Creek Rocks

Adapted from: An original Creek Connections Activity, 2003. Creek Connections, Box E, Allegheny College, Meadville, PA 16335. http://creekconnections.allegheny.edu

Grade Level: Intermediate

Duration: 2 class periods. More if students are not familiar with rock identification.

Setting: Classroom, stream site

Summary: Collect, classify, and identify rocks collected from a stream site.

Objectives: Students will research and identify the types of rocks that are in our streams, how the rocks got there, whether they are new to the stream based on their texture and shape.

Vocabulary: They are bold in the background text.

Related Module Resources:
- Grain size sorting charts

Materials (Included in Module):
- Geological maps of PA - various (Binder)
- Hand lenses (Box 1)
- Rock sample collections (Box 1)
- Washington School Rock Collections and Charts (Box 1)
- Books - Rock ID, field guides (Box 2)
- Common Rocks and Minerals of PA photocopy (Binder)

Additional Materials (NOT Included in Module):
- Other rock identification guides, textbooks, etc

ACADEMIC STANDARDS: SCIENCE & TECHNOLOGY

7th Grade
3.5B Recognize earth resources and how they affect everyday life.
- Identify and locate significant earth resources (e.g. rock types, oil, gas, coal deposits) in Pennsylvania
- Explain the processes involved in the formation of oil and coal in Pennsylvania

10th Grade
3.5A Relate earth features and processes that change the earth.
- Interpret topographic maps to identify and describe significant geologic history/structures in Pennsylvania.
- Evaluate and interpret geologic history using geologic maps.
- Describe and identify major types of rocks and minerals.

12th Grade
3.5A Analyze and evaluate earth features and processes that change the earth.
- Apply knowledge of geophysical processes to explain the formation and degradation of earth structures (e.g. mineral deposition, cave formations, soil composition

BACKGROUND:

This activity is best completed after students are familiar with rock identification or should be part of your rock identification unit. This activity does not actually cover the process of rock identification; that should be part of any traditional earth science course. This activity can be used as an extension to that unit/set of lessons.

Everyone that has ever stood in a creek has picked up a few smooth rocks, rubbed their thumb over a pebble, or tried to pick out an odd colored rock out of all the brown ones. The rocks that are found in a waterway can reveal the geological history of the area, whether the rocks are new to the creek or if they have been there for many years.

Rocks are classified as sedimentary, metamorphic, or igneous depending on how they formed. Rocks go through a process called the **rock cycle** (*see-included poster*). Sedimentary rocks are formed from muds and sands which settled out of bodies of water and were later compressed and hardened into rocks. A sedimentary rock may undergo heat and pressure to form a metamorphic rock; an original rock's minerals are changed in form and appearance. Igneous rocks

are formed from the cooling and solidification of hot solutions called from below the earth's surface.

The building blocks of rocks are minerals. There are about 3,000 minerals all together and only 300 in Pennsylvania. The simplest minerals are graphite (pencil lead) and diamond; they contain only one chemical element. Other examples are gold, silver, copper, and sulfur. Some minerals are compounds of other elements such as halite (NaCl); it is composed of sodium and chlorine. Minerals are classified according to their chemical composition and they can be identified by their physical properties. Some of these properties are color, luster (shiny, dull, and glassy), shape, specific gravity, hardness, and streak.

Through the rock cycle minerals come together to form rocks. Geologic Map #7 of Pennsylvania from the DCNR shows that sedimentary rocks dominate the landscape of Pennsylvania. The only rocks near the surface in Pennsylvania that are not sedimentary are the rocks labeled "Jurassic and Triassic", "Lower Paleozoic", and "Precambrian" on the map. These are some of the older rocks found in Pennsylvania.

