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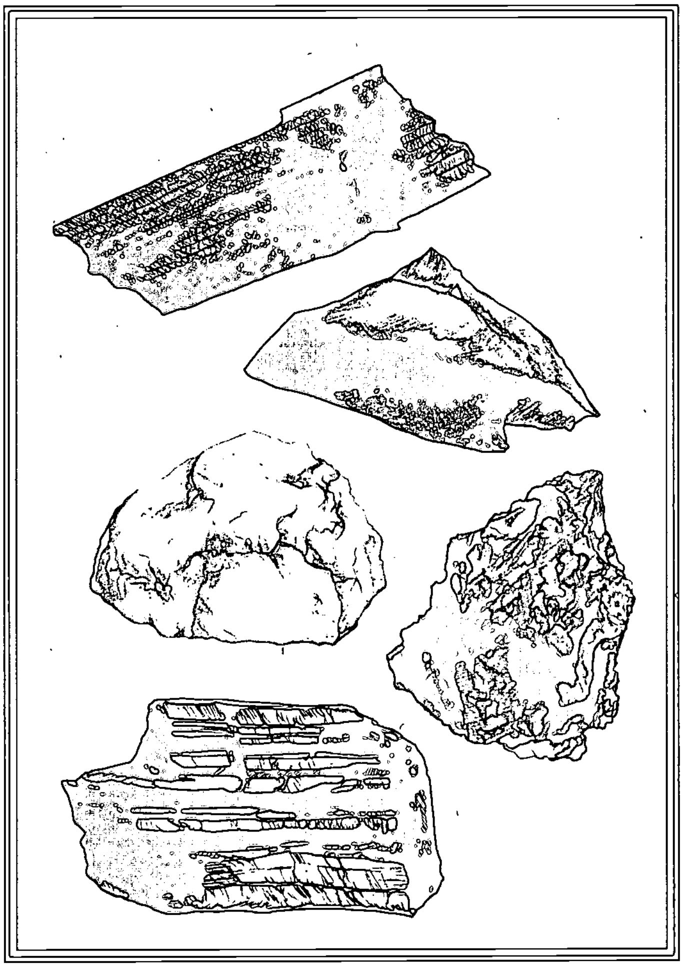
ABSTRACT

This curriculum packet was developed and designed to provide environmental education through a series of hands-on activities for the classroom and the outdoor setting of Morrow Mountain State Park, North Carolina to introduce students to the geology of the Uwharrie Mountains. Designed for grades 5 through 7, the packet meets the established curriculum objectives of the North Carolina Department of Public Instruction. Students are exposed to major concepts such as weathering, erosion, rock cycle, rock types, and geologic processes. The packet is divided into nine sections: (1) introduction to the North Carolina State Parks system, Morrow Mountain State Park, and the activity packet; (2) activity summary and correlation chart showing how each activity correlates with Department of Public Instruction objectives; (3) pre-visit activities on sedimentary, metamorphic, and igneous rock formation; (4) on-site activities on rock types and characteristics of the Uwharrie Mountains; (5) post-visit activities to reinforce and review previous lessons; (6) vocabulary; (7) references; (8) an appendix summarizing the Uwharrie Mountains geology; and (9) a scheduling worksheet, permission form, and program evaluation form. All activities include curriculum objectives for each grade level, descriptions of location, group size, estimated time needed, materials needed, major concepts covered, and activity objectives, as well as background information for the educator, instructions, student information sheets, and worksheets. Most activities also include extensions and assessment tools. (PVD)

OLD AS



THE HILLS

Morrow Mountain State Park

An Environmental Education Learning Experience

Designed for Grades 5-7

"Rocks and clay are part of the Mother. They emerge in various forms, but at some time before, they were smaller particles of great boulders. At a later time they may again become what they once were. Dust."

Leslie Marmon Silko, b. 1948
American Writer

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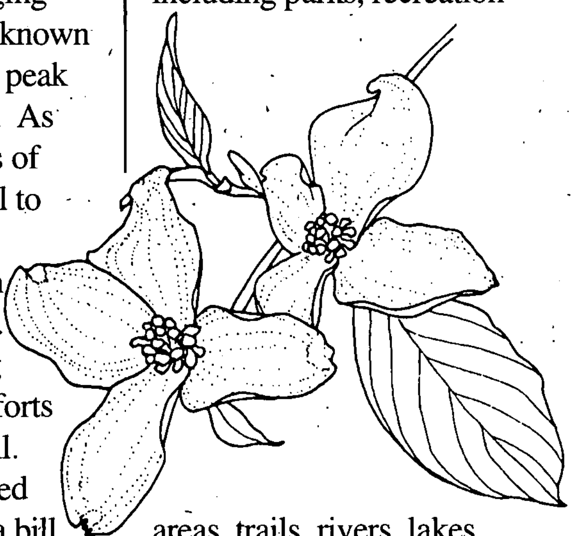
Introduction to the North Carolina State Parks System

Preserving and protecting North Carolina's natural resources is actually a relatively new idea. The seeds of the conservation movement were planted early in the 20th century when citizens were alerted to the devastation of Mount Mitchell. Logging was destroying a well-known landmark - the highest peak east of the Mississippi. As the magnificent forests of this mile-high peak fell to the lumbermen's axe, alarmed citizens began to voice their opinions. Governor Locke Craig joined them in their efforts to save Mount Mitchell. Together they convinced the legislature to pass a bill establishing Mount Mitchell as the first state park.



That was in 1915. The North Carolina State Parks System has now been established for more than three-quarters of a century. What started out as one small plot of public land has grown into 59 properties across the state, including parks, recreation areas, trails, rivers, lakes and natural areas. This vast network of land boasts some of the most beautiful scenery in the world and offers endless recreation opportunities. But our state parks system offers much more than scenery and recreation. Our lands and waters contain unique and valuable archaeological, geological and biological resources that are important parts of our natural heritage.

As one of North Carolina's principal conservation agencies, the Division of Parks and Recreation is responsible for the more than 144,000 acres that make up our state parks system. The Division manages these resources for the safe enjoyment of the public, and protects and preserves them as a part of the heritage we will pass on to generations to come.

An important component of our stewardship of these lands is education. Through our interpretation and environmental education services, the Division of Parks and Recreation strives to offer enlightening programs which lead to an understanding and appreciation of our natural resources. The goal of our environmental education program is to generate an awareness in all individuals which cultivates responsible stewardship of the earth.

For more information contact:

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P.O. Box 27687
Raleigh, NC 27611-7687
919/ 733-PARK
Web ~~e-mail~~: **http://ils.unc.edu/parkproject/ncparks.html**

Introduction to Morrow Mountain State Park

First-time visitors to Morrow Mountain State Park are often surprised to find such mountainous terrain in south-central North Carolina. The Uwharrie Mountains lie on the eastern edge of the Piedmont plateau, forming a barrier of steep hills and ridges between the Coastal Plain and the gently rolling Piedmont.

About 600 million years ago, this area was part of a chain of volcanic islands surrounded by a shallow sea. Layers of volcanic ash, lava and sediment were deposited in this sea. Later, they were deeply buried, folded, tilted on edge and finally exposed at the earth's surface. Today the harder metavolcanic rocks form the mountain peaks, while the softer metasedimentary rocks line many of the stream valleys.

In the 1930's, a local committee began to generate interest in a state park in the area. By 1937, the committee had acquired more than 3,000 acres of land, much of it donated by the citizens of Stanly County.

As a result of their efforts, Morrow Mountain State Park was opened to the public in the summer of 1939. Early development was a cooperative effort of the Civilian Conservation Corps and the Work Projects Administration. Work crews constructed many of the park's facilities, including the stone bathhouse. Today, the park comprises almost 5,000 acres of the Uwharrie landscape.

Morrow Mountain State Park affords the student the opportunity to study basic rock types and the geological processes of mountain building, volcanism, weathering and erosion.

For more information contact:
Morrow Mountain State Park
49104 Morrow Mountain Rd.
Albemarle, NC 28001
(704) 982-4402

Introduction to the Activity Packet for Morrow Mountain State Park

The Environmental Education Learning Experience (EELE), Old as the Hills, was developed to provide environmental education through a series of hands-on activities geared to Morrow Mountain State Park. This activity packet is designed to introduce the student to the geology of the Uwharrie Mountains. It is targeted for the 5th through 7th grades and meets established curriculum objectives of the North Carolina Department of Public Instruction.

There are three types of activities in this packet; pre-visit activities, on-site activities and post-visit activities. On-site activities will be conducted at the park, while pre-visit and post-visit activities are designed for the classroom environment. Pre-visit activities should be introduced prior to the park visit so the students will have the necessary background and vocabulary for the on-site activities. We encourage you to use the post-visit activities to reinforce concepts, skills and vocabulary learned in the pre-visit and on-site activities. These activities may be performed independently or in a series to build upon the students' newly gained knowledge and experiences.

The environmental education learning experience, Old as the Hills, will expose students to the following major concepts:

Weathering
Erosion
Rock cycle
Rock types
Geologic processes

Vocabulary words used throughout this environmental education learning experience appear in **bold type** the first time they are used in an activity. Their definitions are listed in the back of the activity packet. A list of reference materials used in developing the activities follows the vocabulary list. A summary of the geology of the Uwharrie Mountains is also located at the end of this activity packet.

To make these learning experiences on geological processes more effective, we encourage the students to create a notebook of all their activities, drawings and worksheets.

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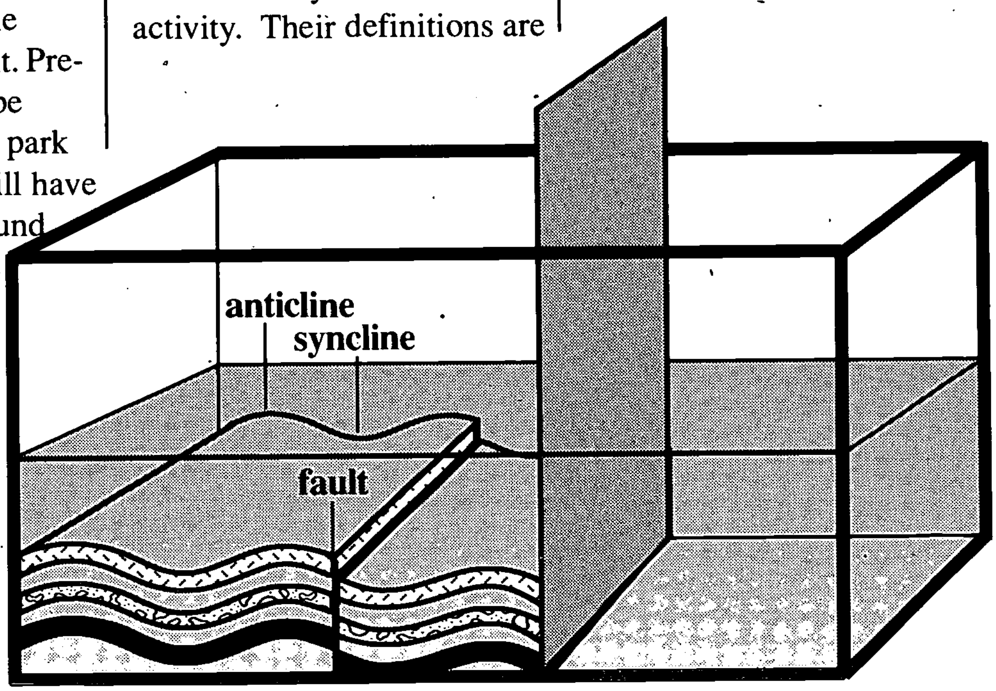


Illustration of Pre-Visit Activity #1– **Layer On Layer.**

Activity Summary

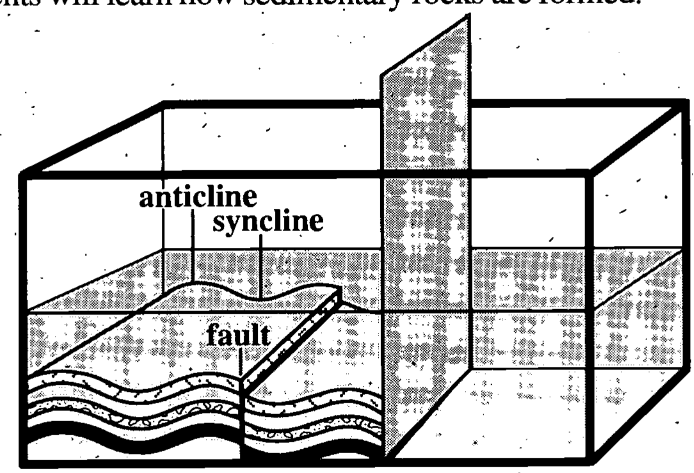
The following outline provides a brief summary of each activity, the major concepts introduced and the objectives met by completion of the activity.

