Note to 4-H Member

Learning about geology is fun for people of all ages. “Geology” exists all around you, wherever you live. The Indiana 4-H Geology curriculum was written for youth who enjoy rocks, fossils, and minerals, and for those who want to learn more. The first manual introduces basic geology concepts. We hope this study is just the start of a lifetime enjoyment of geology. The key to learning, as with any 4-H project, is for you to enjoy your studies and to learn at your own pace. You can enhance your learning experience by using other resources from the Internet, school, or a local library.

Notes:

- To complete this project we suggest that you purchase the booklet *Let’s Look at Rocks*. It has information about many of the topics introduced in this manual and color pictures that are very helpful with identification. The “Resources” section has information about where you can get the publication.

- Geologic terms bolded in the text can be found in the glossary.

- When you see this icon, you’ll find a Fun Fact about geology.

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Safety Reminder

Think safety first when collecting or working with your specimens. Safety glasses (or goggles) should be part of your equipment. Wear hiking boots or other appropriate footwear when working in the field, and always watch for people above and below you (on hillsides) before you begin digging.

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Collection Warning: You should seek permission from the Indiana Department of Transportation and from the Indiana State Police or local county sheriff’s office to collect along road cuts. If you do collect along road cuts, be sure that you and your vehicle are well off the road and do not pose a traffic hazard. Collecting on private property requires permission from the owner. Collecting at state parks is strictly prohibited, but limited collecting may be possible at some state or federally owned or managed properties if you have obtained permission or a permit. For information about collecting in the Hoosier National Forest, go to the forest’s Web site, send an e-mail message, or call (812) 275-5987. For information about collecting at state forests or reservoirs, contact the Indiana Department of Natural Resources.

Adult Supervision Recommended

You will see this reminder for activities that may require adult help and supervision for youth in grades three through five.
Note to Parents and Project Leaders

The 4-H Geology curriculum offers many educational experiences, from collecting and identifying rocks to learning how the earth was formed. Parents and project leaders can be a big help if they are involved with their children's learning, especially for younger 4-H members. As they mature, youth should take on more responsibility. The helper's guide has a variety of information to help adults work much more effectively with youth. These include:

- Ages & Stages – This article gives a summary of the general youth developmental stages and gives ideas of what to expect.
- Learning Styles for Youth – This article discusses how kids learn by different methods.
- Experiential Learning – This article gives tips on how to make the most of any activity by teaching to a variety of learning styles.

Parent involvement is very important for a successful geology project, especially with younger 4-H members. If you can sit in on meetings and ask your child what they learned and what they did not understand, it will help your child have a much better experience. Kids will be much more excited to learn if they have parental support and interest in what they are doing. The geology experience will be more rewarding for your child if you can take him or her to collection sites; gem, mineral, and fossil shows; museums; and other special events.

**Goals of this publication:** The 4-H Geology, Level 1 manual encourages youth to

- begin to learn about rocks, minerals, and fossils; and
- develop an understanding of, and an appreciation for, earth science.

Experiential learning distinguishes 4–H youth development education from many formal educational methods. Activities are designed so youth experience a learning activity, reflect on what they did (explore the meaning of the activity), generalize what they learned (to test comprehension and appreciation of the activity), and then think about how they can apply what they learned to other situations (generalize). You can help guide youth as they explore each activity by discussing each section.

For more information on working with youth, see the Geology Helper's Guide.
What Is Geology?

Geology is the study of the earth; “ge” is Greek for “Earth” and “ology” means “the study of.”

Why study Geology? Geology determines how people live anywhere and everywhere on Earth. Will their homes be built of stones or clay? Will roofs be made of slate? Will they have rich soil for farming or rocky hills best suited for grazing? There may be oil or natural gas, coal, or diamonds buried under the surface. All of these things are the result of geologic processes!

The Three Kinds of Rocks

There are three kinds of rocks: igneous, sedimentary, and metamorphic.

Igneous rocks are crystallized from magma (or melted rock) that forms deep below the surface of the earth. Igneous rocks can be divided into two types:

- **Intrusive rocks** – magmas formed and cooled deep within the Earth
- **Extrusive rocks** – magmas that cool on the Earth’s surface, often in lava flows

The textures of intrusive and extrusive rocks are different, because intrusive rocks cool more slowly than extrusive rocks. Slow cooling allows for larger, coarse crystals.

Sedimentary rocks are formed from igneous and metamorphic rocks weathered by water, wind, and ice. Three types of sedimentary rocks are formed depending on the conditions under which they are weathered. Igneous rocks that are dissolved in water create sedimentary rocks composed of crystallized minerals. If water is not present in the weathering process, the sedimentary rock contains a collection of mineral and rock fragments.

Metamorphic rocks are formed from igneous and sedimentary rocks by heat and pressure.
Activity 1. Rock Crossword Puzzle

Complete the crossword puzzle using the clues (Across and Down) and the Word Bank. You can also look up the definitions of these words in the “Glossary” at the back of your manual.

