activity Sheet 2, *Major Tectonic Plates of Earth*. Have members label the continents. Use the *Leader's Key* to check answers.

Show sample of granite for an igneous rock.

Show your members a piece of shale and limestone to represent a common sedimentary rock.

Show your members a piece of basalt and obsidian for examples igneous rocks you would find around a volcanic mountain.

Distribute Member Handout 1, *Glossary of Geological Terms*, to each member.

sediments. Over millions of years, the valley widens and the river continues to cut down into the land mass. These mountains continue to stay at the original elevation and are higher than the surrounding land area only because the river and stream have cut the land area away.

The Ozark Mountains are an example of dissected mountains.

The third type of mountains are volcanoes that may have any type of rock. They always have some igneous rocks. Mount St. Helens, Washington; Mount Shasta, California, and Kaplan Mountain in New Mexico are examples of volcanic mountains.

Now we are going to review some definitions of geological terms which we have talked about. (You might ask for volunteers to take turns reading a different definition, or you can read them, depending on reading skills of your members.)

Dialogue for Critical Thinking

Share:

1. What happens when the plates of the earth run into each other?
2 How do the different kinds of rocks feel? Which ones are smooth? Chalky? Gritty?

Process:

3. What role did weather have in forming dissected mountains?
4. Why do dissected mountains take a long time to form?
5. What type of mountain might will be most likely to occur in our lifetime? Why?

Generalize:

6. Do you like to wait on things that seem to take a long time? Why or why not?
7. What do you think about the old saying, "Good things come to those who wait."
8. Have you had something good happen because you were patient? How can you learn to be more patient when working with others?

Apply:

9. Have you ever visited a mountain range? What kind of rocks did you find?
10. What other recent natural forces have significantly changed the earth's landscape?

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Making Mountains

Member Handout 1, Glossary of Terms

Geological Processes — Geology, Level II

MANTLE The zone of the earth below the crust and above the core. It can be divided into the upper mantle and lower mantle.

PLATE A rigid, thin segment of the earth's crust that moves horizontally on the mantle.

MOUNTAIN Any part of the earth's crust higher than a hill. It can occur as a single land form, or in chains such as ranges. There are three types: structural, dissected and volcanic cones. Each are formed differently and have different types of rock.

STRUCTURAL MOUNTAINS A result of the uplift segment of the earth's crust, they usually cover a large area. The center part or core is made up of igneous rocks. As you travel away from the core, metamorphic rocks are found that are usually highly faulted and folded. The foothills adjacent to mountains have sedimentary rocks present and can also be faulted or folded.

DISSECTED MOUNTAINS Formed by erosion that results in the surrounding area being cut away by wind and water. The rocks in the mountains are sedimentary and may be gently folded.

VOLCANIC MOUNTAINS Formed by volcanoes and can be single cone or in ranges. They are always made up of igneous rocks.

Making Mountains

Activity Sheet 2, Major Tectonic Plates of Earth

Geologic Processes — Geology, Level II

Below is a map with the major continents and oceans. Name the oceans and continents.

A. North America
B. South America
C. Atlantic Ocean
D. Pacific Ocean
E. Africa
F. Europe & Asia

The black lines represent major tectonic plates that are moving on the earth's mantle.

Making Mountains

Activity Sheet 3, Major Tectonic Plates of Earth, Leader's Key

Geological Processes — Geology, Level II

Below is a map with the major continents and oceans shown. Name the oceans and continents.

A. North America
B. South America
C. Atlantic Ocean
D. Pacific Ocean
E. Africa
F. Europe & Asia

The black lines represent major tectonic plates that are moving on the earth's mantle.

Understanding Earth's Forces

Geologic Processes — Geology, Level II

What members will learn...

About the Project:

- An understanding of the tectonic forces that affect the Earth.
- Long term processes occur over millions of years and affect us and our environment.

About Themselves:

- Things are not always what they seem to be.
- How to explore options before drawing conclusions.

Materials Needed:

- 2 to 3 members per group
- 3 large rubber bands per group
- 1 12-inch ruler per group
- 1 pair of gloves per group
- 1 pencil and paper per group
- 1 large rock per group
- masking tape

Activity Time Needed: 20 Minutes (plus one month for long-term experiment)

Activity

Look at the rock and take a couple of minutes to describe it on paper. Look at one of the rubber bands, given the choice between solid, liquid or gas, what states of matter are the rubber band and rock in? Being a solid, the rubber band shares many characteristics of the rock. Do you agree? Name some of the similar characteristics.

Take a rubber band and stretch it as far as you can without breaking it. Release the stress on the rubber band. What happens to the rubber band? When an object returns to its original shape after being subjected to tension or pressure it is said to have elastic behavior. Do you think rocks have elastic behaviors?

A familiar substance that exhibits the same behavior is the elastic in your waistband or socks.

Now put on the gloves. Take the rubber band in both hands and give it a very sudden and big pull. If the rubber band did not break, try it again. In terms of the amount of stress and how long that stress was applied, what were the differences in the two experiments? Did the rubber band behave

Leader's Notes

Divide into small groups and give each group a rubber band, ruler, gloves, pencil paper, and rock. Have a recorder make notes about the experiment.

Is the rock round, hard, soft, colorless, heavy, etc.?

Does the rubber band return to its original size and shape?

Take a piece of gyp-board or sheetrock (6″x 2″), lay it over two bricks and place a third on top of it. Next dampen it with water and let it sit until the end of the meeting. What happened to the gyp-board? Was it altered?

The leader can also show a piece of mica and show its elastic behavior by flexing the piece.

differently in each example?

Glass responds like the rubber band did in the last example. A large stress over a very short period of time results in the glass breaking as did the rubber band. The term "brittle" is applied to this type of breakage that occurs when a large amount of stress occurs over a short period of time, resulting in broken or fractured material.