Sedimentary rocks are formed from older rocks that have been exposed to rain, snow, heat, cold, ice, wind, plants, and creatures. The disintegration and decomposition of rock at or near the surface of the Earth is called **weathering**. There are two types of weathering, mechanical and chemical. **Mechanical weathering** is the physical breaking up of rock into smaller pieces. Frost wedging (*water works its way into cracks in the rock and when the water freezes it expands and breaks the rock*), unloading (*expansion and breaking due to a great reduction in pressure when overlying rock is eroded away*), thermal expansion (*weakening of rock as the result of expansion and contraction*), and biological activity are physical processes that break rocks into smaller pieces. **Chemical weathering** alters the chemical makeup of a rock. Water is the most important agent of chemical weathering. Oxygen that is dissolved in water will oxidize iron-rich minerals and carbon dioxide dissolved in water forms carbonic acid, which chemically alters the rock. The rate of weathering depends on three things. First, the size of the particles, smaller particles weather faster than large particles. Second, the minerals that make up the rock will determine how resistant the rock is to weathering. Calcite dissolves easily in mildly acidic solutions making it less resistant to weathering. Third, climatic factors, especially temperature and moisture influence weathering.

A product of the weathering of rocks is sediment. **Sediment** has two sources; either from **detrital material** or from **soluble material**. Detrital material originates and is transported as solid particles from mechanical and chemical weathering. Only chemical weathering produces soluble material. These sediments are **lithified** (converting sediments into solid rock) into solid rock through two processes; **compaction** and **cementation**. Compaction occurs when the weight of overlying materials compresses the deeper sediments. Cementation occurs when soluble cementing materials, such as calcite and iron oxide, fill in open spaces in rocks and join the particles together. After sediments have been lithified they are now classified as a sedimentary rock.

There are two main groups of sedimentary rocks, detrital or chemical, depending upon the **parent material** (origin of the sediment). All detrital rocks have a **clastic texture,** fragments and particles of rock that are cemented and compacted together. Particle size determines the classification of detrital rock. Examples of detrital rocks are shale (silt & clay sized particles), sandstone, and conglomerate (rounded, gravel-size particles).

Substrate changes from headwaters to the mouth of the stream. At the headwaters of a stream the sediment grains and rocks are very **immature**. The grains are poorly sorted; they vary in size from large boulders to silt size grains and the grains have sharp, jagged edges. This is often because they are new to the creek, having just fallen in, eroded into the creek, or broken away from the land. There has not been enough time for the water to wear away the sharp edges.

Rocks that have been in a stream for a long time are well-rounded, smooth, and sometimes pebble-like. Rocks can also be broken down into smaller sediments. **Mature sediments** have a well-rounded shape, very fine particle size (1/16 - 1/8 mm), and the sediments are well-sorted (uniform size of sediments). A stream sorts the particles it carries by depositing them in order of size, the heaviest are deposited first and the lighter sediments are carried to the mouth of the stream. The further particles travel the more mature and better sorted they become. (*Refer to the grain size sorting charts included in the module for grain sizes, sorting and shape comparisons.*)

Coal is a sedimentary rock that forms from plant remains such as wood, bark, and leaves. The plants that formed the coal in Pennsylvania lived in a warm swampy environment about 300 million years ago. When the plants died they accumulated in the swamps to form peat. The peat was eventually buried deeply enough to undergo heat and pressure to form a rock. Most of the coal found in Pennsylvania is soft coal or **bituminous coal**. Hard coal or **anthracite** is mined in eastern Pennsylvania. Anthracite was subjected to deeper burial and higher temperatures than bituminous coal.

Chemical sedimentary rocks can originate through two processes. **Inorganic processes**, such as evaporation and chemical activity produce halite (salt), limestone, and dolostone. **Organic processes** of water-dwelling organisms produce sediments of biochemical origin. Coral reefs, coquina and chalk are all formed by marine organisms.