I. Pre-Visit Activities

The pre-visit activities are designed to introduce the student to the different rock types: sedimentary, igneous and metamorphic. Students will also learn how these rocks are formed, how to recognize them and how they erode.

#1 Layer On Layer (page 3.1)

Through layering soils into water, students will learn how sedimentary rocks are formed.

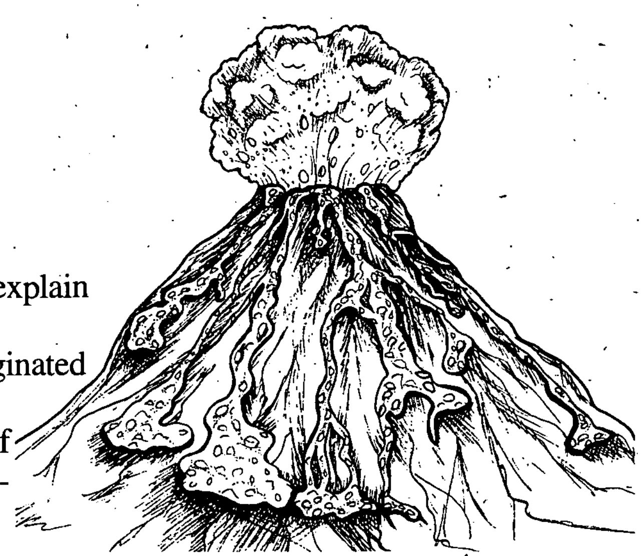


Major Concepts:
- Sedimentary rock formation
- Sedimentation

Objectives:
- Describe how sedimentary rock is formed and list three typical soils that make up sedimentary rock.
- Describe how metamorphic rock is made from sedimentary rock.
- Describe what happens to rock when powerful forces within the earth begin to shift, move and compress sediments.

#2 Cooking, Volcano Style (page 3.2)

Through making peanut brittle, students will learn how igneous rock is formed.



Major Concepts:
- Igneous rock formation
- Lava
- Magma

Objectives:
- Name the two types of igneous rocks and explain how each is formed.
- Name two rocks found at the park that originated from volcanoes.
- Explain how the Uwharries can be made of old volcanic rock, yet are not extinct volcanoes.

#3 Hard Rock Crayola (page 3.3)

Through this activity students will learn how sedimentary, metamorphic and igneous rocks are formed and will be introduced to the rock cycle.

Major Concepts:
- Rock cycle
- Mechanical weathering
- Sedimentary rock formation
- Metamorphic rock formation
- Igneous rock formation

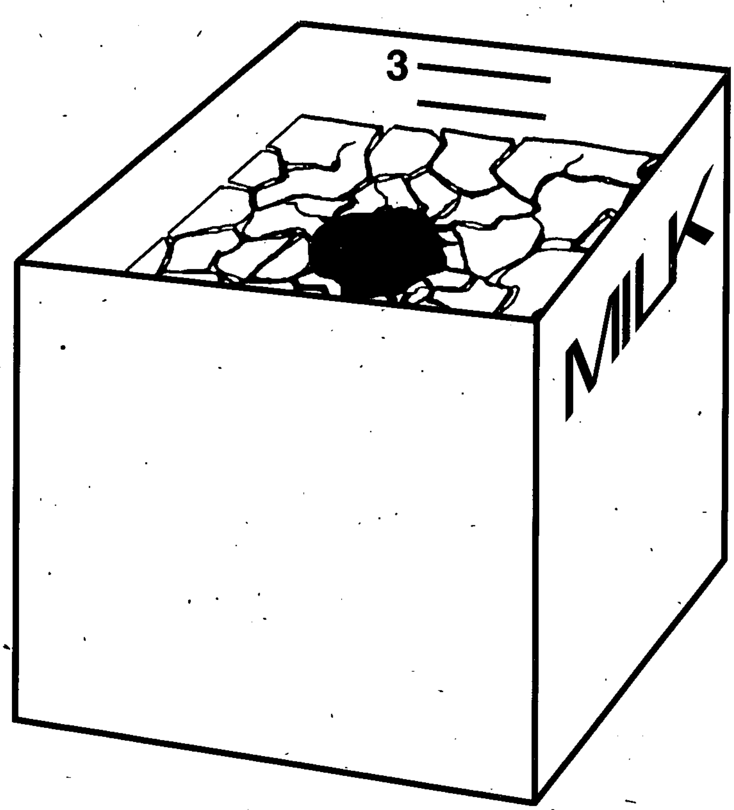
Objectives:
- List the three main rock types.
- Describe how these three rock types are formed.
- Explain the rock cycle.
- Describe four processes by which one rock type changes into another.
- Name two metamorphic rocks found in the park; one should have an igneous origin and the other should have a sedimentary origin.

#4 Cracking Up (page 3.4)

Through this activity, students will learn the importance of freezing water in the breaking down of rocks.

Major Concepts:
- Weathering
- Environmental changes
- Erosion
- Hypothesis testing

Objectives:
- Write and test hypotheses on what happens to water when it freezes.
- State what happens to water when it freezes and how the freezing of water can shape the land.
- Explain how sediments suspended in water or ice shape the land.

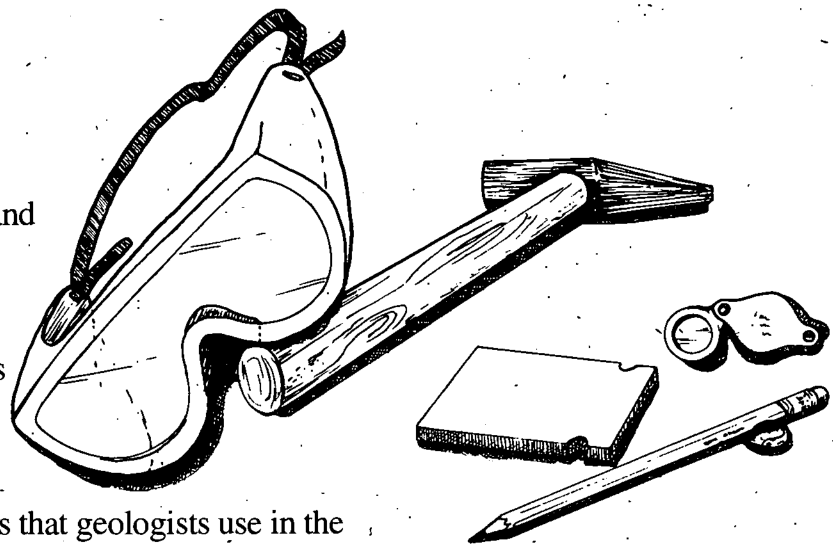


II. On-Site Activities

The on-site activities are designed to familiarize the student with the specific rock types of the Uwharrie Mountains, their characteristics and where they are found in the park. Before coming to the park, students and educators should read the Summary of the Geology of the Uwharrie Mountains in the Appendix.

#1 Rock ID (page 4.1)

Through this activity, students will be able to identify and name the characteristics of five different rocks found in the park.



Major Concepts:
- Rock formation
- Rock characteristics
- Sedimentary, metamorphic and igneous rocks

Objectives:
- Identify three common rocks found at Morrow Mountain State Park and explain their origins.
- List three rock characteristics that geologists use in the identification process.
- Describe how various groups of people have used the rocks and minerals found at the park through time.

#2 Water Over The Rocks (page 4.2)

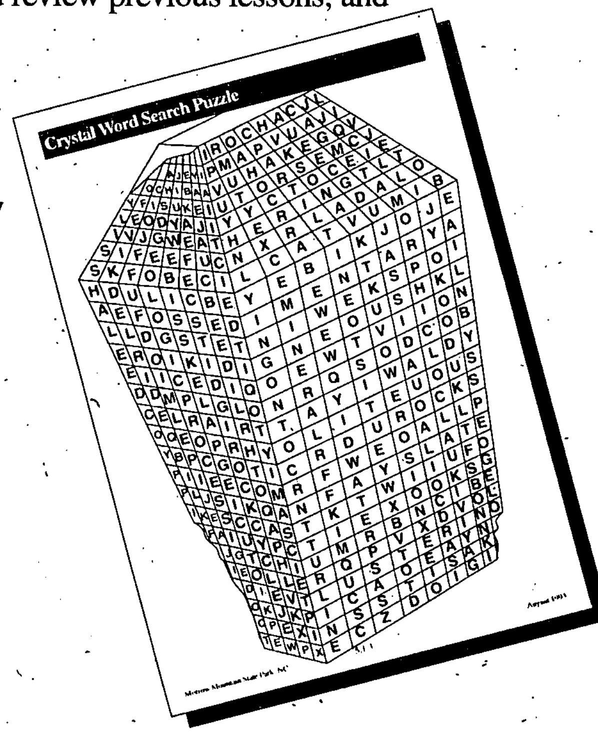
On a geological hike through a quarry located in the park, the students will observe firsthand the effects of geologic processes on the landscape.

Major Concepts:
- Erosion
- Water cycle
- Rock cycle
- Use of stone

Objectives:
- Name one natural and one unnatural thing that have greatly affected the weathering of the rocks in the park.
- Explain how metamorphic rocks are formed and name one common to this area.
- Explain how sedimentary rocks are formed and how they are layered.
- Explain why rocks found in this area are no longer in a horizontal plane.
- Identify two geologic formations found in the quarry.
- Observe and record the effects of moving water on rock surfaces.
- Name the type of stone used for building material in the park and explain why it was used.

III. Post-Visit Activities

The post-visit activities are designed to reinforce and review previous lessons, and to broaden the student's understanding of geology.



#1 What's Your Crystalline Structure? (page 5.1)

This activity will reinforce the geological vocabulary to which the students have been exposed.

Major Concepts:
- Geologic processes
- Geologic cycle
- Vocabulary

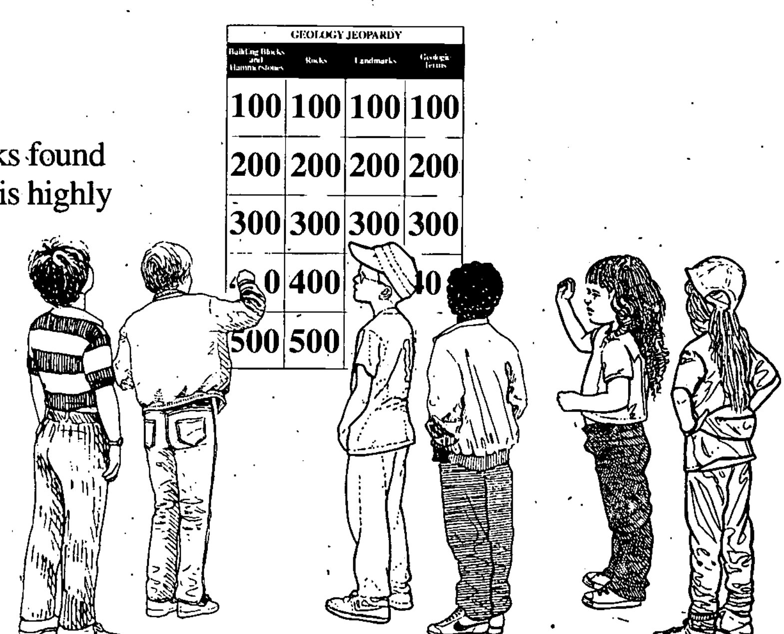
Objectives:
- Name the three basic rock types and explain how they are formed.
- List two geologic processes.
- Describe what a rock is and name two rocks common to this area.

#2 Geology Jeopardy (page 5.2)

Through participation in this geological version of the popular television game show, the important concepts, facts and processes covered in this entire activity packet will be reinforced.

Major Concepts:
- Rock formations
- Landforms
- Rock composition
- Use of native stone

Objectives:
- List the three most common rocks found in the park and state which rock is highly resistant to erosion.
- Explain how sedimentary, metamorphic and igneous rocks are formed.
- Name two local rocks and tell how they have been used by humans in this area.



Correlation Chart

Note to classroom teachers: The following Correlation Chart shows how each activity in this Environmental Education Learning Experience (EELE) correlates with the North Carolina Department of Public Instruction (DPI) objectives in science, mathematics, social studies and English language arts. The activities are listed in the order in which they appear in this EELE. The recommended grade levels are listed along the side of the chart. Notice that only the objective numbers are listed. Use your DPI Teacher Handbook for each subject area to get a complete description of the objectives in that subject area.

