PURDUE UNIVERSITY | Extension - 4-H Youth Development

4-H-985

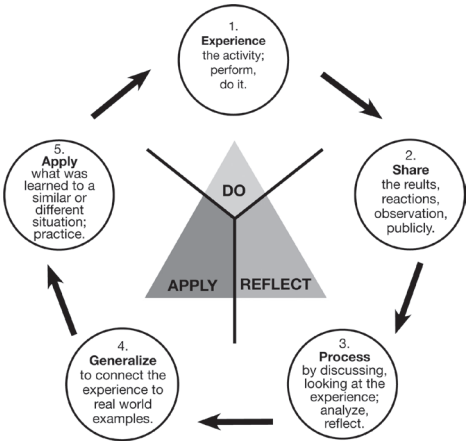
4-H GEOLOGY

Level 1

Geology Division 1

Note to Parents and Leaders

The 4-H Geology project helps youth learn about rocks, fossils, and minerals. Geology offers many exciting experiences, from collecting interesting rocks, fossils, and minerals to cutting and polishing gems. Youth are encouraged to take responsibility for their geology collections. They can enhance their learning by consulting resources on the Internet, at school, at the library, and especially on the Indiana Geological Survey Web site (http://igs.indiana.edu/) for help with identification and background information.



Experiential learning distinguishes 4-H activities from many other 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 the 4-H'ers 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.

Purpose

Geology I encourages youth to

- develop inquiring minds and the habit of asking questions and searching for answers;
- collect and study rocks, minerals, and fossils;
- keep accurate records;
- develop an understanding of and an appreciation of earth science;
- present the results of their work to others in an effective manner;
- ask questions and search for answers;
- make decisions based upon experiences, new knowledge, facts, and observations.

Geology, Division I, is for youth interested in broadening their knowledge about rocks, fossils, and/or minerals. This project offers the opportunity to

- collect and study rocks, fossils and/or minerals;
- go on field trips and collect and study geology specimens;
- teach others about rocks, minerals, or fossils by doing an Action Demonstration.

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4-H Geology Project Division I

Youth in the Division I Geology project will

- collect and learn about individual rocks, fossils, and minerals (in later divisions, you will have the opportunity to enlarge your collection and learn more about geology);
- go on field trips to collect rock and mineral specimens and learn how to identify them;
- become acquainted with resource materials available to study geology.

Introduction

Whenever you find a rock that attracts your attention, the first questions that come to mind may be, “Why is this rock different from the others? What is it?” The publication *Let’s Look at Rocks* can help you answer these questions. It contains a great deal of information about collecting and identifying rocks. See the References section for ordering information.

Among the rocks that you will collect, some will be easy for you to identify as a first division geologist. You may want to save others for later years when your skill and knowledge have increased. You should keep a special place in your collection for “unknown” rocks that you will want to study later or take to an expert for identification.

In this manual we will introduce you to some of the rocks in your collection. **Note: not all of the rocks that might be in your collection are discussed in the manual.** Therefore, you will need to consult your *Let’s Look at Rocks* booklet, encyclopedias, the Internet, and other references to identify your rocks.

How Rocks and Minerals are Formed

Rocks are the essential building materials from which the earth is constructed. They are a mixture of minerals present in varying amounts. *Minerals* are the individual substances that combine to make rocks. A single mineral may also be considered a rock, if it exists in a large enough amount. Pure limestone is an example of a rock that contains only one mineral — calcite.

The many rocks that constitute the earth’s crust are the result of geological processes acting through the ages, building up some rocks and breaking down others. The normal rock cycle is described in the following pages.

The Rock Cycle

Fire Rocks (Igneous)

The first stage in the rock cycle is the formation of igneous rocks. Igneous rocks were in a heated molten state before they cooled and hardened into rock. This is the reason they are sometimes called fire rocks. Hot liquid called *magma* (magma in Greek means dough) is pushing toward the surface of the earth and forming new rocks, just as it has been since the beginning of time. During its travels, the liquid rock fills in cracks, forces its way between the layers of other rocks, and occupies 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 may blow 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.

These actions give igneous rocks specific physical characteristics. The key to identifying rocks and minerals is to become acquainted with their physical characteristics or *properties*.