Word Bank
- bedrock
- coal
- color
- coarse
- extrusive
- fizz
- fossil
- glacier
- gravel
- hardness
- igneous
- intrusive
- magma
- metamorphic
- mineral
- rock
- sand
- sedimentary
- soil
- structure
- texture
Across
2. Grain size of particles about the size of salt.
3. Rocks formed by heat and pressure.
4. Large, worn, rounded pebbles and smaller grains of sedimentary rock.
9. A physical property that describes how a rock is formed.
10. Rocks formed from magma, coming from deep below the surface of the Earth.
11. A sediment made of very small grains.
13. Small bubbles created when dilute acid reacts with lime or other calcareous materials.
14. The upper layer of the earth in which plants grow.
15. The most easily seen physical property of minerals.
16. A naturally occurring, inorganic substance with a definite chemical composition and crystalline structure.
17. Rocks weathered from older rocks by water and wind and hardened into layers.
18. Solid rock that lies underneath the weathered rock material.
20. Melted rock under the Earth’s crust.

Down
1. A physical property describing the size and arrangement of the minerals in a rock.
5. Igneous rocks cooled on the Earth’s surface.
6. A solid made up of one or more minerals or Earth materials.
7. The resistance of a mineral to scratching.
8. Preserved remains or imprints of animal and plant life.
10. Igneous rocks that are cooled deep within the Earth.
12. Moving sheets of ice that covered part of the United States during the ice age.
19. Black sedimentary rock from plant and animal remains, commonly mined to burn as fuel.

Think about It!
Did completing the crossword puzzle help you learn different geologic terms?
Make your own crossword puzzle, using some of these terms, or other words from the glossary.
The Rock Cycle

Igneous rocks are formed from magma that is cooled and hardened into rock. Magma moves toward the surface of the Earth filling in cracks, forcing its way between the layers of other rocks, and occupying large spaces as the surrounding rock is melted or pushed aside. All of this takes a long, long time. Sometimes magma finds a weak spot and flows slowly to the surface of the Earth where it cools. Sometimes magma blows violently out through a hole in the Earth, and we say a volcano has erupted. The magma that spills out of a volcano is called lava.

Once igneous rocks crystallize (harden) and are exposed at the surface of the Earth, they begin to wear down (decompose or weather). They may become exposed because the magma has been pushed to the Earth’s surface or because of erosion. Rain pours down on mountains and washes away loose chunks and small particles on upper surfaces. Rivers carry the pieces along, bumping and scraping and banging together, crushing some of them into sand and some into fine powder. Some of the minerals are decomposed into dissolved material or into clay minerals. Water may seep into the rocks, freeze, and split the rocks apart. Winds may carry the finer pieces. Glaciers, too, help form sedimentary rocks as they move over the Earth, pushing and grinding rocks together, until even the hard pebbles of quartz are ground to sand.
As time passes, great quantities of igneous rock wear away. These materials drop to the bottom, creating layers of soil. As layer after layer of sediment accumulates, it creates ever-increasing pressure on the lower layers. The lower layers containing organic material, mud, sand, silt, and clay begin to harden into sedimentary rock.

Metamorphic rocks are formed by high pressures and high temperatures that push and crumple rocks. This happens when mountains are created. When rocks are changed into metamorphic rocks, they may change the mineral makeup of the rock or recrystallize. The crystals may grow all in the same direction or separate into layers of crystals.

**Activity 2. The Rock Cycle**

The rock cycle is not a one-way street. Under certain conditions, each of the three types of rocks can change into any other type of rock. Study the diagram above and fill in the blanks below. Think about the processes that cause one type of rock to change into another.

**Fill in the Blanks**

- Igneous rocks become ____________________ rocks through increasing heat and pressure.
- Igneous rocks become ____________________ rocks through decomposition, erosion, and weathering.
- Metamorphic rocks become ____________________ rocks through crystallization and melting.
- Metamorphic rocks become ____________________ rocks through decomposition, erosion, and weathering.
- Sedimentary rocks become ____________________ rocks through heat and pressure.
- Sedimentary rocks become ____________________ rocks by melting and crystallization.
Activity 3. Rock Cycle Fill-in

Complete the rock cycle diagram using the following clues.

- Igneous rocks become metamorphic rocks through heat and pressure.
- Igneous rocks become sedimentary rocks through decomposition, erosion, and weathering.
- Metamorphic rocks become igneous rocks through crystallization and melting.
- Metamorphic rocks become sedimentary rocks through decomposition, erosion, and weathering.
- Sedimentary rocks become metamorphic rocks through heat and pressure.
- Sedimentary rocks become igneous rocks by melting and crystallization.

Fill in the boxes with words that describe processes that change one type of rock into another type.
Fill in the empty sections with the names of the three kinds of rocks.

For more information about the rock cycle, see the Rock Cycle Activities, Handy Handouts (MI41). This publication is available from the Indiana Geological Survey (see “Resources” section).

**Think about It!**

Did completing the rock cycle help you understand how rocks are formed?

Describe another natural cycle.

Make a board game using the rock cycle.
Activity 4. How Rocks Change

Color the picture showing how igneous rock can turn into sedimentary rock. Use red for igneous rock, brown for sedimentary rock, and yellow for metamorphic rock.

Think about It!

Describe the Earth processes that change an igneous rock into a sedimentary rock.

How can pictures help people learn?