Pre-Visit Activity #1: Layer on Layer, p. 3.1.1

Grade	Science	English Lang. Arts	Social Studies	Mathematics
5	2.1, 2.4, 2.7, 2.8, 2.10, 2.13, 2.14, 4.1, 4.3, 5.5	1.1, 1.3, 2.1,2.2,2.3		
6	2.1, 2.4, 2.7, 2.8, 2.10, 2.13, 2.14, 4.1, 4.3, 6.5	1.1, 1.2, 1.3, 2.1, 2.2, 2.3		
7	2.1, 2.4, 2.7, 2.8, 2.10, 2.13, 2.14, 4.1, 4.3	1.1, 1.2, 1.3, 2.1, 2.2, 2.3		
8	2.1, 2.4, 2.7, 2.8 2.10, 2.13, 2.14, 4.1, 4.3, 6.1	1.1, 1.2, 1.3, 2.1, 2.2, 2.3		

Pre-Visit Activity #2: Cooking, Volcano Style, p. 3.2.1

Grade	Science	English Lang. Arts	Social Studies	Mathematics
5	2.1, 2.3, 2.4, 2.5, 2.10, 2.14, 3.1, 4.1, 5.5	1.1, 2.3		
6	2.1, 2.3, 2.4, 2.5 2.10, 2.14, 3.1, 4.1, 6.4, 6.5	1.1, 1.2, 1.3, 2.1		4.1, 4.2
7	2.1, 2.3, 2.4, 2.5, 2.10, 2.14, 3.1, 4.1, 6.1	1.1, 1.2, 1.3, 2.1		4.1, 4.2
8	2.1, 2.3, 2.4, 2.5 2.10, 2.14, 3.1, 4.1, 6.1	1.1, 1.2, 1.3, 2.1		

Correlation Chart

Pre-Visit Activity #3: Hard Rock Crayola, p. 3.3.1

Grade	Science	English Lang. Arts	Social Studies	Mathematics
5	2.1, 2.2, 2.4, 2.6, 2.10, 2.14, 3.1, 4.1, 5.5	1.1, 2.1, 2.2, 2.3		
6	2.1, 2.2, 2.4, 2.6 2.10, 2.14, 3.1, 4.1, 6.5	1.1, 1.2, 1.3, 2.1, 2.2		4.1
7	2.1, 2.2, 2.4, 2.6, 2.10, 2.14, 3.1, 4.1, 6.1	1.1, 1.2, 1.3, 2.1, 2.2		4.1
8	2.1, 2.2, 2.4, 2.6 2.10, 2,14, 3.1, 4.1, 6.1	1.1, 1.2, 1.3, 2.1, 2.2		

Pre-Visit Activity #4: Cracking Up, p. 3.4.1

Grade	Science	English Lang. Arts	Social Studies	Mathematics
5	2.1, 2.4, 2.6, 2.7, 2.10, 2.14, 4.1, 5.5	1.1, 1.2, 1.3, 2.1, 2.2, 2.3		
6	2.1, 2.4, 2.6, 2.7; 2.10, 2.14, 4.1, 6.5	1.1, 1.2, 1.3, 2.1, 2.2		
7	2.1, 2.4, 2.6, 2.7, 2.10, 2.14, 4.1	1.1, 1.2, 1.3, 2.1, 2.2		
8	2.1, 2.4, 2.6, 2.7 2.10, 2.14,	1.1, 1.2, 1.3, 2.1, 2.2		

Correlation Chart

On-Site Activity #1: Rock ID, p. 4.1.1

Grade	Science	English Lang. Arts	Social Studies	Mathematics
5	2.1, 2.2, 2.4, 3.1, 3.3, 4.1, 5.3	1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 4.3	5.1, 5.2 Skill Goal I	
6	2.1, 2.2, 2.4, 3.1, 3.3, 4.1, 6.5	1.1, 1.2, 1.3, 2.1, 2.2		
7	2.1, 2.2, 2.4, 3.1, 3.3, 4.1	1.1, 1.2, 1.3, 2.1, 2.2		
8	2.1, 2.2, 2.4, 3.1, 3.3, 4.1	1.1, 1.2, 1.3, 2.1, 2.2	1.3, 2.2 Skill Goal I	

On-Site Activity #2: Water Over Rocks, p. 4.2.1

Grade	Science	English Lang. Arts	Social Studies	Mathematics
5	2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 3.1, 4.1, 4.3, 5.3, 5.5	1.1, 1.2, 1.3, 2.1, 2.3, 4.3	3.1, 5.1, 5.2 Skill Goal I	
6	2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 3.1, 4.1, 4.3, 6.5	1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1		
7	2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 3.1, 4.1, 4.3	1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1		
8	2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 3.1, 4.1, 4.3, 6.1	1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1	1.3 Skill Goal I	

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Correlation Chart

Post-Visit Activity #1: What's Your Crystalline Structure? p. 5.1.1

Grade	Science	English Lang. Arts	Social Studies	Mathematics
5	2.10, 5.5	1.1		
6	2.10, 6.5	1.1, 1.2, 1.3, 2.1		
7	2.10	1.1, 1.2, 1.3, 2.1		
8	2.10, 6.1	1.1, 1.2, 1.3, 2.1		

Post-Visit Activity #2: Geology Jeopardy, p. 5.2.1

Grade	Science	English Lang. Arts	Social Studies	Mathematics
5	2.10, 5.5	1.1	3.1 Skill Goals I & II	
6	2.10, 6.5	1.1, 1.2, 1.3, 2.1		
7	2.10	1.1, 1.2, 1.3, 2.1		
8	2.10, 6.1	1.1, 1.2, 1.3, 2.1		

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Pre-Visit Activity #1 — Layer on Layer

Curriculum Objectives:

Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: group cooperation
- Science: earth science
- Social Studies: organize and analyze information, draw conclusions, participation

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: group interaction
- Science: earth science
- Social Studies: gather, organize and analyze information, draw conclusions

Grade 7
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: being responsible in a group
- Science: soils
- Social Studies: gather, organize and analyze information, draw conclusions

Location:
Classroom

Group Size:
30 or less

Estimated Time:
One hour

Materials:
Provided by the educator: small aquarium, 2-liter clear plastic soda bottles with the tops cut off (one per group), sand*, clay*, water and leaves
Per student: "Layer on Layer" worksheet, pencil

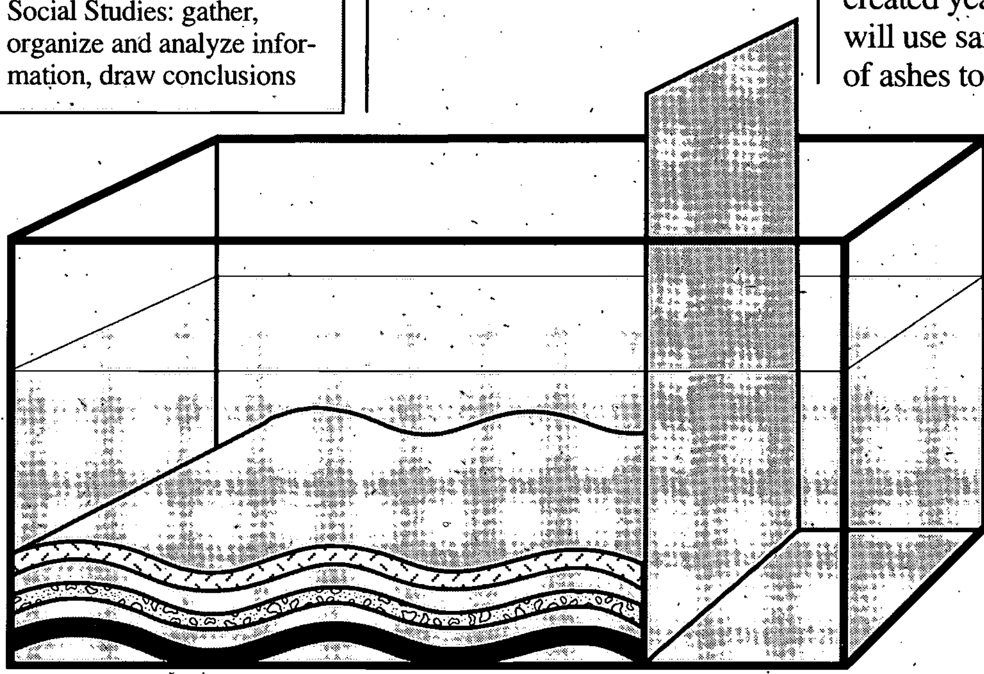
(*Any type of fine material that will settle in water can be used for the sand and the clay. Preferably, the materials should be of several different colors so the layering effect can easily be seen. Powdered paints mixed with plaster of Paris, sand, etc., could be used. Make sure none float.)

Major Concepts:
- Sedimentary rock formation
- Sedimentation

Objectives:
- Describe how sedimentary rock is formed and list three typical soils that make up sedimentary rock.
- Describe how metamorphic rock is made from sedimentary rock.
- Describe what happens to rock when powerful forces within the earth begin to shift, move and compress sediments.

Educator's Information:

During this activity, the students will create their own sedimentary layers in much the same way they were created years ago. The students will use sand and clay instead of ashes to show layering.

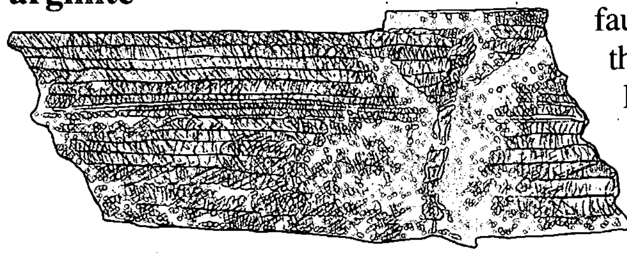


Student's Information:

Sedimentary rock can be formed in a variety of ways. Running water, such as a river, will deposit **sediments** along flood plains and deltas. **Volcanoes** spew out ash which will settle on land or in bodies of water. Under the proper conditions and with enough pressure, these sediments will become sedimentary **rock.** When exposed to greater extremes of heat and pressure, sedimentary rock can become **metamorphic rock**.

Geologists have found evidence deep in the earth that the Uwharrie Mountains were once a flat sea bottom. This tranquil sea was disturbed by powerful forces within the earth that began to cause changes 500 million years ago. The changes caused volcanoes to form, spewing ash and **lava**. For millions of years, ash from these volcanoes fell into the surrounding sea and slowly settled into sediment layers thousands of feet thick. In time, due to the weight of the sea above them and the ever increasing depth of the sediments, the layers of ash turned into soft sedimentary rocks such as **shale** and **mudstone**. Later, with deep burial (perhaps over six miles deep), these soft rocks were metamorphosed, or changed by heat and pressure, into a harder rock called **argillite**. Argillite can be found within the park.

argillite



Some of the argillite has reverted back to a soft, brownish colored rock known as weathered argillite. This has occurred as six miles of earth and rock above the argillite eroded away. This **erosion** greatly lessened the pressure that had been on the argillite and exposed it to **weathering**. Weathered argillite is sometimes mistakenly called shale. Although weathered argillite appears much like shale, shale is a sedimentary rock, whereas the weathered argillite is a slightly metamorphosed rock undergoing **decomposition.**

weathered argillite

After the argillite-forming era, pressure from inside the earth caused much uplifting of the rock layers. These layers are seldom found in a horizontal position, even though that is the way they were formed. Instead they are **folded**, faulted, and tilted to the extent that the layers visible in the park's abandoned quarry are tilted nearly vertical!

Folded rock units have two common forms in this area. The folds, which are basin-like, or bowl-shaped are called **synclines**. The ones that are hill-like or humped are called **anticlines** (see Figure 1).

Sedimentary rock and metamorphosed sedimentary rock are the rock types in which fossils of plants and animals are found. Fossils are formed in a process where plants and animals are surrounded by silt. The organic material is then slowly changed chemically to a rock-type matrix. However, fossils are rarely found in the argillite of this area for several reasons. The rocks are very old (over 500 million years), which means that when these rocks were forming, life was restricted to oceans and rivers. Also, most of these life forms were soft-bodied, so they did not fossilize well. However, against all odds, three fossils have been found in argillite in Stanly County. All three fossils are of an animal called a **pteridinium**.

There are deposits of argillite in Morrow Mountain State Park but, so far, fossils have not been found in them. When you visit the park, look for fossils in the rocks. Both argillite and weathered argillite are easily seen along the creek beds, road cuts and in the abandoned flagstone quarry.

Figure 1

a. Rocks uplifted and folded, so the beds create anticlines and synclines.

b. Rock uplifted and tilted so the beds are at an angle or tilt.