Now, try a long term experiment. First, measure a rubber band by laying it on a ruler. Don't stretch it, but take the slack out. On a small piece of tape put the day's date and how long the rubber band is. Tape this information to the rubber band. Now carefully stretch it without breaking, around an object and let it stay there for at least a month. Think what happens to the elastic in your waistband and socks after they have been stretched many times.

The leader may do this one month earlier, so that members can see the effect or change.

Predict what will happen to the rubber band as it is continually being stretched by the object it surrounds. Check the rubber band in one month and measure to see if any change has taken place. Measure it the same way as you did the first time. Has there been any increase in length? If so how much?

If the rubber band lengthened, it exhibited what is called a plastic behavior. It deforms as a redult of tension. The tension can't be great enough to exceed its brittle limits or it breaks. However, when the tension is released, it doesn't snap back to its original shape (elastic limit). It is said to have exceeded its elastic limit. Is this what happened with the gypboard?

Now back to your original description of the rock. Did you say a rock can bend or that it can be squeezed and then pop back? Be honest! If you did you are a better geologist than most. The first time doing this activity, most assume rocks should behave in one particular way. That way is what we are accustomed to on the surface of the earth. Rock is an aggregate or mass of mineral matter that has solidified. Most descriptions of rocks would characterize them as hard, solid, rigid, jagged, etc., but not what we just saw above. In studying the earth, keep in mind that rocks behave differently because of the amount of stress (tensional and comprehensional) applied to the rocks, and the rate at which it was applied and the duration of the stress.

With enough time, moisture, and weight, the gyp-board should be bent, but not broken.

Dialogue For Critical Thinking

Share:

1. What happened when you compared a rock to a rubber band?
2. Were you surprised with the final comparison? Why or why not?

Process:

3. What areas on the Earth's surface do you think the most stress is put on the bedrock?
4. Do the rocks in areas that have mountains and volcanoes have stress on them?
5. How do you think metamorphic rocks are formed?

Generalize:

6. What other items do you think have elastic, brittle or plastic behavior?

Apply:

7. How does this activity relate to the continually occurring forces on Earth?
8. Can you think of a time when you have jumped to a conclusion without first getting all of the facts? What did you learn from this?

Going Further:

- Members could make reports on plate tectonics, the mountain building process or volcanoes.
- Can you think of a local example of the change in rocks because of pressure or tension?
- Review Peanut Butter and Jelly Lesson plan in the Geologic History Section.

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The Earth's Changing Looks

Geologic Processes — Geology, Level II

What members will learn...

About the Project:

- Stress or pressure can easily modify and change rocks.
- Faults occur when the rock layers can no longer bend. They simply break or fracture to relieve the stress or pressure being applied to them.
- Folds occur when the stress being applied to the rock layers causes the rock layers to bend without breaking.

About Themselves:

- How models help us understand.
- The effect of physical and emotional forces.
- How observations of the present impact the future and help us to understand the past.

Material Needed:

- Four colors modeling clay or play dough (per group of 3) recipe in Going Further section
- 2 pine boards, 8" x 4" x 1" (per group of 3)

Activity Time Needed: 35 Minutes

Activity

We are going to construct a model of a fold and a fault. A model actually has three purposes:

A. It helps explain what we see.

B. It allows us to predict and imagine the past.

C. It may suggest experiments.

A fold in strata or rocks is any bend away from a flat surface. A bend upward results in an anticline, and a downward bend in the strata or rock results in a syncline.

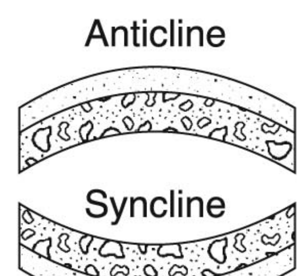
A fault is a break in the bedrock or rock layer forming the earth's crust. The bedrock must have some movement or displacement, either up or down or right or left.

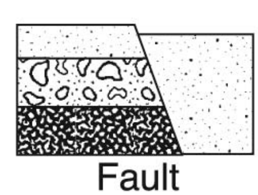
To begin, roll out different colored layers of clay or play dough in 6"x 6" x 6" sections. Now, stack one layer on the other, alternating colors in three or four layers. These layers will represent different rock layers.

Leader's Notes

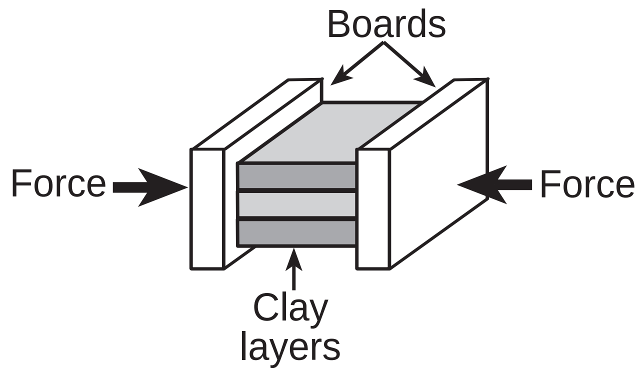
Divide the members into groups of 2 to 3.

You may want to build a poster showing a fold and fault, an anticline and syncline.





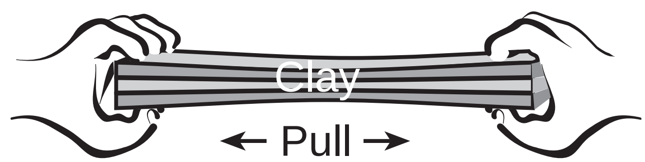
Put the play dough in between the two boards and squeeze. The force presented on the play dough is compression. Compression is caused by the squeezing of the Earth's crust. Describe or draw what the layers look like now.



If you continue the compression, what eventually will happen to the folds? Could you use this model to explain a type of earthquake or mountain building process?

Yes, because you have exceeded the elastic behavior of the rocks that result in a fault or earthquake.

Next, flatten out the layer of clay, or use a fresh supply of clay or dough. Rather than squeezing the layers, pull them instead. This force is called tension. Some places on the earth are subjected to tension and being pulled apart. Describe what happens to the layers as you continue to pull. If these were rock layers, would they finally break and cause an earthquake or a fault?