Draw a picture that shows how you have changed since the time you were born.
More about Earth Processes

The geology of the Earth is affected by what happens both underground and above ground. The following activities (activities 5-10) will help you think about Earth’s processes.

Activity 5. Earth Processes Matching

Draw a line from the word bank to the definition that best describes the word. You can use the glossary to help you.

<table>
<thead>
<tr>
<th>Word Bank</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensation</td>
<td>A process in which water changes from a liquid to a gas.</td>
</tr>
<tr>
<td>Evaporation</td>
<td>A process in which water enters the soil.</td>
</tr>
<tr>
<td>Ground water</td>
<td>A process in which water changes from a gas to a liquid.</td>
</tr>
<tr>
<td>Infiltration</td>
<td>Water that falls from the sky as snow, rain, hail, or sleet.</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Examples include lakes, streams, rivers, and oceans.</td>
</tr>
<tr>
<td>Surface water</td>
<td>Water that is found below the water table, underneath the surface of the Earth.</td>
</tr>
<tr>
<td>Transpiration</td>
<td>A process during which water is released from plants to keep them cool.</td>
</tr>
</tbody>
</table>

Think about It!

How many of the words did you need to look up in the glossary?

List any tricks or study methods that would help you remember these long words.

Make a matching game that helps you learn other difficult words from the glossary.

Dig Deeper

Watch a video or TV show about an earthquake, geyser, or volcano. Write up the following information and keep it with your geology manual: title of show, channel, time and date the program aired (or date video was made), place and time of geologic interest, and three interesting facts that you learned from the show.
**Activity 6. Earth Processes Fill-In**

The drawing shows a diagram of a volcano, earthquake, geyser, and magma and how they are interconnected. Fill in the boxes that show which is which.

**Think about It!**

Make your own picture of one of these processes.

**Activity 7. Make a Volcano**

Create your own volcanic eruptions without the high temperature.

**Procedure**

1. Place 3 to 4 tablespoons of baking soda into the glass jar.
2. Add a few drops of food coloring to 1/2 cup vinegar. Pour vinegar over the baking soda and watch it fizz.
3. You can also create a hollow mountain structure from paper mache, cardboard, or clay and place a cup

**Supplies**

- Baking soda
- Vinegar
- Red food coloring
- 8 oz. glass jar

**Adult Supervision Recommended**
containing the baking soda inside. Leave the top open as your volcano’s vent. Pour the vinegar into the vent and over the baking soda and watch your miniature volcano erupt.

**Think about It!**

What happened when you poured the vinegar onto the baking soda?

What causes lava flows?

What change happens to the magma when it cools on the Earth’s surface?

**Activity 8. The Effects of Pressure**

Observe the effects of pressure and movement by making a sandwich model.

**Procedure**

1. Cut your peanut butter and jelly sandwich in half.
2. Place toothpicks in a straight row across the cut.
3. Move the two pieces different directions to show how an earthquake can move the Earth in different directions – sideways, up and down, bent, etc.
4. You can also show the effects of pressure by putting half the sandwich in a plastic bag (remove toothpicks) and squishing the bag between your hands or under a book.
5. Carefully open the bag, remove the sandwich, and observe how the layers were pressed together, but still remained different layers.

**Think about It!**

What happened to the toothpicks when you moved the sandwich halves?

Have you ever seen evidence of Earth surface movements?

How does this activity show some Earth processes?

What happened to your sandwich? Can you still eat it?

How could you change the activity?
**Activity 9. Igneous Mint Fudge**

Igneous rocks form from metamorphic or sedimentary rocks due to melting and crystallization. You can observe how substances can change properties through melting by creating an edible snack. Be sure to ask a parent or other adult for help.

**Supplies**
- Water
- 4 cups sugar
- 1¾ cups evaporated milk
- 1½ cups butter
- 12 oz. package of chocolate mint wafers
- 16 oz. package of marshmallows
- Stove
- Candy thermometer
- Heavy, high-sided saucepan
- Measuring cups
- 13” x 9” x 2” pan
- Butter (for greasing pan)

**Directions**

Butter the sides of the saucepan. Combine milk, sugar, and butter. Stir until the sugar is dissolved and the mixture boils. Place candy thermometer into mixture and cook to soft-ball stage (236° to 243° F). Remove from heat, then add mint wafers and marshmallows. Stir until blended. Pour immediately into a buttered 13” x 9” x 2” pan. Cut when cool and firm.

**Procedure**

1. Prepare the fudge ahead of time according to the directions.
2. Use your fudge to explain to a friend how igneous rocks form. (They are the result of magma, or molten rock, which has cooled.)

**Think about It!**

- Why was it necessary to use heat in this activity?
- Does the fudge represent intrusive or extrusive igneous rock?
- How could you change this activity?
Activity 10. Make Your Own Sandstone

Learn the process of the formation of sedimentary rocks by creating your own sandstone.

Procedure

1. Put one inch of the sand into a paper cup. In the other cup, put one inch of water.

2. Add Epsom salts to the water in the second cup. Stir in salt until no more salt will dissolve.

3. Add the water/salt solution to the sand. Stir well, then place the cup in an area that will be undisturbed for several days.