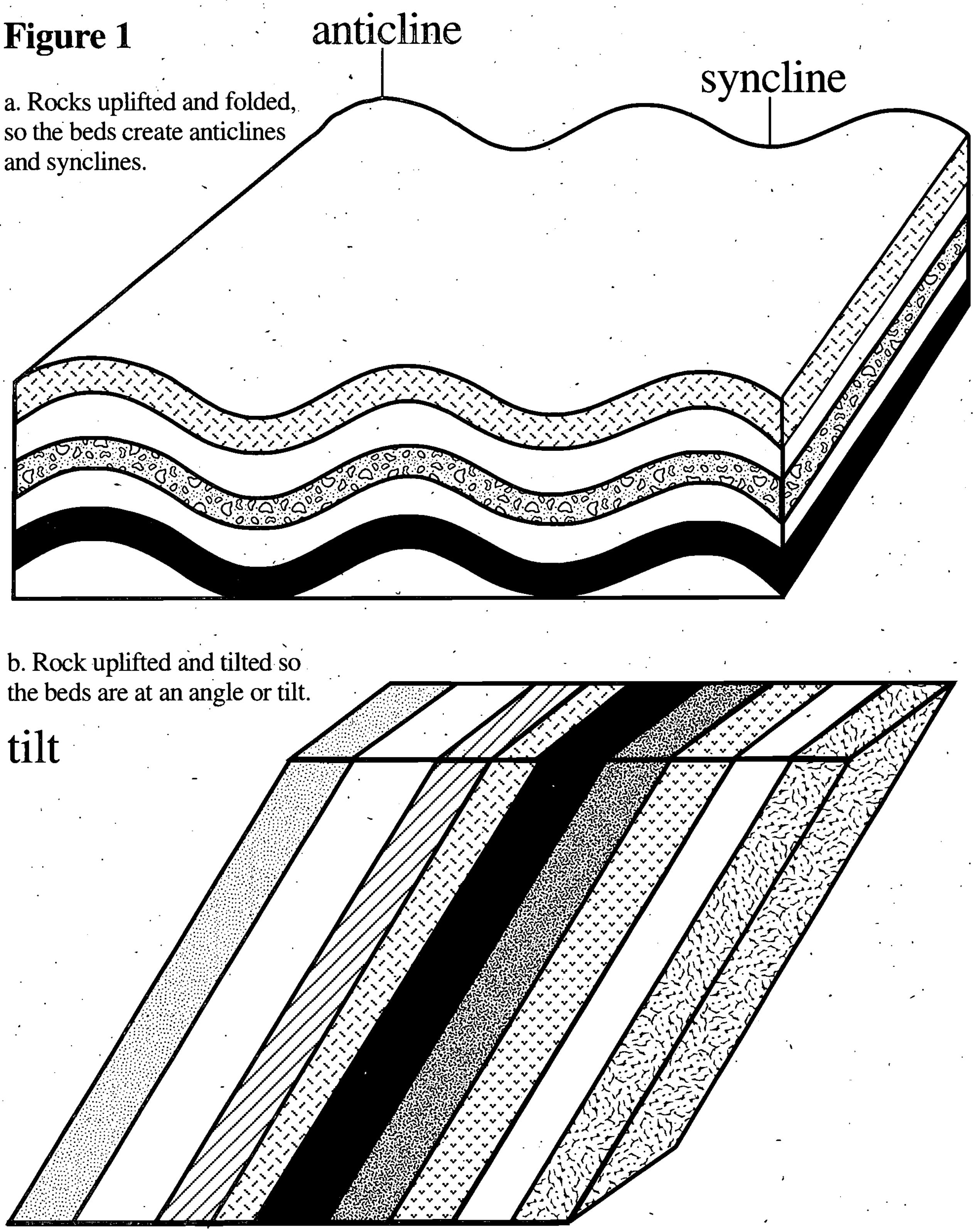
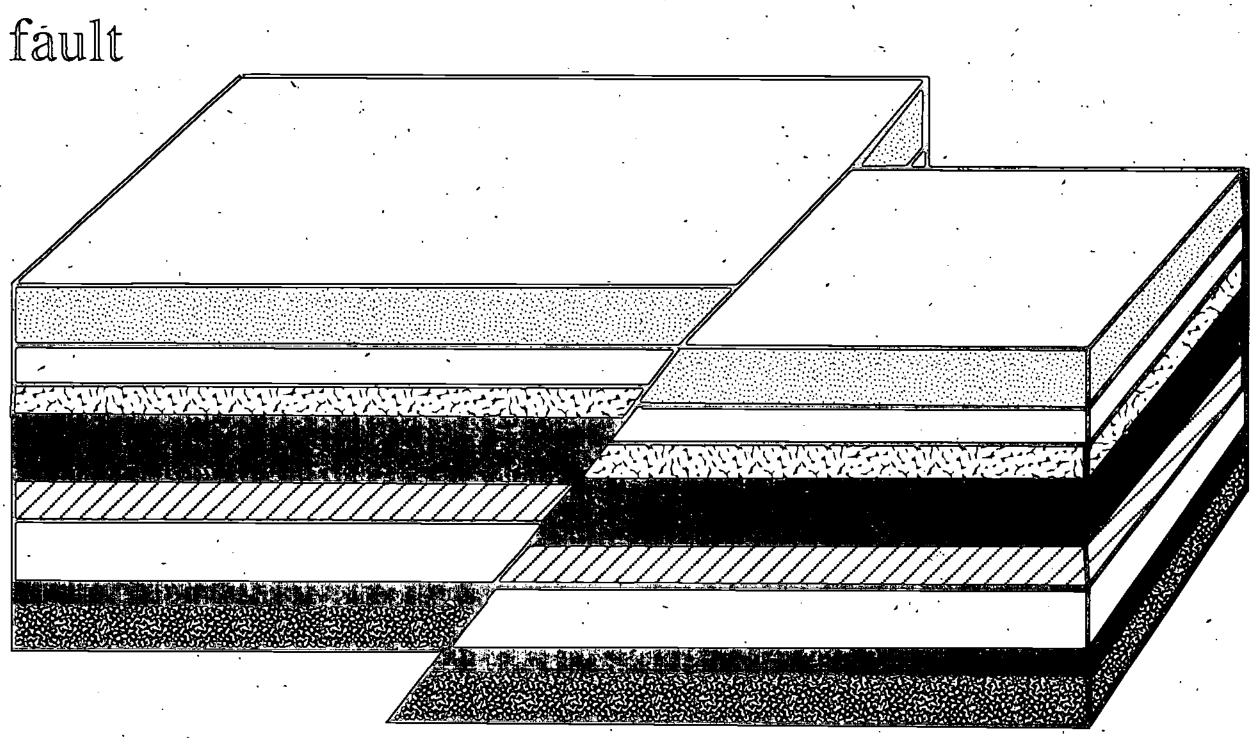
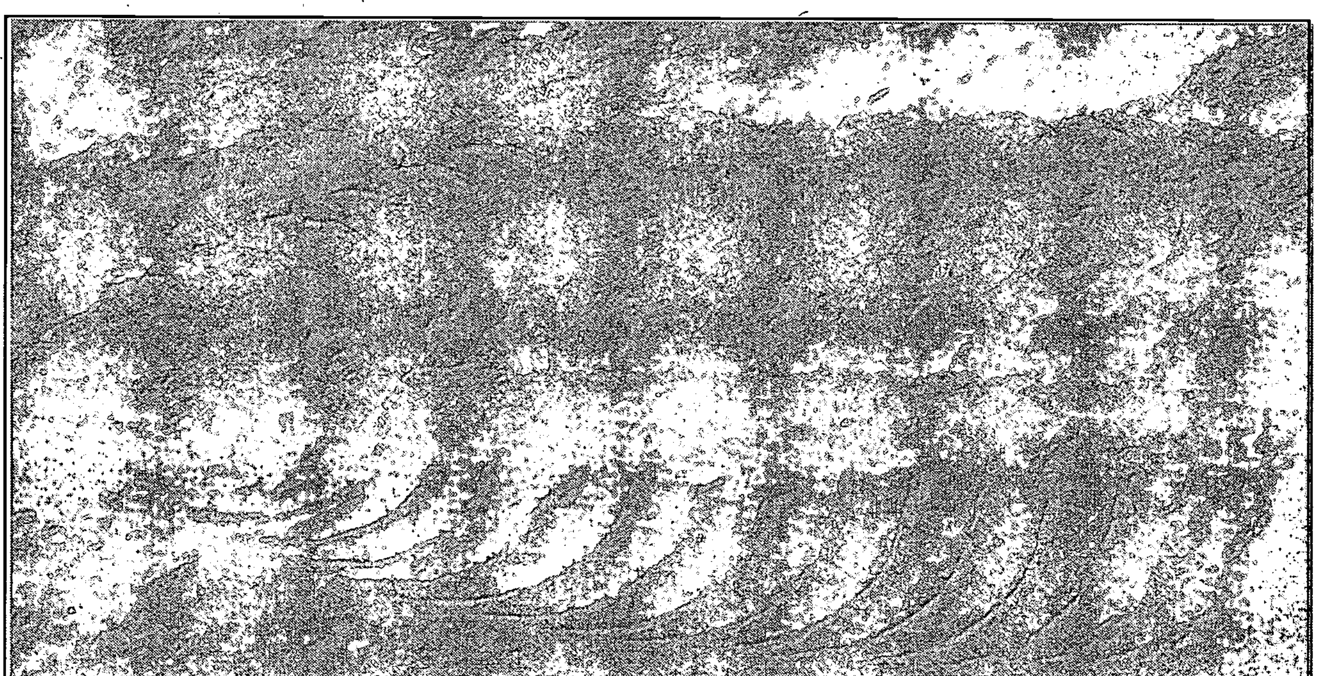


Figure 1 (con't.)

c. Rock shifted and broken so the beds have a fault.





Pteridinium fossil

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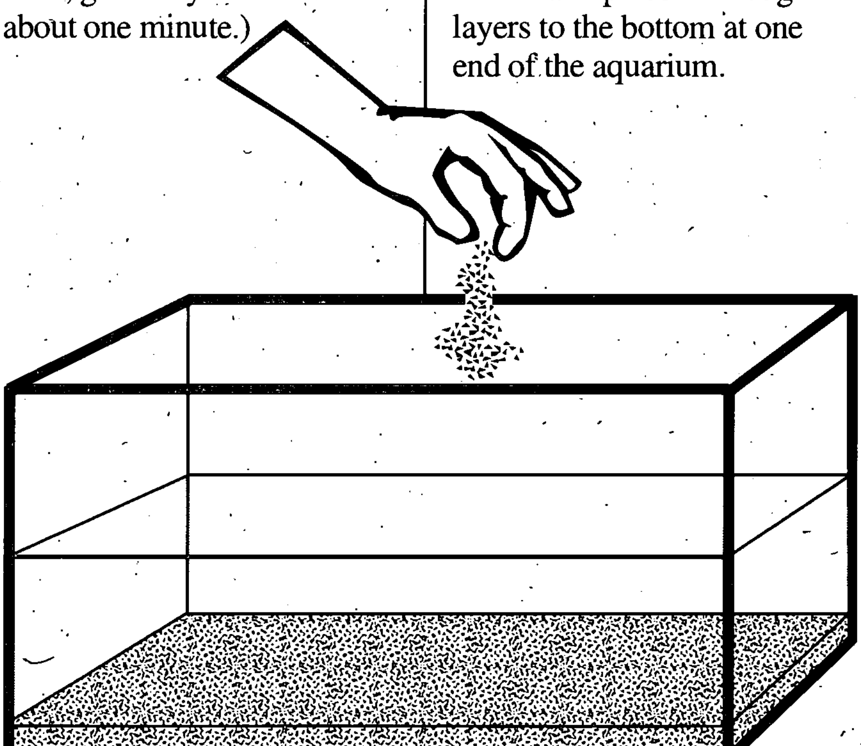
Instructions:

1. Divide the students into groups of four, with a container, water and portions of clay and sand available to each group. Make sure one group of students uses an aquarium, or you can complete the activity in the aquarium as a demonstration.

2. Each group should fill their container about halfway with water.

3. Have the students, very slowly, sprinkle some clay soil (or whatever material they are using) into the container of water to create a complete layer across the bottom.

4. Allow all of the deposited material to settle to the bottom of the container. (Timing will vary depending on the material used; generally it will take about one minute.)



5. After the first layer has settled, add a layer of sand (the second material). Then add one or two leaves to symbolize fossils embedded in the sedimentary rock. Continue making layers, alternating the clay and sand materials, until there are a minimum of eight layers. Remember to let the soil or sand settle for about a minute before adding the next layer.

6. After the final layer has settled, have the students observe the results in their container and make a sketch of the container with its different layers on the worksheet. The students should be sure to include the leaf "fossil" in their sketch.

7. Using the aquarium as a demonstration, take a stiff piece of cardboard or similar device and place it through the layers to the bottom at one end of the aquarium.

8. Ask the students to hypothesize what will happen to the horizontally layered **sediments** as you push the cardboard towards the other end. Have them write down their **hypothesis**.