Sedimentary rocks can also provide clues to the past environment in which the rocks formed. Sedimentary rocks may contain fossils or other physical structures that indicate the environment where they formed. Sedimentary rocks are deposited in horizontal layers of rock called **strata** or **beds**. The layers are not always horizontal; this is called **cross bedding**. Most often cross-bedding is found in sand dunes, river deltas, and some stream channel deposits. Graded bedding may occur with in a single layer of rock. Through rapid deposition coarser sediments are on the bottom and fine sediments are on the top. This is typical of rapid deposition by water containing sediments of various sizes. **Ripple marks** are small waves of sand that develop on the surface of a sediment layer from moving water or air. **Mud cracks** indicate that the sediment was alternately wet and dry; they are usually associated with shallow lakes and desert basins. **Fossils** are the remains or traces

of prehistoric life. Knowing the types of life forms found in the rocks not only tells us about the environment in which the rock was deposited but they can also help us determine the **relative age** (whether the rock is older or younger than another, no exact age is determined) of the rock.

When rocks are exposed to even higher temperatures and pressure the minerals in a rock can transform into completely different minerals. Through this process **metamorphic** rocks are formed. A common feature of metamorphic rocks is the arrangement of minerals in parallel bands; this is called **foliation**. The environment that the rock formed in is indicated by the presence of minerals that form only at certain ranges of temperatures and pressure. If the temperature gets too high some minerals may be destroyed and others form in their place. If the temperature and pressure does not get high enough some minerals will not form at all.

There are three types of metamorphism. The first type is **contact metamorphism** in which rock is altered by the intense heat of a nearby body of molten rock. An example of a contact metamorphic rock is hornfels, a fine-grained rock that is formed from shale that underwent great heat and pressure. **Hydrothermal metamorphism** is related to contact metamorphism; hot solutions or gases percolate through fractures in rocks causing changes in the chemistry and mineralogy of the surrounding rock. Examples are skarn and serpentinite. The third type of metamorphism is **regional metamorphism**. It involves rocks over a large area that has been dramatically transformed by a major event such as deep burial or mountain building. Regional metamorphism may also extend to great depths within the earth's crust and takes place over a long time span. Important Pennsylvania rocks of this type include slate, schist, gneiss, and marble. Schist is the most common metamorphic rock in the state. All metamorphic rocks native to PA are found in Southeast PA. Metamorphic rocks might be found in a stream in Western PA, if the rocks were brought down from the North by glaciers and deposited as till in Pennsylvania. It is important to realize that recent glaciers did not cover the entire state though, only portions of the northern part of the commonwealth.

Igneous rocks form when **magma** cools and solidifies. **Extrusive** igneous rocks result when lava cools at the surface. When magma cools and solidifies at depth **intrusive** igneous rocks are formed. When magma cools slowly large crystals form and when magma cools rapidly the rock has a glassy appearance with no visible crystals. Igneous rocks are classified by their texture and mineral composition. The texture of an igneous rock is broken down into three classifications. **Aphanitic** texture the grains are too small to see with the unaided eye. **Phaneritic** texture refers to igneous rocks with intergrown crystals that are approximately equal in size and large enough to see with the unaided eye. Glassy texture is known as **porphyritic**. The mineral composition of an igneous rock is determined by the chemical composition of the parent material, magma. Minerals with higher melting points crystallize before minerals with lower melting points.

Igneous rocks can be found in Pennsylvania, mostly in the mountains and eastern part of the state. You might also find igneous rocks in waterways because they were brought down with the glaciers, left as glacial till, and streams can flow through the till. Granite,

a common igneous rock, is not as abundant in Pennsylvania as it is in other states. Diabase or "traprock" or "ironstone" can be found in Southeast PA. Rhyolite, basalt, and andesite are fine-grained volcanic rocks that can be found in the Lancaster area of the state

OVERVIEW: Students will collect rocks from their stream or various streams, review pre-collected rock samples from streams, and classify and identify them. Students will study the source of the rocks, use geologic maps, and study the differences in rocks from different stream locations and different types of streams.

PROCEDURE:

This activity is best completed after students are familiar with rock identification or should be part of your rock identification unit. This activity does not actually cover the process of rock identification; that should be part of any traditional earth science course. This activity can be used as an extension to that unit/set of lessons.

Pre-Stream visit:

1. Using the Pennsylvania geology maps (Geologic Map of PA, Surficial Materials of PA, Physciographic Provinces of PA, Limestone and Dolomite Distribution in PA) and/or other resources, have students predict what types of rocks they might find in their creek.