4. When the mixture is dry, tear the cup away from your sandstone. Compare your sandstone to pictures of naturally formed sandstone.

Think about It!

What happened to the sand after it dried?

Is the sandstone you made fine or coarse?

What is needed for sandstone to form on the Earth’s surface?

Is sandstone igneous, sedimentary, or metamorphic rock?

How could you change this activity?

Supplies

- Coarse sand
- Two paper cups
- Water
- Epsom salts
- Magnifying lenses

Fun Fact

Mountains are formed by different processes. They can be formed by a volcano (examples: the Cascades, Hawaii), dome (examples: Stone Mountain, Georgia, or the Black Hills, South Dakota), or by an earthquake (examples: Yosemite, Nevada).
Collecting Rocks

The preceding pages introduced you to some basic geology concepts. You can learn much more by collecting and identifying rocks. Collecting and studying rocks can be a life-long hobby and career. Begin to collect special rocks that you find, if you have not already. Why do you like them? Can you think of ways to use or exhibit your rocks? One of the best ways to learn about geology is to work with your 4-H leader, your parents, or an interested friend. Visiting a rock shop or show is a great place to find many rocks and knowledgeable people to help you learn.

When you begin to collect rocks it can be very difficult to classify and identify them. You will get better at this as you practice and gain experience.

The rocks shown below are the common ones that you are likely to find as a first-time collector.

**Basalt (Igneous)**

Minerals are not easily seen with unaided eye. Cannot be split into layers. Does not **fizz** in acid. **Color**: black. Mineral content: pyroxene, olivine, and feldspar.

**Coal (Sedimentary)**

Organic textured rock: minerals are not easily seen with unaided eye. **Color**: black. Soft, easily scratched. Does not fizz in acid. Regarded as a sedimentary rock because it is found in layers.

**Note:** Coal, while commonly found in most Indiana counties, is usually not native except in southwest Indiana. There are other areas in the United States and the world where coal is extensively mined because of the very large deposits.

**Conglomerate (Sedimentary)**

Minerals and rounded rock fragments are easily seen with unaided eye. **Color**: variable. Appearance: like a **coarse**, pebbly sandstone. Mineral content: quartz, feldspar, and different rock types as pebbles.
**Dolomite (Sedimentary)**
Minerals may or may not be seen easily with the unaided eye. Dense to granular. Color: gray to tan-pink. Dolomite fizzes slightly in acid. Powdered dolomite will fizz more rapidly. Minerals: dolomite (a mineral similar to calcite). Often contains poorly preserved fossils.

**Gabbro (Igneous)**
Minerals are easily seen with unaided eye. Minerals mutually intergrown (like a jigsaw puzzle). Dark color; heavy weight. Does not fizz in acid. Mineral content: feldspar, pyroxene, hornblende, and olivine.

**Gneiss (Metamorphic)**

**Granite (Igneous)**

**Limestone (Sedimentary)**

**Marble (Metamorphic)**
Minerals may or may not be seen with unaided eye. Cannot be split into layers. Fizzes in acid because it’s metamorphosed limestone. Color: usually white. Mineral content: calcite, dolomite. Recrystallized limestone or dolomite.

**Quartzite (Metamorphic)**
**Rhyolite (Igneous)**


**Sandstone (Sedimentary)**

Sand-sized minerals may be seen with unaided eye. Cannot be split into layers. Usually does not fizz in acid. Color: variable. Mineral content: quartz, feldspar with different cementing material, some of which will fizz. May contain poorly preserved fossils.

**Schist (Metamorphic)**

Minerals are usually seen with the unaided eye. Can be split along mica surfaces. Color: variable. Does not fizz in acid. Mineral content: variable but usually some variety of mica is predominant. The wavy, layered structure is typical.

**Shale (Sedimentary)**


**Slate (Metamorphic)**

Activity 11. Rock Collection

Collect and display eight rocks using the cards in the back of this manual. Show at least one rock from each classification (igneous, sedimentary, and metamorphic) and identify the rock and its classification. Suggestions for your first collection are:

- Igneous – granite, basalt, gabbro
- Sedimentary – limestone, dolomite, shale
- Metamorphic – quartzite, schist, basalt, granite

Think about It!

Did you enjoy collecting your own rocks?
Did you find it easier to find some types of rocks than others?
Can you find a rock that you could paint to look like a sleeping bunny or other animal?

Activity 12. Rock Artwork

Use sand, gravel, colored rocks, or a combination of these items to make a colorful, textured picture. On a separate sheet of paper, write a story about your picture.

Think about It!

Was it fun to use rocks in your artwork? Have you ever done that before?
List some other ways to use rocks in artwork.

Collection Equipment and Safety

You will need some special tools and equipment to collect and identify rocks and rock material. Most of the equipment is quite simple and can be found around your home. Review the list given on the next page, then begin building your own equipment collection. You won’t need all the items at first, but you will need them if you stick with this project. A four-gallon plastic milk crate, tool box, or old shoe box makes a good place to keep your equipment where you can always find it. You can divide the milk crate into sections by filling it with milk jugs with the tops cut off.
Safety Reminder

When breaking a rock specimen, don’t forget to:

1. Put on your safety glasses.
2. Put your rocks in a fabric sack or grain bag.
3. Put the sack in a vice, tighten as hard as you can, and hit the vice (not the rocks) with a hammer.