9. Slowly move the cardboard, pushing and compressing the layers of sand and clay. By doing this you are changing the position of the layered soil that was deposited in the still water of the aquarium. This change in position of the sediments can be used to represent the rocks in the earth that are **folded**, **faulted** and changed by movement in the earth's crust. If you want, take your cardboard out and thrust it through the layers to show breaking and faulting. Have the students draw and write down the results of this compression and label the new geologic formations.

10. Discuss whether their hypotheses were supported or not, and why.

11. Be sure to discuss the following questions:

• How are sedimentary deposits, such as those which formed the rock found at Morrow Mountain State Park, formed naturally?

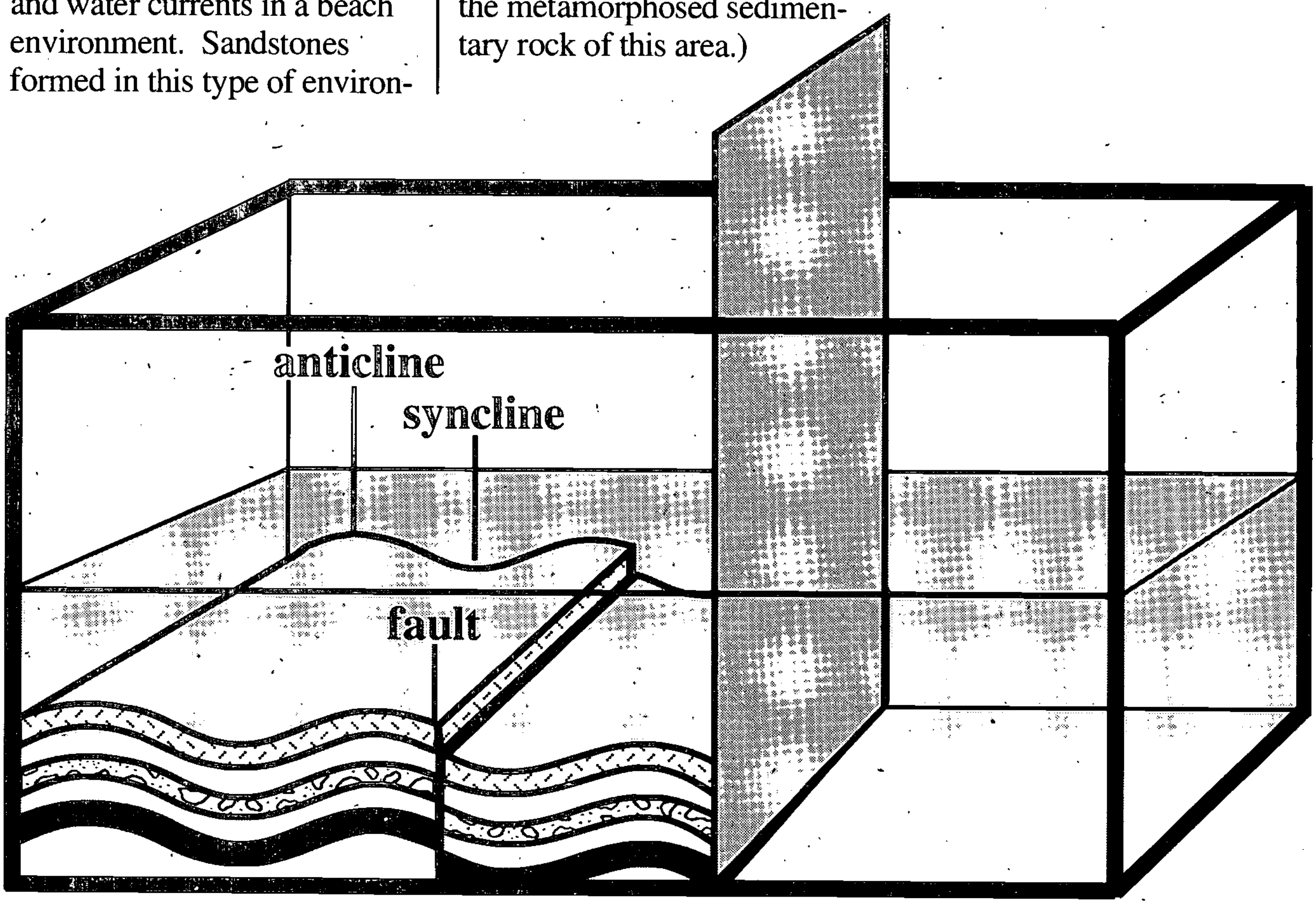
(They can be soils, rock fragments or the ash from **volcanoes** that are carried by wind or water and deposited in a layered fashion which produces results similar to those you can see in this activity. Note: **Sedimentary rock** and **metamorphic rock** that is produced from sedimentary rock often show this layering effect. Some of the metamorphic rocks found at Morrow Mountain State Park started out as volcanic ash that formed layers at the bottom of inland seas.)

- Which layer is the oldest?
  (Usually the bottom layer.)
- Which is the youngest?
  (Usually the top layer.)
- Why are sediments often deposited in parallel layers?
  (Due to gravity and the even distribution of sediments in still water.)
- Can the soil be layered on a slope?
  (Not usually; however, sand can be layered on a slope as it is moved around by wind and water currents in a beach environment. Sandstones formed in this type of environment frequently show cross-bedding, where layers are oriented at an angle, one to another.)
- Vertically?
  (No.)
- If the layers are tilted before they set up, what would happen?
  (They would get jumbled and not show layers clearly.)
- What happens when they're tilted after they set up?
  (They fold and fault. This should corroborate that the "uplift" and movement that occurred in the Uwharrie Mountains happened after the sedimentary rock was deposited.)
- What do the leaves represent?
  (Fossils, that are rare in nature but have been found in the metamorphosed sedimentary rock of this area.)

Suggested Extension:

1. The making of a multi-layer cake is also a way of showing layers. You could explain that the cake batter changes from its wet stage, by a process of time and heat, into solid layers.

2. The making of jello in layers can also be done to show layers. (Both the layered cake and "jellology" activities are available in the park's files.)



1. Draw the newly formed "sedimentary" rock, with fossil.

2. What will happen to the horizontally layered sediments when pressed from the side?

____

____

____

3. What actually happened?

____

____

____

4. Draw the compressed "sedimentary" rock. Label on your drawing the geologic formations created by this process.

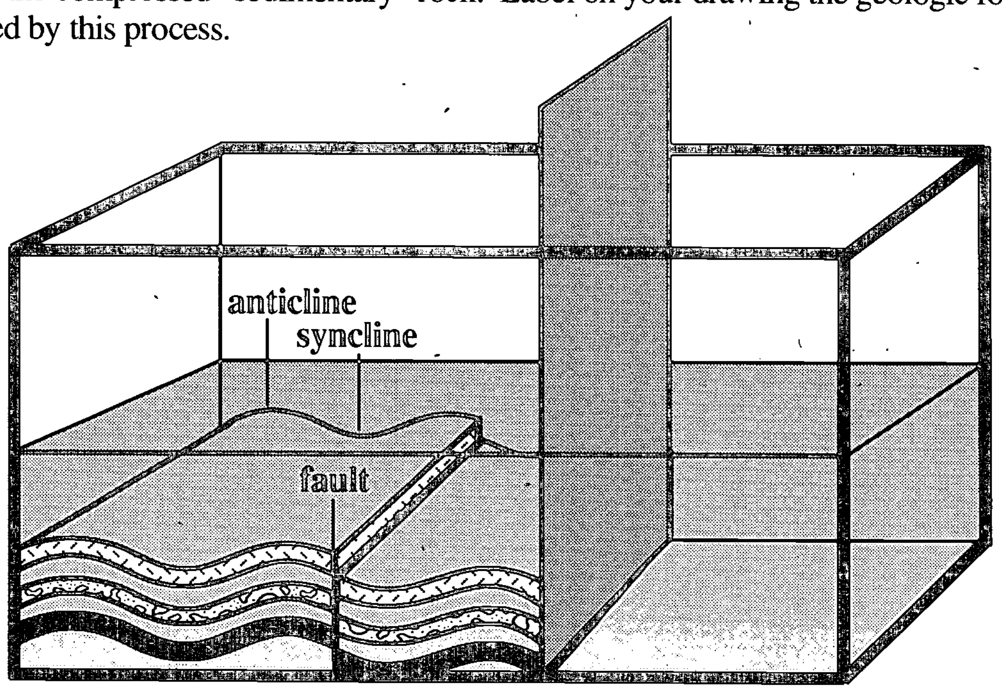
Answer Sheet for Pre-Visit Activity #1 Layer on Layer

1. Draw the newly formed "sedimentary" rock, with fossil.

2. What will happen to the horizontally layered sediments when pressed from the side?
(ANSWER: They will be compressed together to form folds; the basin-like or bowl shaped ones are called synclines; the hill-like or humped ones ore called anti-clines.).

3. What actually happened?

4. Draw the compressed "sedimentary" rock. Label on your drawing the geologic formations created by this process.



Pre-Visit Activity #2 Cooking, Volcano Style

Curriculum Objectives:

Grade 5
- Communication Skills: listening, reading and viewing comprehension
- Guidance: group interaction
- Healthful Living: school safety
- Science: earth science, environment
- Mathematics: measurement
- Social Studies: gather, organize, and analyze information, draw conclusions, cooperation

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: group interaction
- Healthful Living: recreational and home safety
- Mathematics: measurement
- Science: earth science
- Social Studies: gather, organize and analyze information, draw conclusions

Grade 7
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: group cooperation
- Mathematics: measurement
- Social Studies: gather, organize and analyze information, draw conclusions

Location:
Classroom

Group Size:
30 students; one adult supervisor for every ten students is suggested, one adult per five students is preferred, especially for students in the lower grades

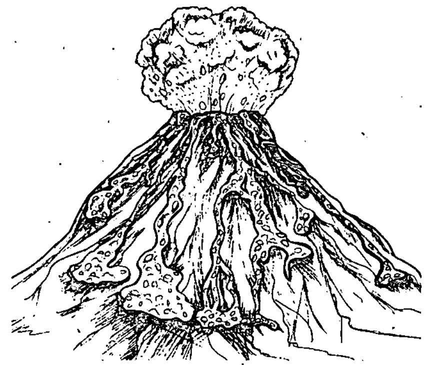
Estimated Time: 1 hour

Materials:
Provided by the educator:
One per group: hot plate, cookie sheet, candy thermometer, measuring cup, measuring spoons, spatula, 1 cup light corn syrup, 2 cups sugar, 1 cup water, 2 cups raw peanuts, 1/4 teaspoon baking soda, 1/4 teaspoon salt, 1 teaspoon butter or margarine plus enough extra to grease the cookie sheet, 1 heavy medium-sized skillet

Special Considerations:
Caution should be used as the hot plate and peanut brittle will reach temperatures of over 290 degrees Fahrenheit.

Major Concepts:
- Igneous rock formation
- Lava
- Magma

Objectives:
- Name the two types of igneous rocks and explain how each is formed.
- Name two rocks found in the park that originated from volcanoes.
- Explain how the Uwharrie Mountains can be made of volcanic rocks, yet are not extinct volcanoes.



Educator's Information:

Through the making of peanut brittle, this activity shows how heating and cooling changes the structure of **rocks**. Just as the sugar starts off as a solid and is changed by heat into a liquid, **magma** is solid rock that has been melted below the earth's surface. When it reaches the earth's surface it is called **lava**. Peanut brittle compares to lava in many ways.

- They both flow very easily in their liquid state.
- Lava will flow over and around rocks just as the "brittle" will surround the peanuts in this activity. Rocks that are surrounded by lava but retain their integrity and are not melted are called **xenoliths**. In this activity the peanuts represent xenoliths.
- Both the "brittle" and lava change from a liquid to a solid state very quickly.
- The heating and melting of the "ingredients" of both peanut brittle and rocks causes changes in them, chemically and physically.