Types of Igneous Rocks

Igneous rocks are classified by their texture (size and arrangement of the minerals), mineral content, or origin. Based on texture, igneous rocks are classified as one of two types: intrusive rocks or extrusive rocks. Intrusive and extrusive rocks differ chiefly because they have cooled at different rates. This gives them some of their physical properties.

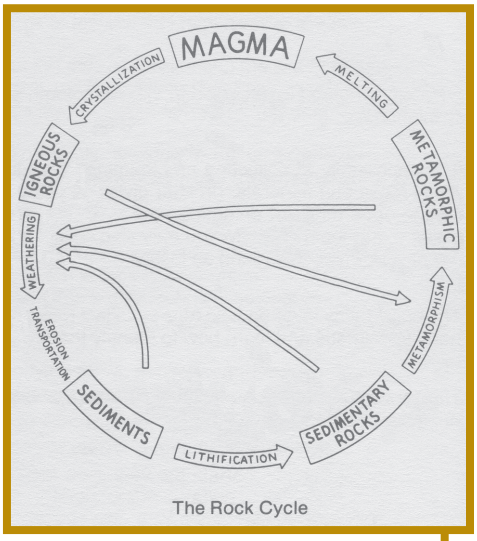

Figure 1. Rock Cycle

If the magmas cool deep within the surface of the earth, they form *"intrusive rocks"* (under the surface) and develop a typical structure that may later be exposed by erosion. Intrusive rocks, losing heat slowly while beneath the earth's surface, acquire a coarse texture because individual minerals have time to grow to a considerable size. Granite is an example of this type of rock.

Magmas reaching the earth's surface form *"extrusive rocks"* such as lava flows. Extrusive rocks, cooling rapidly on the surface of the earth, give an opportunity for grains to get started, but each is small because they cool before they have time to develop. Basalt is an example of this rock. In extreme cases of sudden chilling, no minerals are visible at all and we may have obsidian, a smooth, glassy rock.

A porous texture, especially characteristic of pumice, results from the escape of gas as it bubbles into the air from cooling lava. The cooling of magma also causes cavities or pockets, which may later be filled in with crystals. Cracks, or joints, the result of contraction as magma cools and crystallizes, often cut igneous rocks. Lava flows exhibit remarkable vertical column like jointed blocks.

Layered Rocks (Sedimentary)

The next step in the rock cycle is the formation of sedimentary rocks. Once igneous rocks 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.

First, water attacks them. Rain pours down the mountains and washes away loose chunks and small particles on top. 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 rubbing rocks together, until even the hard pebbles of quartz are ground to sand.

As time passes, great quantities of igneous rock wear away. A rushing flood of water carries sand and clay down to quieter lakes and oceans. 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. Those lower layers of mud, sand, and clay begin to harden into layers of rock. Scientists call rocks formed in this manner sedimentary rocks.

Two types of sedimentary rocks can be formed. In one, the original material was dissolved in water, and the resulting rock is composed of crystallized minerals. In the other, the original material moved as undissolved fragments, which results in a sedimentary rock made of a collection of mineral and rock fragments.

Properties of Sedimentary Rocks

One distinctive property of most sedimentary rock is its *stratification*, which refers to the layers or beds in which it is deposited.

Another distinctive property of some sedimentary rocks is the presence of foreign lumps or nodules, called *concretions*.

Preserved remains of animal and plant life, called *fossils*, are found only in sedimentary rocks. These remains provide the key to unlocking a fascinating portion of the earth's history.

Joints are abundant in sedimentary rocks and are caused by shrinkage resulting from drying and from minor bending of rock layers.

Common Sedimentary Rocks

Shale typically contains quartz, feldspar, and clay minerals. It breaks apart along bedding planes. Shale is usually brown, gray, or black and is one of the most common of the sedimentary rocks. It is a source of clay and is used in ceramic or brick manufacturing. This rock was formed from very small fragments. Shale may be quite fossiliferous (full of fossils).

Sandstone is formed by the action of wind, water, and ice on older rocks. It consists mainly of grains of quartz cemented by silica, lime, or iron oxide. Silica

cement may produce hard, durable sandstone. Lime and iron oxide are not so resistant. Sandstone may range from coarse, as in conglomerates, to fine as in sandy shales. It is used for building stones, glass manufacturing, and monuments. Sandstone may contain a few poorly preserved fossils.