Dialogue for Critical Thinking

Share:

1. What happened when the clay layers were pressed together? Why?
2. What happened when the clay layers were pulled from each end? Why?
3. What happened when the clay layers were squeezed at angles?

Process:

4. What are the differences between an anticline, a syncline, and a fault?
5. What are the differences in the forces of compression, tension and a shearing force? What might each cause? Why?

Generalize:

6. How well did the models help explain the various forces?
7. Do you ever feel compressed or tense? When?

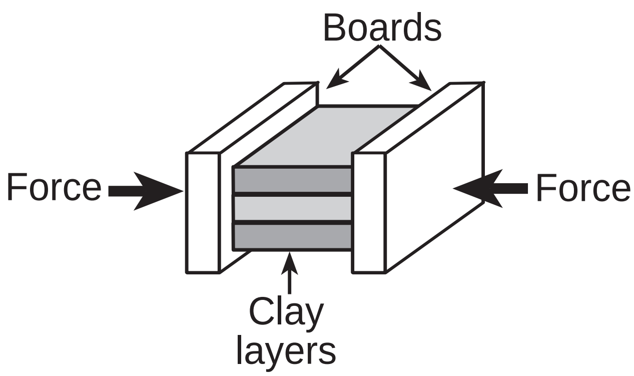
Apply:

8. How can you tell when others feel tense?
9. What can you do to help relieve or understand tense feelings?

Going Further:

- Visit a faulted area and make a cross section of the rock layers.
- Make models of the different types of faults.

Re-stack and flatten the clay. Try squeezing the clay again, but this time offset the boards so the force is not equal, or bring the boards toward each other on a diagonal line. See what happens to the clay when the forces are not applied directly opposite each other. This is a shearing force. Right now it is happening in Southern California. Does this give you any idea what it may produce over time?



A Better Play Dough

1 cup flour
2tsp. Cream of tartar
1 cup water
1 Tbls. Cooking oil
1 cup salt
food coloring

Mix the dry ingredients in sauce pan, add oil, water and food coloring to dry ingredients. Cook until the mixture pulls away from the sides of the pan. You may want to add a few drops of wintergreen, cloves or cinnamon to give the dough a more pleasant aroma. Knead the dough slightly almost immediately. Store it in an air tight container. I will keep several weeks.

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Changing Landscapes

Geologic Processes — Geology, Level II

What members will learn...

About the Project:

- Our land has been altered by many processes into its present shape.
- The weathering processes can be classified into mechanical and chemical.
- Freezing and thawing, the work of plants, and acid dissolution are three ways to shape the land.

About Themselves:

- Better understanding and appreciation of change.
- Observation and categorization skills.
- Learning how to use general, then specific questions.

Materials Needed:

- Pad of small sticky notes.
- Pencils
- Colored markers, highlighters, crayons or colored pencils (See Landforms" activity sheet to have the right colors)
- Small glass jar with lid (glass should be thin and not to strong)
- Dried beans, water, plate or pie pan
- Cake pan or other large pan. Fine dry dust or flour. Drinking straw.
- Piece of chalk and vinegar. Small dish or jar.
- Activity Sheet 4, *Landforms*
- Activity Sheet 5, *Erosion Types*
- Activity Sheet 6, *Landforms, Erosion Types, Leader's Key*

Time: Approximately 45 minutes

Activity/Game

Each person gets a sticky note put on his or her back without knowing what it says. They then ask others questions to figure out what landform they have on their sticky note. Only yes or no questions are allowed. Example: "Am I tall?" "Am I a water feature or a land feature?" Then, when they have some idea of what they might be, they can ask more specific questions like "Am I a mountain?" Allow some time until most or all have discovered their identity, gather up the sticky notes, shuffle them and play another round.

Remember when we made a peanut butter sandwich to show how the layers of the earth work? Were the layers flat or hilly? (*A. Yes, they were flat.*) New

Leader's Notes

Ahead of time, write a landform type on enough sticky notes to have one for each person. Suggestions include: plains, mountain, hill, delta, valley, cliff, volcano, island, butte, mesa, trench, continental shelf, etc. This game can be played at the beginning of the session as a mixer, or preferably at the end after they have studied the lesson.

If you haven't done that lesson, just remind them that the layers start out flat.

land is laid down in fairly flat layers, but it doesn't stay that way. Pretty soon weathering and erosion start to wear it down. These processes are not even all over, so more dirt and rocks get worn away, or built up, at different places making the land into different shapes. Soon we have the different land forms that make our Earth so pretty. What are some of the different land shapes, and what do they look like?

Some of these terms your 4-H'ers will know well, others not at all. Discuss other terms also, that relate to field trips, local features, etc., if you wish. See the leader's key for the *Landform* member activity sheet in this lesson for terms.

What is the difference between a mountain and a hill? The mountain is much larger, of course. Mountains are usually formed when they are being pushed up by forces deep within the earth. Newer mountain ranges tend to stand higher and have sharper ridges than older ones that have had lots of time to wear down. Have you heard of foothills? What are those? (*A. Hills that form near mountains from material eroded from the mountains.*) What is a plain? (*A. Yes, very flat area without mountains.*) What are buttes and mesas? (*A. Both are landforms that have flat tops where a hard rock layer has kept the softer material under it from washing away.*) Here is an activity sheet on different land shapes or landforms.

Hand out Activity Sheet 4, *Landforms*, and colored pencils, markers or crayons.

Let's read the instructions and see what we need to do. When you are done, you can put it in your geology notebook for a reference.

Weathering and erosion must be very effective processes to do all this. What do you think would wear down a mountain? It sounds very hard to do doesn't it? Erosion works just a little at a time, but after a while, it can make big changes.

See materials needed at the beginning of this lesson.

We are going to start an experiment now so it can work while we do other things. Here is a glass jar. Fill it full of beans. Another person can fill it almost to the top with water and put the lid on tightly.

This a good time to talk about slow changes adding up over time also. Can you see it changing?