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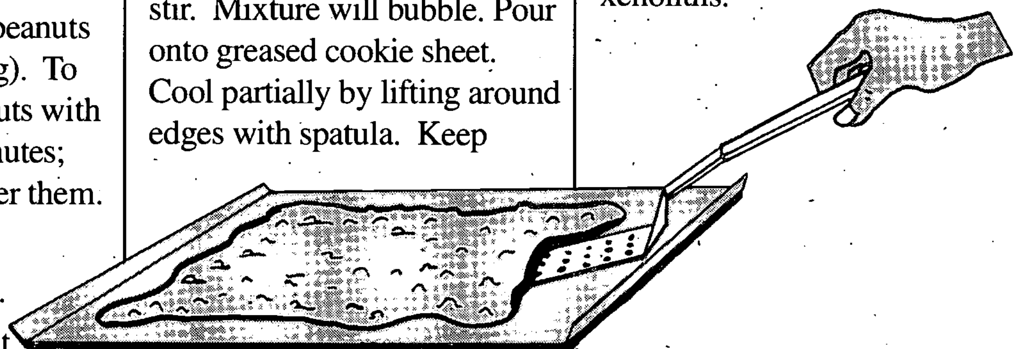
Instructions:

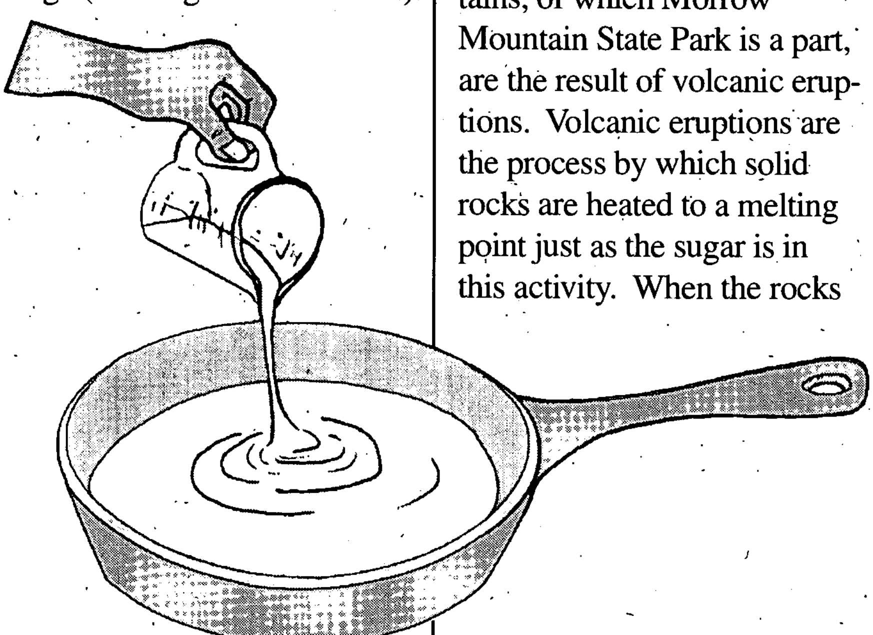
1. Read the following instructions to the students:

a. Blanch 2 cups unroasted peanuts (raw Spanish peanuts will not need blanching). To blanch, cover the peanuts with boiling water for 3 minutes; then run cold water over them. Remove coating.

b. Grease cookie sheet.



c. Combine sugar, light corn syrup and water in a heavy skillet. Cook slowly, using the hot plate, stirring until the sugar dissolves. Check the temperature using the candy thermometer. Remove from heat while testing temperature. Cook to the soft-ball stage (238 degrees Fahrenheit).



d. Add nuts and salt to mixture and continue to heat, checking the temperature using the candy thermometer. Cook to hard-crack stage (290 degrees Fahrenheit), stirring constantly. Remove from heat.

e. Add butter and baking soda; stir. Mixture will bubble. Pour onto greased cookie sheet. Cool partially by lifting around edges with spatula. Keep spatula moving under mixture so it doesn't stick. When firm but still warm, turn over. Break into pieces when cool.

2. Be sure to discuss the following points: The rocks that formed the Uwharrie Mountains, of which Morrow Mountain State Park is a part, are the result of volcanic eruptions. Volcanic eruptions are the process by which solid rocks are heated to a melting point just as the sugar is in this activity. When the rocks cool, the structure of the rocks changes greatly just as the ingredients of this recipe are changed. Molten lava that flows from a volcano sometimes engulfs other rocks but leaves them intact. In this activity, the peanuts represent such rocks which are called xenoliths.

Suggested extensions:

1. Convert the recipe measurements to metric. (See conversion table.)

2. Make brownies. The batter will represent the earth in its molten state 4 1/2 billion years ago. The cooking represents the condensing and heating of the earth as it changed into a more solid sphere. The baked brownies, with their harder crust and softer interior would be the earth with its solid, igneous crust and softer mantle beneath. The bottom of the pan would be the earth's core which is believed to be made of heavy metals such as iron, nickel and lead. However, unlike the solid pan, which reaches a temperature of 290 degrees Fahrenheit, the earth's core is believed to be in a molten state with a temperature of 4,500 degrees Fahrenheit.

Student's Information:

Igneous rock has two forms: intrusive and extrusive. **Intrusive igneous rock** is melted rock, called **magma**, which never reaches the earth's surface but cools slowly within it. **Granite** is a good example of this type of igneous rock. Intrusive rock such as granite becomes exposed on the earth's surface due to **erosion** of the soil and rock above it.

Extrusive igneous rock is formed when magma (molten rock) spews out of a **volcano** onto the earth's surface. In this stage it is called **lava**. Lava on the earth's surface cools much faster than the intrusive form trapped beneath the surface. **Rhyolite** and **basalt** are two examples of extrusive igneous rock.

A slightly altered (metamorphosed) form of these rocks occurs at Morrow Mountain State Park. The rhyolite and basalt found here are **metamorphic rocks**, not true igneous rocks. Geologists use the igneous terms *rhyolite* and *basalt* because the park rocks resemble freshly made basalt and rhyolite from other parts of the world. However, geologists classify the rhyolite and basalt at Morrow Mountain as **metavolcanic rocks** – metamorphic rocks that originated from volcanoes but were later changed by heat and pressure.

If Morrow Mountain has rocks that come from volcanoes, where are the volcanoes today? Long after the volcanoes became extinct, the rhyolite and basalt were deeply buried, then later folded and pushed up. During mountain building, these volcanic rocks were slightly altered, or metamorphosed. After millions of years of erosion removed the overlying rocks, the hard metavolcanic rocks were exposed at the earth's surface. Today, these ancient rocks form the peaks of the Uwharrie Mountains. (The rhyolite is especially resistant to erosion and forms a protective cap over softer rocks below.) Remember – the Uwharries are NOT extinct volcanoes. Rather, they are made of very old metavolcanic rock that is interlayered with other kinds of rock.

Metric Conversion Table For Volume

Symbol	When You Know	Multiply By	To Find	Symbol
tsp	teaspoon	5	milliliter	ml
Tbsp	tablespoon	15	milliliter	ml
fl oz	fluid ounce	30	milliliter	ml
c	cup	0.24	liter	l
pt	pint	0.47	liter	l
qt	quart	0.95	liter	l
gal	gallon	3.8	liter	l

Pre-Visit Activity #3 Hard Rock Crayola

Curriculum Objectives:
Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: group cooperation
- Healthful Living: recreational and school safety
- Science: earth science, environment
- Mathematics: measurement
- Social Studies: organize and analyze information, draw conclusions, participation

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills
- Guidance: group cooperation
- Healthful Living: recreational and home safety
- Mathematics: measurement
- Science: earth science
- Social Studies: gather, organize and analyze information, draw conclusions

Grade 7
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills
- Guidance: group cooperation
- Mathematics: measurement
- Social Studies: gather, organize and analyze information, draw conclusions

Location:
Classroom/science lab

Group Size:
30 students or less, divided into six groups

Estimated Time:
Two to four hours

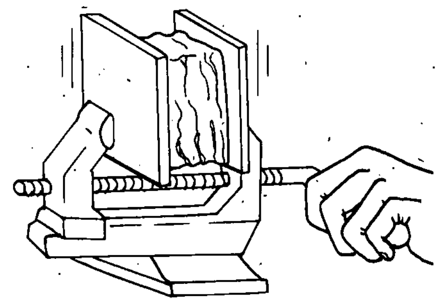
Credits:
This activity has been adapted from "Color Me Metamorphic" by Donald L. Birdd, *The Science Teacher*, April 1990, pp. 21-26.

Materials:
Provided by the educator:
Per group: hot plate, oven mittens, petri dish or finger bowl, aluminum foil (45cm x 45cm), three aluminum foil pie trays, wax paper, a metal or wooden trivet, newspapers
Per student: "Rock Cycle" and "Hard Rock Crayola" worksheets, safety goggles, pencil sharpener or carrot peeler, candles or four to six crayons of the same color (red, green, blue, or yellow), envelope
Per class: one or more vises with two boards (12.5 cm x 20 cm), rock samples

Special Considerations:
Take proper safety precautions. The hot plate and hot crayon wax can cause burns. The vise can pinch/crush fingers.

Major Concepts:
- Rock cycle
- Mechanical weathering
- Sedimentary rock formation
- Metamorphic rock formation
- Igneous rock formation

Objectives:
- List the three main rock types.
- Describe how these three rock types are formed.
- Explain the rock cycle.
- Describe four processes by which one rock type changes into another.
- Name two metamorphic rocks found in the park; one should have an igneous origin and the other should have a sedimentary origin.



Educator's Information:

Many students have a difficult time understanding the abstract concept of the **rock cycle**, the process by which **sedimentary, metamorphic**, and **igneous rocks** are transformed into and from one another. The students can see **rock** examples in the classroom; the difficulty lies in their inability to visualize just how these rock samples were formed. The following activity will give the students the opportunity to "see" the rock cycle through a series of simulations of mechanical **weathering, erosion**, and formation of sedimentary, metamorphic and igneous rock. The activity can be done as one continuous process or can be broken down into five separate parts.

Student's Information:

There are three basic **rock** classifications:

1) **Sedimentary rock** - rock that is composed of particles of sand, clay, or other rocks that were deposited in layers on land or on the bottom of lakes, rivers or oceans. Over time, the extreme pressure from the weight of the layers above pressed the materials into rock. Examples are limestone, sandstone, **shale** and **mudstone**.

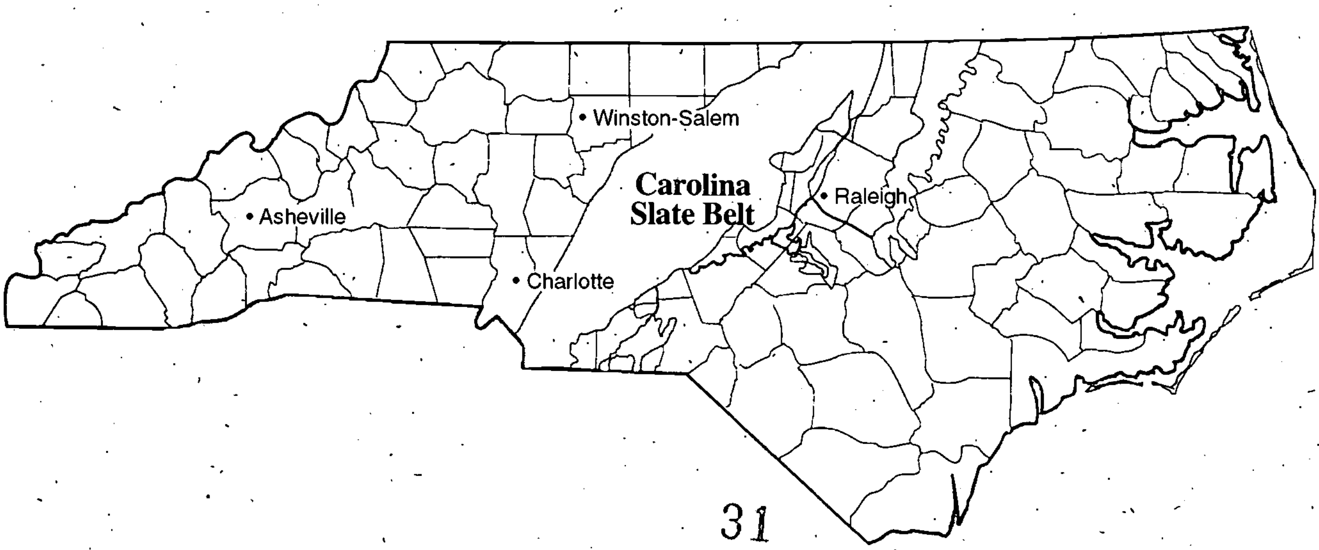
2) **Igneous rock** - rock which is solidified from a molten state. Igneous rocks form deep within the earth in **magma** chambers embedded in solid rock. They may be intrusive or extrusive in nature. Magma which cools and stays within the earth is intrusive. An example of an **intrusive igneous rock** is **granite**. Magma which is spewed out by **volcanoes** is known as **lava** and is extrusive. Examples of **extrusive igneous rocks** are **rhyolite** and **basalt**.

Note: The rhyolite and basalt found at Morrow Mountain State Park are not true igneous rocks because they have been changed by heat and pressure. See metamorphic rock.