This method breaks most rocks.

Fun Fact

The book *Let’s Look at Rocks* shows pictures and descriptions of important equipment (pages 37-39).

Common Geology Collection Equipment

**Acid** – used to test certain rocks for the presence of lime; usually very dilute hydrochloric acid

**Chisel** – a tool used for breaking out rock specimens

(Always wear eye protection when using a chisel. Note that often fingertips are better than a chisel for extracting specimens.)

**Collecting bag** – used for carrying specimens [Buy collecting bags from an army surplus store. To make your own, cut the bottom part of jeans (knee down), sew closed, and add a handle.]

**Gloves** – used to protect your hands when you are trimming small specimens to size

**Hammer** – a tool used for breaking rock specimens

**Journal** – used to record information about your specimens

(In your collecting bag, always have a small piece of paper and masking tape to mark where specimens came from. Roll specimens, especially minerals, in newspaper. Note the nearest city, or at least the county. Put information in your journal when you return home.)

**Magnifying glass** – used for looking at the grains in rocks

**Microscope** – used for looking at small details in rocks

**Newspaper** – used to prevent breakage and to separate specimens

**Pocket knife** – used for testing the hardness of rocks and rock materials

**Protective glasses** – used to protect your eyes

**Safety kit** – useful for small cuts

**Specimen box** – used for storing your collection at home
Activity 13. Geology Equipment Word Search

Find the 13 pieces of equipment listed in the Word Bank, hidden in the letters below. (Note: two-word items in the Word Bank will be two separate words in the Word Search.) Label the geology equipment shown.

Word Bank

<table>
<thead>
<tr>
<th>Acid</th>
<th>Journal</th>
<th>Protective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chisel</td>
<td>Magnifying</td>
<td>Safety kit</td>
</tr>
<tr>
<td>Collecting</td>
<td>Microscope</td>
<td>Specimen</td>
</tr>
<tr>
<td>Gloves</td>
<td>Newspaper</td>
<td></td>
</tr>
<tr>
<td>Hammer</td>
<td>Pocket knife</td>
<td></td>
</tr>
</tbody>
</table>

Think about It!

How long did it take you to complete the word search?

Make your own word search, using other geology terms.
Minerals

What are minerals?
A mineral is a solid element or compound. All minerals are made of naturally occurring elements. Minerals are inorganic (nonliving) and have a definite chemical composition and internal structure. There are very few pure elements. For example, gold, silver, diamond, sulfur, and copper are found in pure form. Most minerals are compounds.

How are minerals formed?
Most minerals are found as crystals, which are formed when melted or dissolved minerals become solid.

Activity 14. Making Crystal Models
Use the diagrams in Appendix A to construct your own crystal models. Carefully cut the shapes and fold on the dotted lines.

Think about It!
What is your favorite shape to make? To look at?
Make a “piggy” bank from one of your geology shapes. What could you call it?
List two or three places where you can find these shapes in your home or school.
Activity 15. Growing Crystals

Crystals have interesting structures, and watching crystals grow can be fascinating. Use one of the methods listed on the following page to make your own crystals.

Sugar Crystals: Edible Crystals

Procedure

1. Attach one end of the string to the pencil and cut the string to fit inside the jar. Moisten the string with some water and then roll the moistened string in sugar.

2. Put the cup of water into a saucepan and heat until boiling. Add 2 cups of sugar to the water and stir until the sugar is dissolved. Remove from heat. Add flavoring and coloring as desired. Carefully pour the sugar mixture into the jar; the mixture will be very hot.

3. Leave the jar in a place where it will not be disturbed. Crystals will begin forming within 3 hours. Let the crystals grow for 3 to 10 days. The longer the crystals are allowed to grow, the larger they will be.

4. After the crystals are the desired size, remove string from the jar and break apart. Examine the shape of the crystals to understand the structure of the crystal. Then enjoy your edible crystals.

Supplies

- Measuring cup and spoon
- Large heavy metal saucepan
- Long wooden stirring spoon
- Clean glass jar (canning jar is recommended)
- Piece of cotton string (clean!)
- Pencil
- Thick pot holders
- 1 cup water
- 2 cups of granulated sugar
- A few drops of your favorite candy flavoring such as peppermint, cherry or lemon
- A few drops of food coloring, more drops = darker color (optional)
Borax Snowflake: An Inedible Crystal

Create a long-lasting snowflake any time of the year.

Procedure

1. Use the pipe cleaners to form a snowflake that the crystals will grow on. The snowflake should fit inside the jar. Attach one end of the string to the snowflake. Attach the other end to the pencil. Make sure the string is long enough to suspend the snowflake in the jar.

2. Fill the jar three-quarters full with boiling water. Add the Borax one teaspoon at a time, making sure to stir after each teaspoon is added. Use three teaspoons of Borax per cup of water. You can add food coloring to create a colored snowflake.

3. Place the pipe cleaner snowflake in the Borax mixture by placing the pencil on top of the jar. Make sure the snowflake is covered but not touching the bottom of the jar.