What do you think will happen? (*A.Expanding beans will break the glass.*)

Have you ever watched your mother cook beans? What happens when she does? (*A. Soaks the beans; they get softer; they get bigger etc.*) Put the jar on this plate and we will check it once in a while.

Some kinds of erosion are mechanical. That means, it is just a simple act of moving the material around.

Put the fine dust or flour on the cake pan or cookie sheet. You may also add a larger piece if you like, and see which are more resistent to being blown around by the straw.

What might move dirt around? (*A. Wind, glaciers, water, gravity, etc.*) Could I have a volunteer to try blowing this dirt with this straw. Did the dirt move? Now I will sprinkle a little water on the dirt and you can try again. What happened to the places where the dirt was wet?

A long time ago, the middle of the United States didn't get as much rain as usual. Then, when the wind blew, what do you think happened? Right, the dirt blew. A lot of dust blew around and made the sky dark. It was called a dust bowl. Farmers could not raise as many crops, and it was even hard to see. The same thing happened when the glaciers retreated a very long time ago. Wind carried dry glacial silt and deposited it in other areas as loess, a fine, wind blown soil.

River water can carry even more dirt. Sometimes the water even looks muddy. A heavy rain can wash new gullies in a field.Can you think of any examples of this kind of erosion locally?

Place chalk in small dish or jar. Watch closely. This mild but safe combination will not put on a big show.

Another kind of weathering is called chemical. For this, the materials have to change to another material entirely. This experiment is a little harder to see, so watch closely. Here is some chalk and vinegar. Vinegar is a weak acid and chalk is made of calcium carbonate, as is limestone. I need another volunteer to put a little of the vinegar on the chalk, and then observe what happens.

What did you see? (*A. Gas bubbles coming from the chalk.*) Where is the gas coming from? Was there that much air in the chalk? The gas is coming from a chemical change between the chalk and the vinegar. It is changing some of the rock into carbon dioxide (the bubbles) and calcium. These are entirely different materials, so it is a chemical change. Can you see much difference in the chalk, except for being wet? Chemical change usually is a slow process. Over time, it can dissolve large caves in limestone the same way it is dissolving this chalk. We can put the chalk in the rest of the vinegar and come back later to see what has happened.

In nature, we can get acid from plants and from pollution. One kind of pollution is even called acid rain.

Here is a worksheet on different kinds of erosion. Let's read the directions and do the sheet. Then you may keep it in your geology folder.

Hand out Activity Sheet 5, *Erosion Types* and pencils.

When we are done with the activity sheet. it is time to check our experiments. What happened? How do you explain the results?

Dialogue for Critical Thinking

Share:

1. What happened (or do you think will happen) to the glass jar with beans?
2. Where did the dust go from the dust blowing experiment?
3. What new landforms did you learn?

Process:

4. Why did the glass with the beans break?
5. What is chemical weathering?

Generalize:

6. What landmarks or national parks have been carved by erosion? (*Grand Canyon, Badlands, Chimney Rock etc.*)
7. Can you think of other slow changes in your life?

Apply:

8. If you were a farmer, why would you **not** want your field to blow around?
9. If you were a farmer and your field was blowing, what could you do?

Going Further:

1. Look for examples of erosion and landforms on your next field trip.
2. Find some area that is endangered by erosion. Try to think of ways to stop the erosion.
3. Do some other erosion experiment. Books have a lot of them.

Reference:

VanCleave, Janice, *Earth Science for Every Kid*, John Wiley & Sons, New York 1991.

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Changing Land-scapes

Activity Sheet 4, Landforms

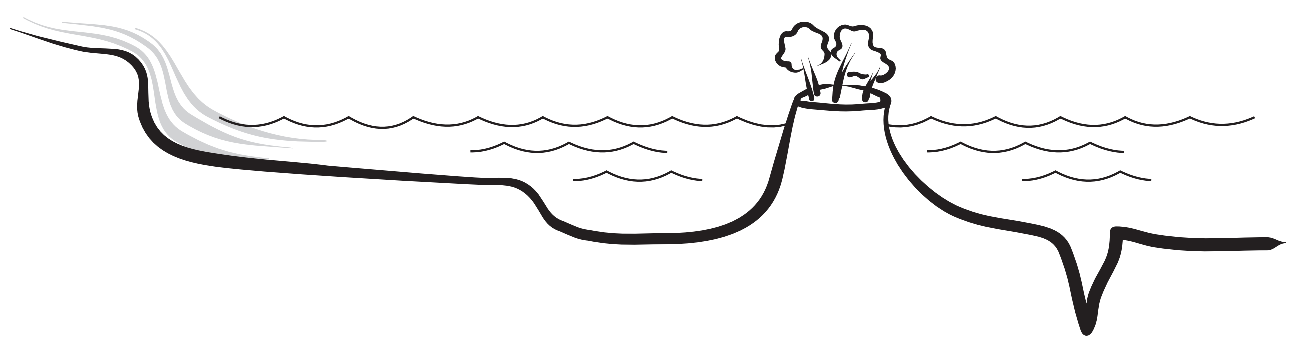
Geological Processes — Geology, Level II

Here is a picture showing some different landforms. Color each with the color by its description.