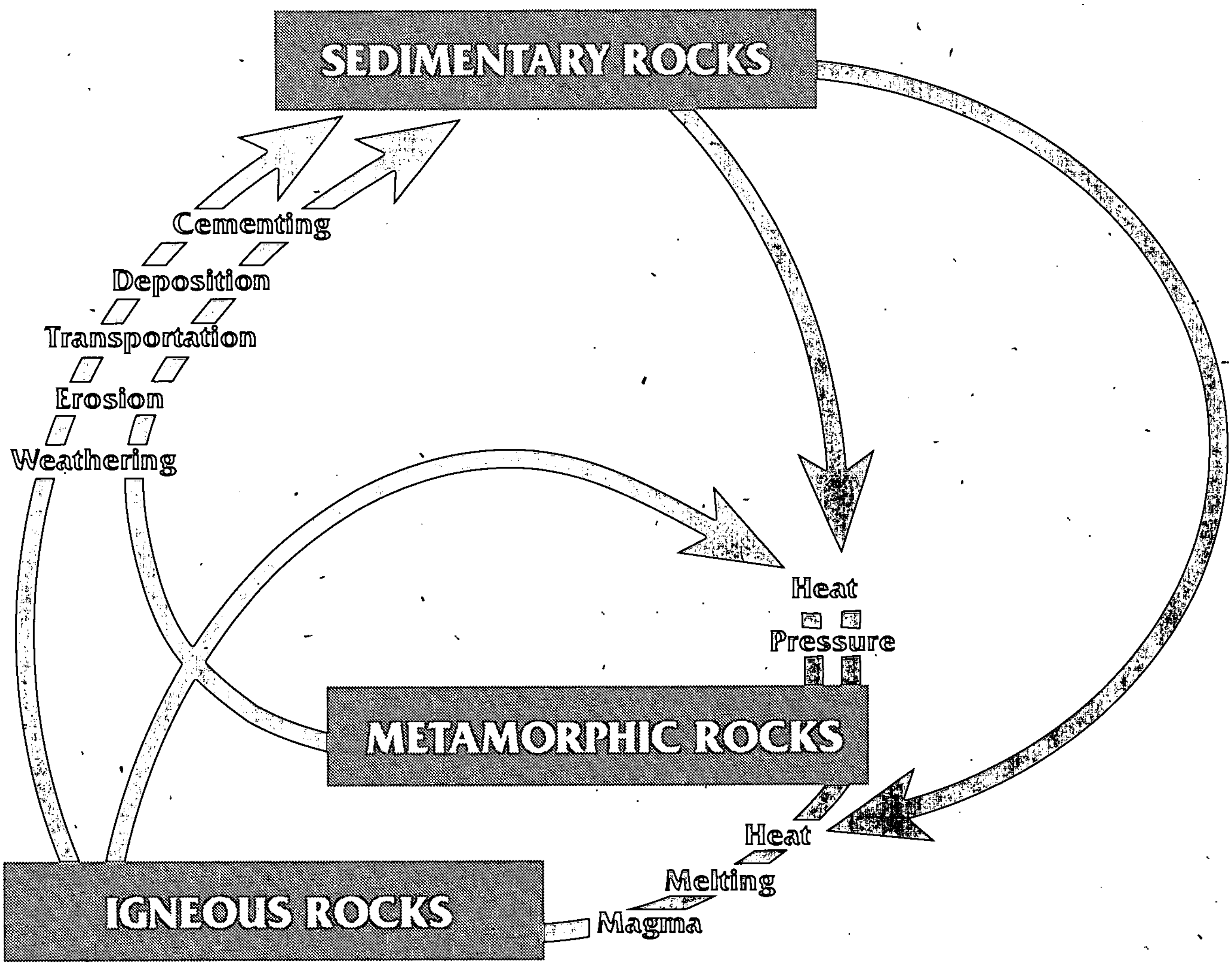
3) **Metamorphic rock** - sedimentary or igneous rock that is changed by heat and pressure into a harder rock, with different qualities. Metamorphism of rocks usually occurs as a result of deep burial and is often related to mountain building. The basalt and rhyolite found in the park have been slightly metamorphosed and so are called **metavolcanic rocks**. Geologists have kept the igneous names, *rhyolite* and *basalt*, but group them with the metamorphic rocks.

Another example of a metamorphic rock found in the park is **argillite**. It is formed from shales or mudstones, which are fine-grained sedimentary rocks. Over time and with deep burial, these rocks were slightly metamorphosed to the harder rock, argillite. The original layers of ash **sediments** can still be seen in this new metamorphic rock. Used to construct many of the buildings at Morrow Mountain State Park, argillite can be found along stream beds and in the abandoned quarry (Quarry Trail).

In fact, argillite underlies a large section of the Piedmont of the southeastern United States. Called the Carolina slate belt, this region stretches from northeastern Virginia to southwestern Georgia, but reaches its greatest width in central North Carolina. Interestingly, the slate belt contains very little true **slate**. Most of the rocks that look like slate are really argillite. While true slate can be split into large, thin plates, argillite breaks into small chips or blocks.



Rock Cycle



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Instructions:

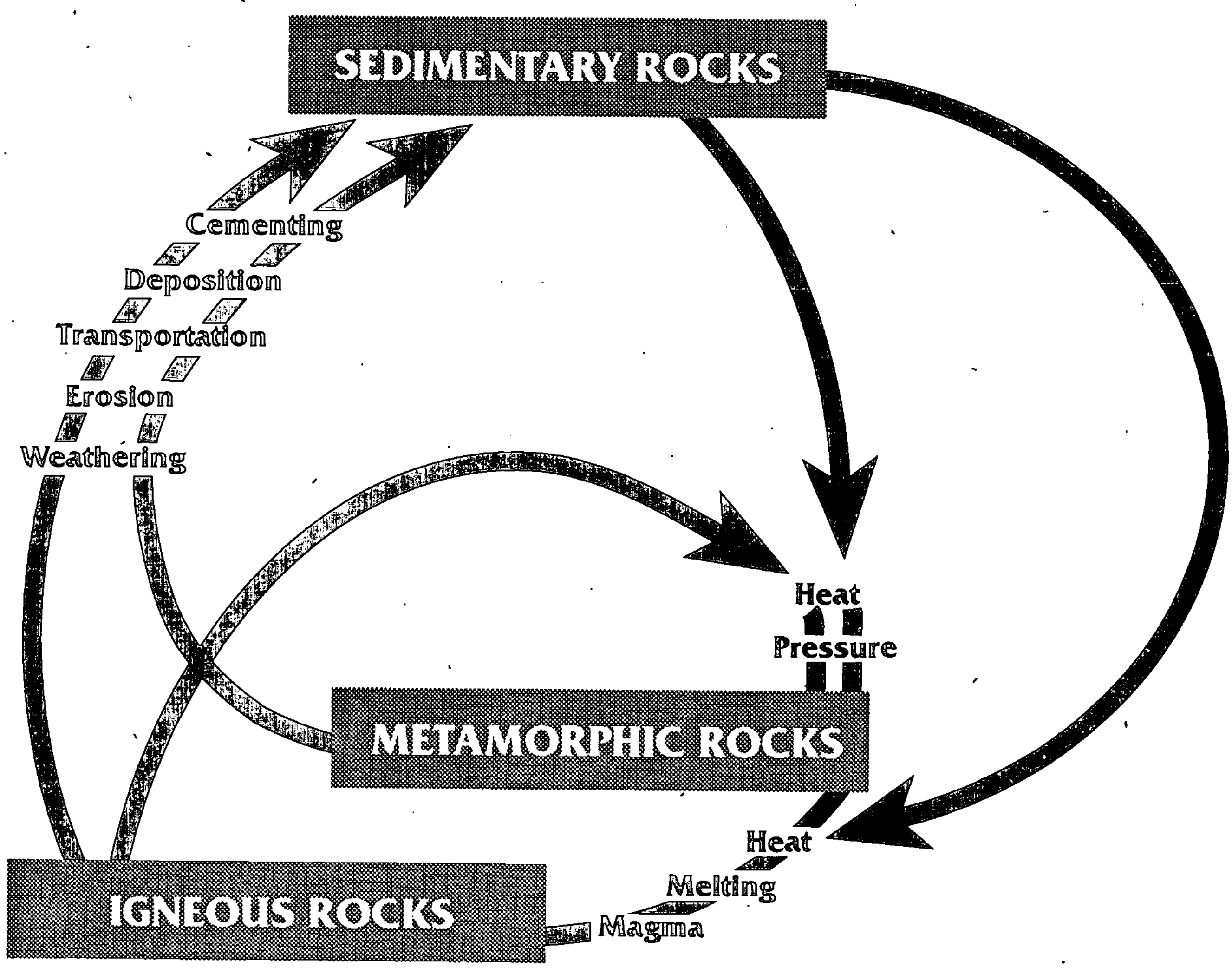
Ask the students to describe local rocks and/or rock formations. They have seen rocks during walks along a lakeshore or river's edge, near or on a mountain, or during a drive along a highway that was built through road cuts. On the chalkboard, write down all the names and characteristics the students can remember about the rocks. Be sure to have several local rock samples distributed around the room.

Ask the students questions such as, "Have you ever wondered just how these rocks formed?" "Are new rocks forming at this moment?"

Be sure to go over the Rock Cycle diagram. Discuss the three kinds of rock with the students.

Part A: Weathering

Cover all desk tops with newspaper. Give each student a sheet of wax paper, a pocket pencil sharpener or carrot peeler, and a candle or four to six crayons of the same color. The candles/crayons represent rock material, and the carrot peelers/pencil sharpeners represent weathering agents. Students should carefully shave each of the candles/crayons keeping all of the fragments in a small pile. As they are "weathering" their candles/crayons onto the wax paper, call their attention to the size and shape of the fragments. "Are they all the same size and shape? Why or why not?" [Not the same size and shape due to varied weathering forces upon them (i.e. how the sharpener or crayon are held) etc.] "What are some of nature's weathering forces?" (Rain, flowing and freezing water, glaciers and wind.) When the "weathering" is complete, the students should wrap their "sediments" in their wax paper and place each color in a separate envelope, unless you plan to do Part B of this activity right away.



Part B: Erosion and Sedimentation

Once rock fragments have been created, they are usually moved by some force of nature. Here, the students act as the erosive force. Ask the students what this force of movement is called, and what some of its causes are. (Erosion, caused by gravity, moving water, glaciers and wind.) Place all the weathered "rock" fragments in four separate piles, one color to a pile. Divide the class into four (or eight) groups, and give each group a sheet of aluminum foil (45 cm x 45 cm). Next, a student from each group should carefully transfer some "weathered sediments", of one color, to the center of the foil. Spread them into a 1 cm thick layer. Repeat with the remaining colors, layering the colors one on top of another.

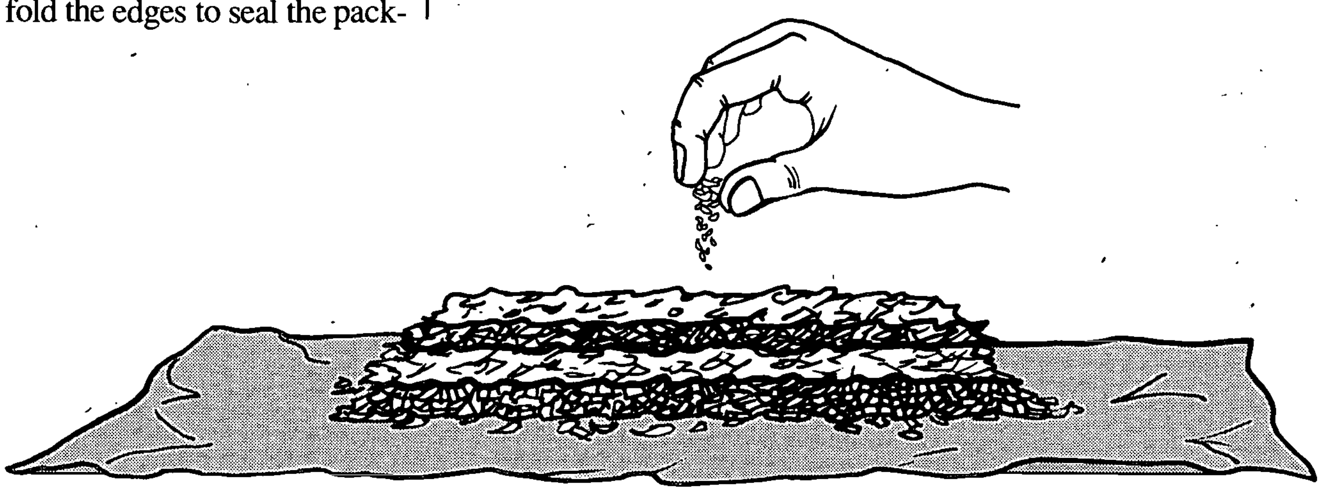
Students should record their observations of their layered "weathered sediments" on the "Hard Rock Crayola" worksheet. Fold the foil over the "sediments" layers, allowing for a 1 cm space all around the fragments, and then carefully fold the edges to seal the packages. If you are breaking the activity into sections, have the students each label their foil packages by their group numbers and stop here.