Limestone is mostly the mineral calcite with traces of clay, dolomite, and quartz. Most commonly it varies in color from bluish white to blue gray to almost black. Limestone is a relatively soft but dense rock. It is quarried for chemical, metallurgical, and agricultural lime; building materials; and highway construction. Limestone may be quite fossiliferous. In fact, some limestone is composed almost entirely of fossils or fossil fragments.

Coal is a plant material that has been partly decomposed by bacteria and chemical action, and then compressed. The effects of compression and heat determine whether bituminous or anthracite coal forms. Anthracite is the result of higher pressures and temperatures and is found in mountainous areas. If pressure and temperature increase, graphite begins to form from anthracite. Coal is often used for fuel, and a large amount is used to make steam in electrical generating plants.

Conglomerate is another distinctive sedimentary rock with pebble-sized, rounded pieces cemented together.

Breccia is similar to a conglomerate, except the pieces are sharp rather than rounded.

Changed Rocks (Metamorphic)

The formation of metamorphic rock brings us to the final stage of the rock cycle. You have seen mountains in pictures or while vacationing. Perhaps you have noticed how distorted the rocks are as a result of the crumpling of the earth's surface. In some cases, igneous rocks form as a result of the pressures and high temperature that accompany mountain building. In other cases, the rocks may not melt but are changed by the heat and pressure. Such changed rocks are called metamorphic rocks.

What happens to rocks when they are changed into metamorphic rocks? A rock such as shale may just become denser, forming a slate in which there are no mineral changes. Rocks such as limestone may recrystallize. That is, under high pressures and temperatures the calcite may reform into larger calcite crystals, resulting in marble. In many cases, however, the conditions completely change the mineral make-up of a rock, just short of melting the rock. The new rock usually bears no resemblance to the original rock. Examples of this kind of metamorphic rock are schist and gneiss (pronounced "nice") which have large amounts of the minerals mica, quartz, and feldspar.

Additional pressure and heat sets the stage for a molten stage and another cycle, should conditions permit. Refer to the rock cycle picture (Figure 1) to see that metamorphic rocks may decompose and "short circuit" the cycle to the sediment side. The same is true for the sedimentary rocks. This shows that all kinds of rocks can break down to form sediments.

Properties of Rocks

There are certain features or properties that can be used to classify (identify) rocks. The first step is to classify your rocks according to origin and the way they were formed. Use the classifications igneous, sedimentary, and metamorphic as described above. After that, you'll need to look at properties listed below to help you identify your rock.

Texture

The size, shape, and pattern of the mineral grains in a rock are included in the term "texture." Nothing indicates better than its texture the conditions under which the rock was formed. If the rock is igneous, the texture tells whether it is intrusive or extrusive. If sedimentary, it tells whether it is an accumulation of particles, as shale and sandstone, or a precipitate, as some limestone. If metamorphic, it tells what changes the rock has undergone, but not necessarily what the original rock may have been.

One of the most significant things about rock texture is whether you can see the individual particles with the unaided eye, and whether separate minerals are large enough to be recognized, as in typical granite. Some rocks, such as shale and lava, have mineral fragments and grains too small to be seen without a lens or microscope.

Layering or Banded

Many rocks appear layered or banded. This may be caused by successive deposits of sediment, may show the repeated flows of lava, or may be a streaked effect caused by cooling magma. It may be proof of metamorphism, which squeezes and stretches the minerals until they take on a ribboned or banded appearance, as in gneiss. Until you are able to recognize the origin of the unknown rock, you can at least determine if it can be split into layers using a prospector's pick or hammer. This experiment classifies the rock as either cleavable into layers, or not cleavable into layers.

Color

Color is not a reliable guide to the classification of rocks except when you work with fine-textured igneous rocks. This is because many minerals may compose one rock, each with quite a different color. However, when the mineral grains are small, a rock may present an over all color easy to describe and compare. For this reason, colors of rocks are included in your guide to classification.

Acid Test Reaction

The carbonate rocks, such as limestone and marble, will fizz (effervesce) when touched with weak hydrochloric acid, because they give off carbon dioxide gas. Gouge the rock with a knife blade to produce a powder before testing. The powder dissolves and fizzes more rapidly than rock.

Pieces of igneous rocks have veins of calcite in them. Sedimentary rocks may have similar veins. To be sure these do not fool you, make sure the rock fizzes over its entire surface by checking multiple places on the rock.