Land Features

Volcano (red) Where magma has burst to the surface and formed a cone
Mountain (purple) A much higher area that has land around it
Plateau (yellow) Large, high flat area near mountains
Valley (blue) A low area where water does, or has, run
Butte (tan) Flat-topped hill
Canyon(orange) Deep, steep gorge
Cliff (black) Steep drop
Mesa (gray) Flat-topped larger area
Plain (green) A flat area

Water Features



Waterfalls (blue) River where it goes over a steep drop
Delta (tan) Triangle-shaped area made of sediment deposited at the mouth of the river where it enters the ocean.
Continental Shelf (brown) Level area near the edge of the ocean
Ocean (blue-green) Large areas of water where water is salty, also called a marine area.
Island (orange) Small area of land with water around it
Trench (black) Deeper valley in the ocean bed

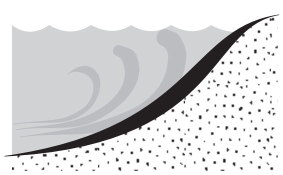
Changing Landscapes

Activity Sheet 5, Erosion Types

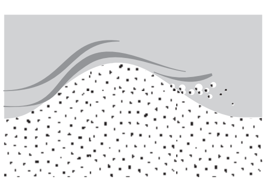
Geological Processes — Geology, Level II

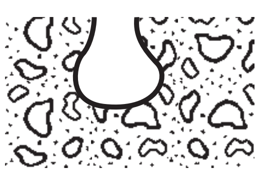
Draw a line from each picture of erosion to the picture for either mechanical or chemical erosion.

Mechanical Erosion
Physical breaking,wearing away, etc.



Chemical Erosion
Changes in the kinds of matter involved



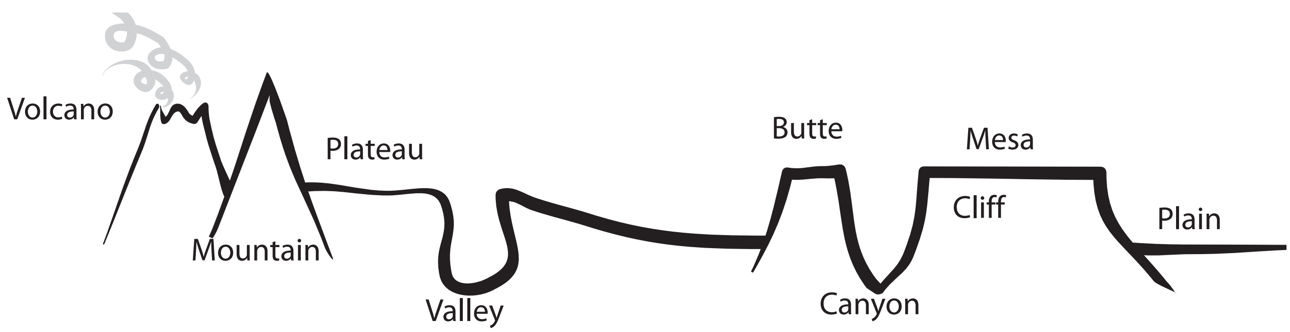


Changing Land-scapes

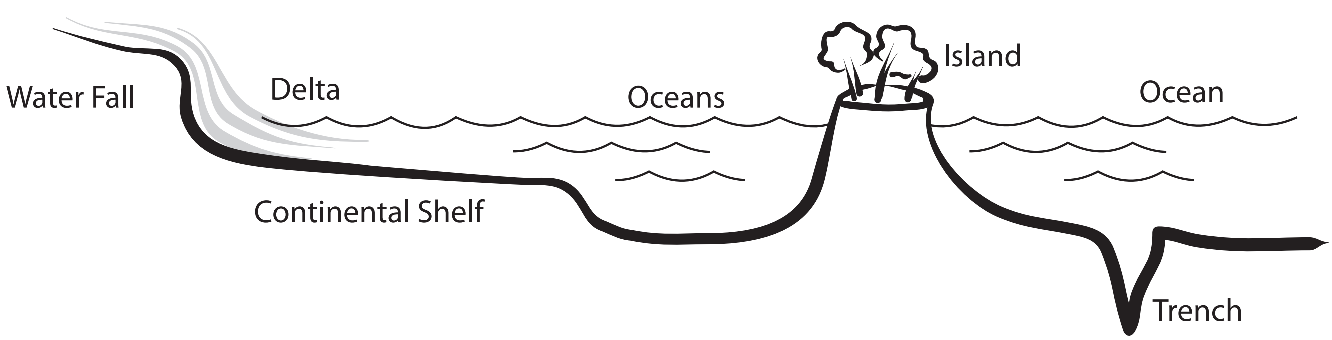
Activity Sheet 6, Landforms, Erosion Types, Leader's Key

Geological Processes — Geology, Level II

Land Features



Water Features



Key Erosion Types

Mechanical – Plants growing, wave action, sand dunes blowing
Chemical – Acid rain, cave dissolved out of rock

The Break Down

Geologic Processes — Geology, Level III

What members will learn...

About the Project:

- How water naturally forms stream patterns.
- Effect of alternate freezing and thawing.
- Effect of glaciers.

About Themselves:

- Value of observation
- Value of comparisons

Materials Needed:

For Freeze-Thaw Activity:

- Small jar without sloping sides (expendable)
- Cold water
- Plate or pie pan
- Freezer

For Glacier Activity:

- Deep dish, like a loaf pan, or larger
- Damp sand
- Spoons
- Newspaper
- Frozen “glacier” – yogurt cup or similar container with sloped sides
- Fill with water, add one tablespoon of sand and a few rocks
- Glass pane
- Large and small foil pie plates
- Ice chest or freezer

For Stream Table Activity:

- Map showing meandering pattern of streams
- Blue marker or highlighter
- Jelly roll pan (preferred) or other shallow large pan
- Dirt or sand, small rocks or clods
- Water hose connected to water, or two large pitchers or milk jug with water
- 2 to 4 bricks, or equivalent items, to elevate end of pan

Leader's Notes

Stream table needs to be set up outdoors in an area where water can drain, and sand washed out of the stream table will not harm anything.

Time Needed: 30-40 Minutes.

It may take hours to freeze first experiment, and "glacier" will take advance preparation.

Activity

Freeze-Thaw:

What do you think is the greatest force in erosion? We'll look at some different ways of erosion and then compare them when we are done. First, we'll look at how something as simple as freezing water breaks up rocks. Then, we'll look at glaciers and how they work. The last force we'll look at is water and how it shapes the landscape.