2. Ask students how they think the rocks have gotten into the stream. List natural ways and unnatural ways (ex. *erosion of human impacted land).*

Stream visit Rock Collection

1. Have students collect a variety of SMALL rocks from the stream site. Students can enter the stream to collect rocks from the bottom or simply stay along the shore and find rocks.

2. Their goal should be to collect a diversity of rocks. Have groups collect their own rocks or contribute rocks to one set. You can ask them to collect a certain number or rocks.

Identification of Collected Rocks

1. Using books, guides, and handouts supplied in the module or using existing classroom resources and textbooks, students should work to classify rocks into groups (sedimentary, metamorphic, igneous). Many of the rocks in Western PA streams will be sedimentary.

2. Students should identify their rocks. Rocks can be numbered, labeled, and placed into a collection. You may elect students to write descriptions and identification characteristics for all of their rocks or some of them.

Identification of Rocks from Supplied Rock Collections

1. There are a number of rock collections provided in the module.
    a. 10 bags for rocks and associated sorting charts from the Washington School Collection.
    b. A 12 rock set from Wards
    c. A tupperware container of rocks collected from French Creek between Saegertown and Meadville.
    d. A tupperware container of rocks collected from a small stream southeast of Meadville.
    e. A tupperware container of rocks collected from a small headwater stream in Pittsburgh (Schenley Park).

2. You can have students identify the rocks from these collections (PLEASE MAKE SURE THEY DO NOT MIX UP or MIX TOGETHER THE SETS/COLLECTIONS). You can also use these sets if you were unable to take students to a stream.

3. For the a) and b) rock sets, you can have students list which of the contained rocks would be found in Pennsylvania, found in Western PA, found in all streams in Northwest PA, found only in small streams in Southwest PA.

4. Students can compare and/or identify the types of rocks found in c) and d) (Northwest PA) to each other and also to e) (from Pittsburgh). There may be some differences because of the effects of glaciers bringing down rocks from the north and leaving them in Northwest PA. Small streams cutting hillsides in Southwest PA will contain only "native" rocks. Pieces of coal can sometimes be found in Southwest PA - not found in Northwest PA. Ask students what types of rocks they might find in the Allegheny River in Pittsburgh? *Even though it is in Southwest PA, the Allegheny River may have some glacial related rocks because it drains out of the Northwest PA.*

Comparison of Old Rocks to Young Rocks in the Creek

1. If not done in other activities, you could have students classify the rocks in the sediment/substrate samples included in the module. Ask students to compare the rocks and come up with explanations on why they are different in shape and texture. Students should predict which of the sample has rocks that a new to the creek (perhaps just eroded in) and which rocks have been in the stream for more time. *See background sections, but jagged, sharp edge rocks that have not been weathered by the stream flow are new to the creek.*

2. Ask students what type of waterways or where they might find waterways that contain "new" rocks.

DISCUSSION:

- What classification of rock (Igneous, metamorphic, or sedimentary) was the most common at your field site? *(most likely it will be sedimentary, but answers may differ depending upon the site visited)*

- Why do you think this rock type was the most common?
- What geologic events may have occurred at your field site? What evidence is there to support this conclusion? *(refer to the Geologic Maps and booklets from the DCNR to support discussion)*
- Why can there be rocks found in a Western Pennsylvania waterway that are not native to Western Pennsylvania? *Glaciers brought them.*
- Was there evidence of weathering at your field site? What type of weathering occurred?
- Had the rocks found at the students' stream site been in the water for a long time or were they new to the creek?

EVALUATION:

- Correct identification of certain rocks.
- Sufficient explanations for discussion questions above.

EXTENSIONS AND MODIFICATIONS:

- Create a mineral collection. There are instructions and tips on pages 753-781 of the National Audubon Society Field Guide to Rocks and Minerals.
- Begin a rock collection. There are instructions and guidelines from the USGS in the module binder.
- Study the rocks in numerous, different types of waterways.

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

Activity version: July 2003