4. Allow the snowflake to stay in the jar overnight. The next day you will see beautiful crystals that create a snowflake that will never melt.

Think about It!

How long did it take to make your crystals?

What could you change in this activity to make different crystals?
What are fossils?

Fossils are the remains of plants or animals or evidence such as footprints, tracks, etc., that are preserved as imprints. They are usually found in sedimentary rock materials.

How fossils are preserved?

A common way fossils were formed is called replacement. This means that the minerals in the ground and water have filled the open spaces of the organism and actually turned it into stone. Petrified wood and petrified bone are some examples of common fossils which have been preserved this way.

Fossils can also be molds or casts. These are the most common types of fossils. Molds are formed around a fossil and show the outside. A cast comes out of the mold, showing the outside features of a plant or animal. A mold or cast is formed when the following steps occur:

- A plant or animal sinks to the seafloor, swamp, or other moist area.
- The specimen becomes covered with sediments.
- It decays and leaves a mold.
- The mold becomes filled with the sediments.
- The sediments harden, forming a cast.

In the scenario described above, there would be both a mold and a cast of the fossil. Fossils may also be formed as carbon prints. These are common in Indiana in coal mine overburden (what is taken off the top of coal). They are formed when a plant or animal decays and leaves a print of the carbon that was in the body. They are almost always found in shale.

Making Molds and Casts

You can make molds and casts of fossils that you want to copy or that you cannot remove from a large rock. A mold is made by pressing a fossil into a substance (like clay or plaster of Paris) so that it will take on the shape and show
the details of the fossil. A cast can then be made from your mold. The cast is a replica of the original fossil.

**Activity 16. Quick Clay Mold**

Make a mold using modeling clay. Work the clay a bit to make it pliable and divide it into two pieces. Find a small object (sea shell, chicken bone, penny, etc.) to press into one of the pieces of clay. You may find it helpful to cover the object with a thin coat of petroleum jelly to keep it from sticking to the clay. Gently press the other piece of clay over the top of your object. Carefully pull the clay away to see your mold. You should be able to see some of the details from your original object.

**Think about It!**

Can you see details from your original object in your mold?

How is the clay mold like mud or clay that was on the Earth millions of years ago?

**Activity 17. Making a Plaster Fossil Mold**

**Procedure**

1. Cover a fossil with a thin coat of petroleum jelly. Try to make the coat as smooth as possible. The petroleum jelly will prevent the plaster from sticking to the fossil.

2. Prepare plaster of Paris in a cup as directed from the package. Make enough plaster to fill the form with about 1 inch of plaster. The plaster should be the consistency of pancake batter. Pour the plaster into the form about 1 inch deep.

3. Place the fossil into the plaster and push until the widest part of the fossil is in the plaster.

4. Let the plaster harden for 15-25 minutes. Test the plaster in an area away from the fossil by using your finger. If the plaster feels firm, you are ready for the next step.

5. Coat the now-hardened plaster with a thin layer of petroleum jelly. Lay a cardboard strip on either side of the fossil, but do not touch the fossil itself.
6. Prepare another batch of plaster, then cover the fossil with more plaster. Let the plaster stand for 15-25 minutes.

7. Remove the plaster from the form; you may have to cut the form. Gently pry the two halves apart to remove the fossil.

8. Let the plaster mold dry completely. In the summer, the drying process can be hastened by placing the mold in the sun for 2-3 days. In the colder months, the plaster can be hardened by placing it in an oven set to 100°F for 24 hours.

**Think about It!**

How can you use your mold?

List two or three other things that you could make molds of and explain what they could be used for.

**Activity 18. Making a Rubber Cast**

Use your plaster mold to make plaster, rubber, or wax casts or half-casts (just the tops).

**Procedure**

1. The rubber latex should be creamy. If it is not, pour the latex into an empty jar and add water to the latex. Let stand overnight.

2. Pour a thin layer of latex into the plaster mold. The plaster will remove water from the latex causing the latex to harden.

3. Add a thin layer of latex as each layer hardens. Continue until the cast becomes about a quarter of an inch thick. It is not necessary to fill the entire mold. Make sure to pour excess latex into the container and cover it, or the latex will dry out.

4. Place the mold in a warm place and allow to dry for 24 hours.

5. Sprinkle talcum powder inside the cast and then remove the mold. Wash the cast off to remove any plaster grains. Using sharp scissors, cut off the excess latex from the cast.
6. Dry the cast either for a few days in the sun, or bake it in an oven at 100°F. Check your cast from time to time. Drying time will depend upon many factors. The cast can then be painted to look like the original fossil.

Think about It!

What are the differences between a plaster mold and a rubber cast?

How long did it take you to make your rubber cast?

How can you use your cast?

Resources

Required Publication: Let’s Look at Rocks

Available from:

Your local Purdue University Cooperative Extension office, ask for Let’s Look at Rocks, 4-H-CIR5

Purdue Agricultural Communication, Media Distribution Center, (888) 398-4636, www.ces.purdue.edu/new, ask for Let’s Look at Rocks, 4-H-CIR5

Indiana Geological Survey (IGS), (812) 855-7636, http://igs.indiana.edu

The Indiana State Museum, www.in.gov/ism/
Additional Publications
From Indiana Geological Survey (IGS), (812) 855-7636, http://igs.indiana.edu/. Note that there is a “Bookstore” link on the top right side of the home page. The following publications might be of interest. IGS has many more.