We are going to start this experiment first, but even then, it may not be finished by the end of the meeting. Would someone volunteer to fill this jar with water and put the lid on tightly. Now we'll put it in the freezer on this plate. What do you predict will happen? Does water contract or expand when it freezes? If it expands, where will this water go? The jar doesn't have slanted sides that let the ice just push up as it gets bigger. How is this similar to water freezing in a small crack in a rock?

Leader's Notes

You could also freeze it ahead of time and bring it frozen to the meeting.

Glacier:

What is a glacier made of? Ice. What else? They usually carry debris such as rocks and dirt they have picked up. They form in high areas of a mountain and flow down into a valley. These are called valley glaciers, or mountain glaciers. Glaciers can also be very large and cover vast areas, even as large as states, and those are called continental glaciers, or ice sheets. At different times, they have reached down into the United States as far as the northeastern part of Kansas.

Here is a big ice cube I have frozen to be somewhat like a glacier.

What have I done to make it like a glacier? (*A. Added sand and rocks. Glaciers can stretch with the materials they carry.*)

Who would like to try to scratch this glass plate with it? Oh, yes, it made a nice scratch. Sometimes, we can still see where a glacier scratched another rock a long time ago. In fact, a glacier scraped off part of the area where New York City now stands. Skyscrapers can be built very tall where it scraped off all the loose rock, leaving firm bedrock. You can still see the grooves and scratches they made in the famous New York Park called Central Park.

Glaciers carve a river valley into a very characteristic shape also. First, would someone shape a river valley in this pan of sand, going the long way? Slope it down gradually, have the riverbed down, about 1 or 2 inches above the bottom of the pan, and have the valley sides slope up wider than the frozen glacier.

It may take a bit of coaching to get the right shapes

If we were to cut a cross section across this valley, what shape would the valley look like? (*A. V-shaped.*) Now let's add a side stream coming into it, sloping down also.

Time for the glacier! Here it comes down the valley! (Push the glacier firmly down the valley in an upright position. The bottom of it should just scrape the bottom of the river.) What is happening to the sand? Yes, it is being pushed ahead of it. Eventually, it should push some to the side also. This debris will make the moraines. The glacier has receded. What happened to the side valley? (*A. It was cut off.*)

What will happen to the water that flows along it? (*A. Form a waterfall.*) This is called a hanging valley.

What shape is the river valley now? (*A. U-shaped, or flat-bottomed.*)

Now we can put the glacier on this upside down pan and the other panwill catch the water and let it melt.

What will happen to the sand and rocks in it? (*A. They will stay in a pile while the ice melts away.*) This is called a glacial till. Is anything else brought along by the glacier? (*A. It is unsorted.*) That means all different sizes are left jumbled together.

Stream Table:

It's almost time to go outside for the last experiment about stream valleys. But first, look at this map. Do you see any stream valleys? Take turns marking in the valleys with this marker. How can you tell if it is just a low place or if it really has water? What do you see about the patterns that the streams make? Are they straight?

Outside:

We are going to pretend this pan and sand is a river valley. Do we have a volunteer to spread the sand out evenly over the top ¾ of the pan, about 1-inch thick? Trace a small stream in the sand, straight down the middle.

Does this look natural, like streams usually look? [*A. No, streams are usually crooked, or meander (weave from side to side).*]

This pitcher (or jug) is going to be water running down the valley. I am going to pour it into the stream at the top of the pan, slowly and steadily. Look carefully to see what happens to the shape of the stream, where the sand goes, etc. Now add a few rocks in the stream bed. What happened? Build a dam and spillway. What happened to the washed out sediments?

Time to check your other experiments. Did what you think would happen, occur? We can also check them later, or I can tell you what happened the next time we meet.

Do this yourself unless some 4-H'er is very responsible.

"Lake" should form at the bottom, with a "delta."

A brick makes a good dam. Sediments should settle out in lake before water goes over spillway.

Dialogue for Critical Thinking

Share:

1. Which of the three activities did you like the best? Why?
2. Which activity was easiest to understand? Most difficult? Why?

Process:

3. Which of the three erosion forces are most prominent in your area?
4. Which of the erosion forces carry the most material?
5. Which erosion force breaks up most large rocks?

Generalize:

6. What is the value of erosion, and why is there so much concern about controlling erosion? (Discuss the positive and negative effects of erosion.)
7. How does erosion affect the quality of your life?

Apply:

8. How will you act differently the next time you observe the result of erosion. Why?

Going Further:

1. Investigate how far debris has been carried by glaciers.
2. Get pictures of Yosemite National Park, which was shaped by glaciers. What evidences that it was glacier sculpted do you observe?
(*A. U-Shaped valley, half of a mountain scraped away, hanging valleys and water falls.*)
3. Investigate local examples of anything we studied. Where did the rocks originally come?
4. Investigate local examples of glacial deposits, and types of features, such as horns, cirques, drumlins.
5. Build a permanent stream table. You could make a model of a stream valley of your choice, or of one near where you live, and try it out.

References:

Beckway, Gregory, *Stream Table Investigations,* Hubbard, P.O. Box 104, Northbrook, IL 60062 (Ph. 312-272-7810) (Advanced stream table and erosion exercises)

Kansas Geological Survey, *Geologic History of Kansas*

Lasca, Norman P., *Build Me a River*, Earth, Jan. 1991, Vol. 1, No. 1, pp 59-65 (Good article on building your own stream table)

Matthews, William H. *Geology Made Simple,* Doubleday & Company, Inc., Garden City, New York, 1967. (Good information on erosion, and glaciers)

Van Cleave, Janice. *Earth Science for Every Kid*, John Wiley & Sons, New York, 1991. (Simple erosion experiments)

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Weathering Forces

Geologic Processes — Geology Level IV

What Members Will Learn...

About the Project:

- Wind and water are potent weathering processes and can sort materials.
- Streams meander and produce different shaped channels as they mature, and have different branching patterns.
- Chemical weathering is a strong force under certain conditions.

About Themselves:

- Observation is a good way to learn.
- Decision making skills.

Materials Needed:

- Fan and garage or other large area where dust can be blown.
- Flat pan of dry dirt containing different size particles.
- Map or pictures showing caves and /or karst topography.
- Copies of Member Handout 2, *Weathering Forces*, to each member.
- Copies of Activity Sheet 7, *Valley Cycle*,to each member.
- Pencils
- Limestone piece and hydrochloric acid (10%) in dropper bottle.

Time Needed: Approximately 30 minutes

Activity:

Weathering and erosion are powerful processes. What examples can you think of around your area that show the power of wind and water? Tuttle Creek Spillway Canyon near Manhattan, Kansas, is a very striking example of erosion. Geologists believe that in prehistoric times, even greater erosion took place. We are going to learn about some different forces of weathering and the way they share the land.

Wind

One powerful force is the wind. Ask your grandparents or great-grandparents for stories of the dust storms if you want some evidence. Sand dunes tend to form characteristic mounds, and if the material blown has different size particles, the wind will sort them. We will try this with a fan and some dry dirt. We'll start it now so it can be blowing as we do the rest of the lesson, then come back later to see what happened. What do you think will happen? Where will the larger particles be? The smaller particles?

Leader's Notes

Set up the fan at one end of a garage or other place where a cross wind will not interfere. A large, smooth surface should be in front of the fan. Then put a shallow pan with the dirt in front of the fan and turn on the fan and let it blow for awhile. Send someone out to turn off the fan about 5 minutes before the end of the lesson so the dust will settle before you observe patterns.

Hand out Activity Sheet 7, *Valley Cycle*.

Provide Member Handout 2, *Weathering Forces*.

This concept often confuses people. There are also 5, 10 and 500 year floods, etc.

Consider doing stream table if you haven't already done it.

Have a member do this common test for carbonates that also shows how chemical weathering takes place.

Water

Water can be a very powerful weathering process. Have you seen a gully? They are formed by water. Water also erodes stream banks. A combination of erosion and deposition shapes stream patterns. The *Valley Cycle* activity sheet has a chart to fill out about stream formations and illustrations of the different land forms. You can keep it as a reference sheet when you are done.

Do you remember when we did the stream table? Did the water run in straight lines in the stream table? (*A. No, it swerved around, or meandered.*) The water erodes the bank of the river on the side that is flowing fastest. When a stream is new, it runs mostly straight, and carves a v-shaped valley, eroding the valley floor. As it gets older, it meanders over a broad area, and has a wider flood plain.

The flood plain is the broad area that is covered by water when the river floods. Flooding waters slow down when they are out of their channel and drop some of the dirt they are carrying, eroding less. More drops near the bank of the river sometimes form a natural levee, or dike, along the edge of the river, and the sediments deposited make the flood plain even more fertile and flat. Sometimes people are tempted to build in this area, especially if it has been several years since a flood. They are now unable to get federal funding for such building, so fewer houses are being built in flood plains. Flood plains are classified by how often they would flood (on the average). A flood might be classified as a hundred year flood, but that doesn't mean you couldn't have similar floods several years in a row, and then none for several hundred years.

A very old river meanders and flows slow as it cut itself into a stream bed with less drop. Sometimes the meander loops will get so close that the river just cuts across and leaves the loop stranded. If the loop is deep enough to hold water, it is called an oxbow lake.

An old river might have several flood plains on different levels. If the earlier ones were when the river was bigger, it can form a stepped arrangement on both sides of the stream. These are called terraces. This is more likely to happen if the area is being lifted up so that the stream continues to have enough energy to cut downward.

Various stream patterns develop depending on geologic conditions. The usual pattern is a tree or branching pattern with smaller streams joining together irregularly to form one bigger stream. A lattice or a rectangular pattern develops when the area is fractured in large blocks, and it is easier to erode along the fractures. A drainage system is the area that one stream drains. Sometimes a more rapidly growing stream will erode back into another stream's area until it captures part or all of the other stream's drainage system. This is called "pirating."

Chemical

There are several kinds of weathering. Chemical weathering is often overlooked, but is important in many places. It can be on a grand scale, or as simple as the chemicals produced by one plant. Kansas has a lot of limestone that is very susceptible to being dissolved by acid. As rain falls, it collects any acid that may be in the air from air pollution, and forms a weak acid solution. Let's do the acid test for limestone.

What happens? As the acid is neutralized by the basic nature of the limestone, bubbles are released. A very small amount of the limestone is dissolved. Of course, this would have to be repeated over a long period of time, for the results to show. Over millions of years, great caves can be formed. If the caves are small and near the surface collapse, the result is a pocked, lumpy landscape known as karst topography. How can this reaction also have results for water contamination? (*A. limestone neutralizes the acid and acts as a stabilizing force in nature.*)

(See "Karst Topography" in the 1995 Kansas State 4-H Geology Field Trip Guide for more on this subject).

Let's go look at the wind experiment. It will be dusty so bring a tissue to cover your nose. Can you tell that different sizes have fallen in a different place? Which went the farthest? (*A. A stream can also sort its material.*) What shape are the deposits? (*A. Drifts, or dune shapes.*)

Compare to sand dune shape on reference sheet.

Dialogue for Critical Thinking

Share:

1. Which experiment did you find the most interesting? Why?
2. Did the blowing dirt bother us all? What do you think it was like to live in the dust bowl days?

Process:

3. Which form of weathering do you think moves the most material?
4. What are the other kinds of weathering and erosion?

Generalize:

5. Did you learn or understand better, or think you will remember better by doing the experiments than if you just read them in a book? How can you use this information in the future?

Apply:

6. What would be good things to do with a flood plain?
7. What examples of weathering do we have in this area? What kind of stream valleys do we have?

Going Further:

1. Observe old and new road cuts or a quarry. What evidence of weathering do you see?
2. Observe an erosion area over time, several years if possible. What changes do you see over the years?
3. Collect two samples of limestone as similar as possible. Arrange to have a weak acid slowly drip on one. An empty milk jug with a small pin or nail hole, and filled with a strong solution of vinegar and water, works for this experiment. Observe and compare the samples periodically. Remember, it usually takes a long time for results to show from acid solutioning. Collect the acid solution and drip it on the rock several times to dissolve more limestone.
4. Study other forms of weathering and erosion.