<table>
<thead>
<tr>
<th>Item Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>MI01A</td>
<td>Overview of Indiana Geology, CD-ROM</td>
</tr>
<tr>
<td>MI41</td>
<td>Handy Handouts</td>
</tr>
<tr>
<td>MM48</td>
<td>Bedrock Geologic Map of Indiana</td>
</tr>
<tr>
<td>MM39</td>
<td>Map of Indiana Showing Topography of the Bedrock Surface</td>
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<tr>
<td>MM40</td>
<td>Map of Indiana Showing Thickness of Unconsolidated Deposits</td>
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<tr>
<td>MM50</td>
<td>Map of Indiana Showing Bedrock Geology</td>
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<tr>
<td>AM10</td>
<td>Glacial Geology of Indiana</td>
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<tr>
<td>MM37</td>
<td>Map of Indiana Showing Thickness of Unconsolidated Deposits</td>
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<tr>
<td>Poster05</td>
<td>Surface Terrain of Indiana</td>
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<td>Poster07</td>
<td>Minerals of Indiana</td>
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<td>Poster08</td>
<td>Fossils of Indiana</td>
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</table>

Web Sites
American Geological Institute: www.agiweb.org/
Indiana Geological Survey: http://igs.indiana.edu/ and http://igs.indiana.edu/GISatlas
Indiana Geographic Information: www.in.gov/igic/
American Geology Institute, Earth Science World: www.earthscienceworld.org/
Department of Earth & Atmospheric Sciences, Purdue University: www.purdue.edu/eas/
Geology Experiments from Ohio State University: http://wow.osu.edu/experiments/geology/geolist.html
Volcano World: http://volcano.und.edu
Geology Level 1

Indiana 4-H Club Record

Name ______________________________  Grade ________ Year ________
Name of Club ______________________________ Year in Club Work _____
County ________________________ Township________________________

1. What did you enjoy most about the geology project? Why?

2. What were the most interesting things that you learned by taking the geology project?

3. What activities did you enjoy doing? Why?

4. How will knowing about geology help you in other areas (school, home, etc.)?

Did you give an action demonstration about geology? ____yes  _____no
If yes, where did you give the demonstration and what was the title?

Signature of 4-H member ___________________________ Date __________

I have reviewed this record and made comments about the individual’s progress and project completion.
Signature of Helper/Leader __________________________ Date __________
Appendix A. Shapes to Cut Out

Shape: hexagonal
Example: quartz
Shape: cubic
Example: halite
Shape: tetragonal
Examples: zircon, chalcopyrite, rutile
Shape: triclinic
Examples: feldspar, kaolinite
Shape: orthorhombic
Examples: barite, celestite, aragonite
Shape: monoclinic
Examples: gypsum, mica, hornblende
Rock

Is the rock made of silt, sand, fossils, or pebbles cemented together OR does it fizz when acid is poured on it?

Are the minerals melted together?

Can you see minerals in the rock?

How are the minerals in the rock distributed?

Is the rock either glassy or frothy (has small holes)?

Is the rock made up of strong, flat sheets that look as though they will split off into slate-like pieces?

ID: Igneous or Metamorphic

ID: Igneous or Sedimentary

ID: Igneous

ID: Metamorphic

ID: Metamorphic

ID: Metamorphic

ID: Metamorphic

ID: Sedimentary
## Geology 1

Types of rocks you might exhibit
(Cut these out for your display.)

<table>
<thead>
<tr>
<th>Basalt</th>
<th>Dolomite</th>
<th>Obsidian</th>
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<tbody>
<tr>
<td>Bituminous</td>
<td>Gabbro</td>
<td>Pumice</td>
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<tr>
<td>Shale</td>
<td>Gneiss</td>
<td>Quartzite</td>
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<tr>
<td>Breccia</td>
<td>Granite</td>
<td>Sandstone</td>
</tr>
<tr>
<td>Chert</td>
<td>Gypsum</td>
<td>Schist</td>
</tr>
<tr>
<td>Clay</td>
<td>Limestone</td>
<td>Scoria</td>
</tr>
<tr>
<td>Coal</td>
<td>Marble</td>
<td>Shale</td>
</tr>
<tr>
<td>Conglomerate</td>
<td>Mudstone</td>
<td>Slate</td>
</tr>
<tr>
<td>Diorite</td>
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</table>
# Rock Identification Cards

<table>
<thead>
<tr>
<th>Specimen Name</th>
<th>Date Collected</th>
<th>Location where found (Area* and State)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

*Examples: Red Lodge, Montana; Beartooth Mountains, Wyoming; or Lafayette, Indiana (its native location — not where it was transferred by people). If it is purchased, record its native location.