References:

Plant Science Book, Kansas 4-H Curriculum

Matthews, William H. III; *Geology Made Simple*, Doubleday & Company, Inc., Garden City, New York.

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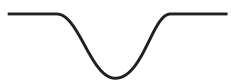
Weathering Forces

Activity Sheet 7, Valley Cycle

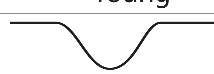
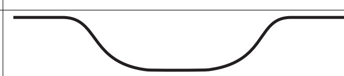
Geological Processes — Geology, Level IV

Valley Cycle

Valleys change as they age. Fill in the blanks to show what the valley would be like at that stage. When you have checked this sheet with the answers at the bottom, and made changes, you may keep it as a reference sheet.

	Young	Mature	Old
Cross-Section View			
Drop	Steep		Low, gentle
Stage	Valley Deepening		Widening and Flattening
Channel Shape		Beginning to Meander	Broad Meanders
Flood Plain	Little or No Flood Plain	Definite Flood Plain	
Tributaries		Many	Few and Large
Features	Rapid and/or Waterfalls		Many Oxbow Lakes Marshy Areas/Natural Levees

ANSWERS: (fold under until you are ready to check answers)

	Young	Mature	Old
Cross-Section View			
Drop	Steep	Moderate	Low, gentle
Stage	Valley Deepening	Cutting Wider and Deeper	Widening and Flattening
Channel Shape	Straight	Beginning to Meander	Broad Meanders
Flood Plain	Little or no Flood Plain	Definite Flood Plain	Broad Flood Plain
Tributaries	Few and Small	Many	Few and Large
Features	Rapid and/or Waterfalls	May Have Oxbow Lakes	Many Oxbow Lakes Marshy Areas/Levees

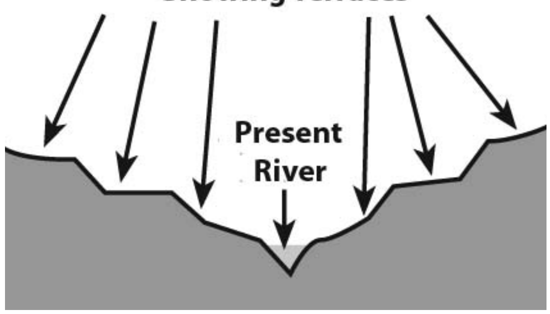
Weathering Forces

Member Handout 2, Weathering Forces

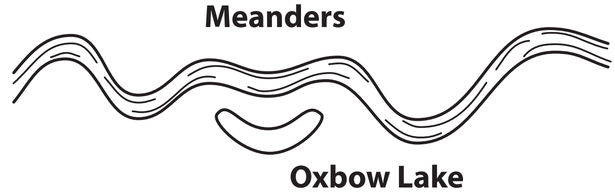
Geological Processes — Geology, Level IV

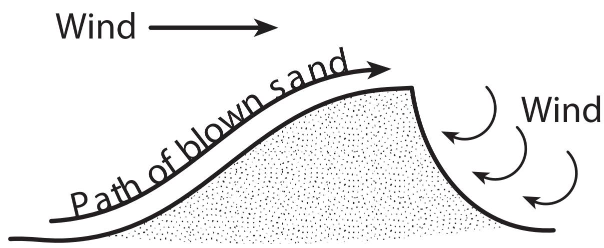
Illustrations of different stream patterns and sand dune shapes to use with this lesson and on your own.

Cross Section of River Showing Terraces

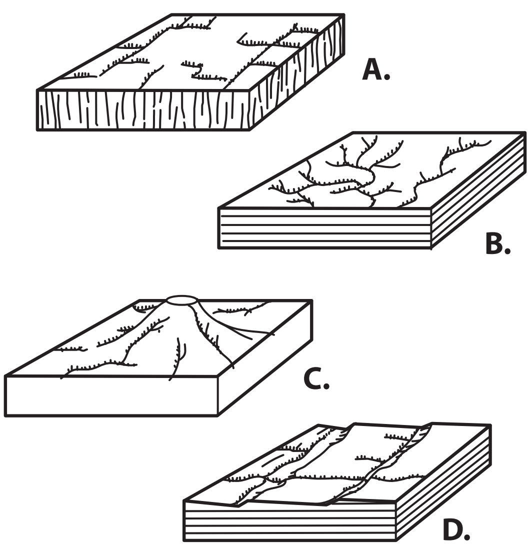


Meanders

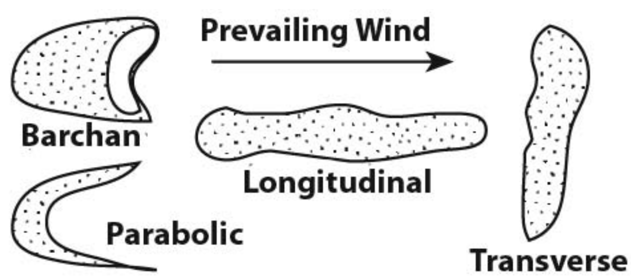




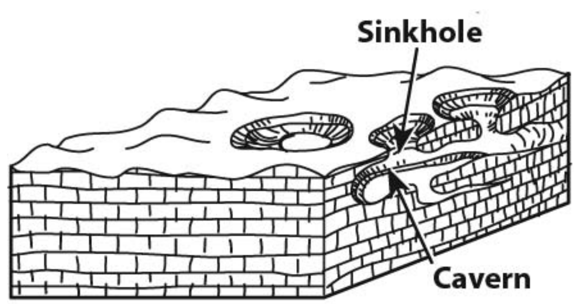
Cross-section of sand dune



Some typical drainage patterns.
A – Rectangular
B – Dendritic
C – Radial
D – Trellis



Types of Sand Dunes



Caverns and sinkholes developed in an area of karst topography.