Copy this page.
Mineral Identification Cards

Specimen Name ____________________________
Date Collected _____________________________
Location  where found (Area* and State) _______
___________________________________________
Hardness _________  Luster ______________

Specimen Name ____________________________
Date Collected _____________________________
Location  where found (Area* and State) _______
___________________________________________
Hardness _________  Luster ______________

Specimen Name ____________________________
Date Collected _____________________________
Location  where found (Area* and State) _______
___________________________________________
Hardness _________  Luster ______________

Specimen Name ____________________________
Date Collected _____________________________
Location  where found (Area* and State) _______
___________________________________________
Hardness _________  Luster ______________

Specimen Name ____________________________
Date Collected _____________________________
Location  where found (Area* and State) _______
___________________________________________
Hardness _________  Luster ______________

Specimen Name ____________________________
Date Collected _____________________________
Location  where found (Area* and State) _______
___________________________________________
Hardness _________  Luster ______________

Specimen Name ____________________________
Date Collected _____________________________
Location  where found (Area* and State) _______
___________________________________________
Hardness _________  Luster ______________

Specimen Name ____________________________
Date Collected _____________________________
Location  where found (Area* and State) _______
___________________________________________
Hardness _________  Luster ______________

*Examples: Red Lodge, Montana; Beartooth Mountains, Wyoming; or Lafayette, Indiana (its native location — not where it was transferred by people). If it is purchased, record its native location.
Fossil Identification Cards

Specimen Name ____________________________
Date Collected _____________________________
Location where found (Area* and State) _______
___________________________________________
Era/Period found in: _________________________

Specimen Name ____________________________
Date Collected _____________________________
Location where found (Area* and State) _______
___________________________________________
Era/Period found in: _________________________

Specimen Name ____________________________
Date Collected _____________________________
Location where found (Area* and State) _______
___________________________________________
Era/Period found in: _________________________

Specimen Name ____________________________
Date Collected _____________________________
Location where found (Area* and State) _______
___________________________________________
Era/Period found in: _________________________

*Examples: Red Lodge, Montana; Beartooth Mountains, Wyoming; or Lafayette, Indiana (its native location—not where it was transferred by people). If it is purchased, record its native location.
Copy this page.
Glossary

**Bedrock** – the solid rock that lies underneath weathered rock materials, soils, or tills

**Coal** – black sedimentary rock commonly mined to burn as fuel

**Coarse grain** – individual particles or grains that are as large as grains of salt or bigger

**Color** – a physical property of rocks, sometimes used for identification

**Condensation** – a process in which water changes from a gas to a liquid

**Crystallization** – the process that forms crystals from fluids or a dispersed state

**Decomposition** – the processes that decay and break up bedrock, by a combination of physically fracturing it or chemical decomposition

**Deposition** – a general term for the accumulation of sediments by either physical or chemical sedimentation

**Erosion** – the downward displacement (due to gravity) of soil and other solids by rain, wind, or ice

**Extrusive rocks** – igneous rocks that are cooled on the earth’s surface, often from lava flows (Extrusive rocks have a fine texture, because they cool too quickly for minerals to grow.)

**Evaporation** – a process in which water changes from a liquid to a gas

**Fizz** – small bubbles made when a drop of dilute acid is used to test a rock containing lime or calcium carbonate

**Fossil** – preserved remains of animal and plant life, and traces of them (for example, dinosaur tracks), found only in sedimentary rocks

**Glacier** – moving sheets of ice that covered part of the world during the ice age (Glaciers still exist on mountain tops and in the Arctic and Antarctic.)

**Gravel** – loose, uncemented rock materials made of large (greater than 0.08 inch), worn, rounded pebbles with smaller grains between

**Ground water** – all water that is found below the surface of the Earth

**Hardness** – the resistance of a mineral to scratching
Igneous rocks – rocks formed from magma, when melted rock materials from deep beneath the Earth’s surface cool, crystallize, and become solid

Infiltration – a process in which water enters into the soil

Intrusive rocks – igneous rocks that are cooled deep within the Earth (Intrusive rocks have a coarse texture because individual minerals have time to grow.)

Magma – melted rock that cools as it pushes towards the surface of the Earth and forms new rocks

Metamorphic rocks – rocks formed when other kinds of rocks change due to high pressures and temperatures; rocks formed by heat and pressure

Mineral – a naturally occurring, inorganic substance with a definite chemical composition and crystalline structure

Molten – heated enough to melt

Precipitation – water that falls from the sky as snow, rain, hail, or sleet

Rock – a solid made up of one or more minerals or earth materials

Sand – a sediment made of very small grains (0.0025 to 0.08 inches)

Sedimentary rocks – rocks that formed from particles that were eroded from previous rocks, transported, deposited, and lithified (compacted under pressure to gradually become solid rock) (This also includes rock that accumulated as chemical precipitates — a solid formed from a chemical reaction.)

Soil – the upper layer of the Earth in which plants grow

Structure – a physical property that describes how a rock is formed

Surface water – examples include lakes, streams, rivers, and oceans

Texture – a physical property describing the size and arrangement of the minerals in a rock (Texture is often used to classify rocks.)

Transpiration – a process where water is released from plants to keep them cool

Volcano – an opening in the Earth’s surface that allows magma to escape from below the surface

Weathering – the breakdown of rocks in response to contact with water, air, or living matter
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Purdue Extension 4-H-985

REvised 8/07