Part C: Sediments/Sedimentary Rock Simulation

Unless you have more than one vise, this step will take some time and will require some patience. Each group will place their folded foil package between two boards. The "sandwich" should then be placed in the vise. Apply light pressure with the vise to compress the "sediments". Once the "rock sandwiches" have been mildly compressed, remove them from the vise. Students should then carefully open their packages and observe the new product. Call their attention to the central region which is more tightly compressed. The students should lift this portion from the non-compressed or more loosely packed "sediments" and carefully break it into two parts. Have the students look at the broken edges, then draw and describe the layers (on the worksheet). How do they compare with the original loose "sediments" layers? (They're similar but much thinner.)

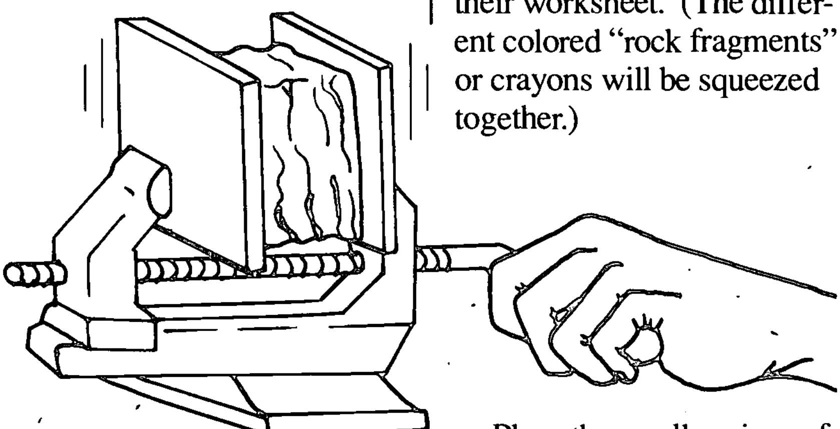
What happened to the spaces between the "sediments"? (Pressure from the vise forced the "sediments" closer together eliminating the spaces.)

Each group should transfer a few of their loose "sediments" and the smaller piece of "sedimentary rock" into a pie pan. Place the rest of the fragments in an envelope, (for part E). The pieces in the pie pan will be used for comparisons with the other "rocks" the students will produce during this activity. Return the larger piece of "sedimentary rock" to the aluminum foil and wrap it up again. If you are breaking the activity into sections, stop here.



Part D: Metamorphic Rock Simulation

Place the foil package with the "sedimentary rock" in it between the two boards and put it into the vise again. Tell the students to add as much pressure to the vise as they can. This part of the activity demonstrates the need for great pressure to cause a rock to metamorphose. In reality, as



the pressure deep within the earth increases, temperatures increase as well. A temperature change is probably occurring in this activity but is difficult to measure. (The heat associated with the formation of metamorphic rock is not a part of this activity.) Remind the students that metamorphic rock may become contorted in appearance. It may actually flow like a plastic material in response to the pressure from the rock load above and crustal plate movement.

Have the students release the compression on the vise, remove the foil package and open it carefully to examine the newly formed "metamorphic rock". They should carefully break this "rock" into two parts and examine it,

noting what happened to the thickness and fragment shape. The students should write down their observations on their worksheet. (The different colored "rock fragments" or crayons will be squeezed together.)

Place the smaller piece of newly-made "metamorphic rock" with the "weathered sediments" and the "sedimentary rock" previously saved. If you are breaking the activity into sections, stop here.

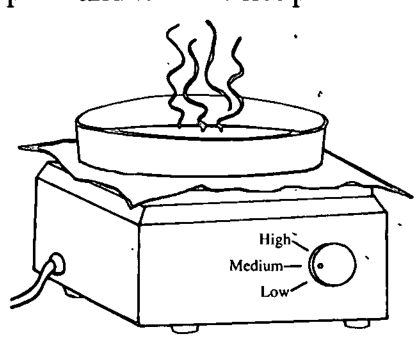
Part E: Igneous Rock Formation

SAFETY NOTE: This portion of the activity requires that the students be especially safety conscious as they will be working with a hot plate and melted wax.

Each group should line their last two trays with aluminum foil: Each group should fill one tray halfway with the following:

- Groups 1 and 2 fill their tray halfway with crushed ice;
- Group 3 fill their tray half way with warm water;
- Group 4 leave their tray empty, except for an aluminum foil lining, and place it on a trivet.

For the "igneous rock" simulation, the groups should place the fragments they set aside in envelopes, and the larger piece of "metamorphic rock", into their second aluminum tray. **Be Especially Careful Here!** This part of the activity requires a hot plate as a heat source. **Students Should Avoid Dropping Wax Fragments on the Hot Plate Surface or Themselves.** The students or teachers doing this portion of the activity should wear protective oven mittens to avoid being burned. Cover each hot plate surface with a layer of foil before you turn it on. (This will diffuse the heat from the coils of the hot plate so the crayons will not burst into flames.) Each group should place their tray of "weathered sediments" and "metamorphic rock" on the hot plate and turn the hot plate



temperature to medium. Melt the wax, being careful that the melting process does not occur so rapidly that the molten wax splatters or burns. When most of the "rock" and "sediments" are molten, turn the hot plate off and carefully remove the tray, using the oven mittens. There is enough heat energy in the molten wax to melt the remaining solid mass. **Caution: Do not let the wax heat to the splattering point!**

While the wax is still in the molten state, a student from each group, or the teacher, should CAREFULLY do the following:

Group 1 - Form a trench in the ice. Using the oven mittens pour the melted wax (magma) into the crack (rock fissure). Carefully cover the wax with more crushed ice. (This will simulate the formation of an intrusive igneous rock.)

Group 2 - Using the oven mittens, pour the melted wax (lava) directly over the surface of the crushed ice. (This will simulate the formation of extrusive igneous rock in a cold region.)

Group 3 - Using the oven mittens, pour the melted wax into the warm water. (This will simulate the formation of extrusive igneous rock in a warm region.)

Group 4 - Using the oven mittens, place the tray of melted wax into the tray on the trivet. Do not pour out the molten contents. Leave them in the original tray. (This will act as the control in this experiment and simulate the formation of extrusive igneous rock in a temperate zone.)

Students should make observations of all the groups' trays, and draw and write these down on their worksheet. Encourage groups to compare their results. For instance, comparisons should be made between the crystal sizes formed by Groups 1 and 4. Comparisons should also be made between these

"igneous rocks" and the "rocks" and "sediments" made in the previous sections of this activity.

Set aside all "igneous rock" trays until the next day's class; the materials must sit overnight. This will allow the wax to cool. The next day, have the students carefully remove the "igneous rock" from the water or tray. Be sure to look at the lower surface of the "rock". Compare the formations of each groups' experiment.

As a class be sure to discuss the following:

With the tray of Group 1, discuss the effect the "magma" had on the "sedimentary or metamorphic rock" it came in contact with.

With the tray of Group 2, discuss the effect the "lava" had on the "surface sediments, rocks and ice" in a cold region.

With the tray of Group 3, discuss the effect the "lava" had on the "sediments, rocks and water" of a warm region.

With the tray of Group 4, discuss the effect of "lava" flowing directly onto the land in a temperate zone, such as Mt. St. Helens in Washington.

Remind the students of the igneous rocks common to this area and the park, such as rhyolite and basalt. Also mention that all conditions for rock formations cannot be simulated. In fact, geologists have never seen intrusive rocks form. However, they are able to look at all of the available evidence, simulate some of the conditions in the laboratory, and arrive at results similar to those found in nature.

Reiterate the concept of the rock cycle by reminding them of the "rocks" (crayons or candles) that were weathered down into "sediments", compressed into "sedimentary" and then "metamorphic rock" and then melted into "igneous rocks".

Worksheet for Pre-Visit Activity #3 Hard Rock Crayola

1. Describe and draw the "weathered sediments" that you made. Note the sizes and shapes of the "sediments".

2. Draw a color picture of the "rock fragments" after light pressure has compacted these "sediments" into "sedimentary rock". Describe the broken edge and the layers that are formed.

3. Draw a color picture of the "sedimentary rock" after heavy pressure has compacted it into "metamorphic rock". Describe the broken edge and the layers that are formed. Note how they have changed with the addition of heavy pressure.

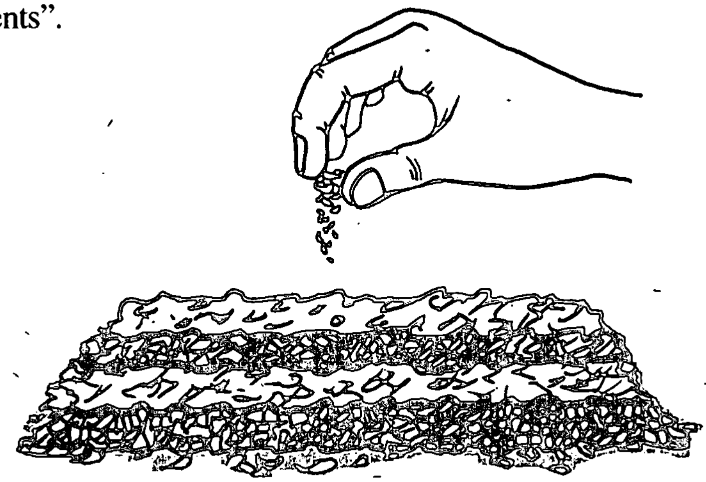
4. Draw each of the melted wax formations created in the four different experiments of Part E. Compare and contrast the experimental results.

Group One's "Igneous Rock"	Group Two's "Igneous Rock"
Group Three's "Igneous Rock"	Group Four's "Igneous Rock"

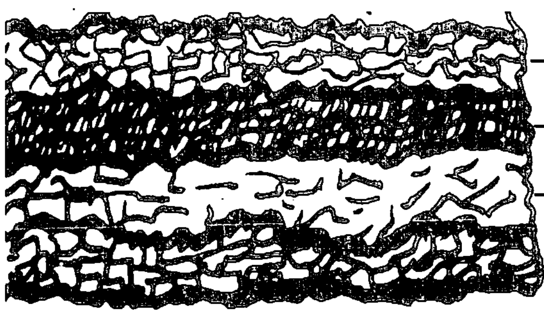
5. Write a comparison between the "weathered rock fragments", "sedimentary rocks", "metamorphic rocks" and "igneous rocks" formed in this activity. Compare and contrast them as to color, crystal size, texture, form and formation.

Answer Sheet for Pre-Visit Activity #3 Hard Rock Crayola

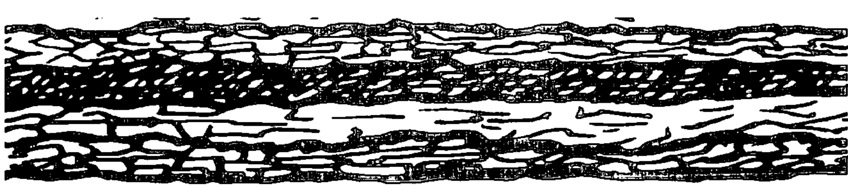
1. Describe and draw the "weathered sediments" that you made. Note the sizes and shapes of the "sediments".



2. Draw a color picture of the "rock fragments" after light pressure has compacted these "sediments" into "sedimentary rock". Describe the broken edge and the layers that are formed.



3. Draw a color picture of the "sedimentary rock" after heavy pressure has compacted it into "metamorphic rock". Describe the broken edge and the layers that are formed. Note how they have changed with the addition of heavy pressure.



4. Draw each of the melted wax formations created in the four different experiments of Part E. Compare and contrast the experimental results.

Group One's "Igneous Rock"	Group Two's "Igneous Rock"
Group Three's "Igneous Rock"	Group Four's "Igneous Rock"

5. Write a comparison between the "weathered rock fragments", "sedimentary rocks", "metamorphic rocks" and "igneous rocks" formed in this activity. Compare and contrast them as to color, texture, form and formation.

The "weathered rock fragments" will vary in size and shape depending on the implement used: pencil sharpener, potato peeler, etc. The "sedimentary rocks" will be bound together very loosely and individual "rock fragments" can be oriented (up/down or right/left) in any direction. In "metamorphic rocks" the space between fragments is very small and the orientation of "fragments" is now flattened (right/left). The thickness is much thinner, but each layer of rock (color) can still be seen. The "igneous rock" is grayish-black (melting and mixing of different "rock fragments") with a variety of forms depending on how the separate groups are cooled. Where the "igneous rock" is poured over ice it tends to fill the spaces between the crushed ice and is very rough to the touch. In cool water it forms short "stalagtites", while in hot water the "stalagtites", are longer. If the "igneous rock" is left in its pan, it is smooth on both sides. **(The different methods of cooling are not intended to simulate real rock formations; they do, however, give the students the understanding that different cooling conditions will create different rocks.)**

Pre-Visit Activity #4 — Cracking Up

Curriculum Objectives:

Grade 5
- Communication Skills: listening, reading and viewing comprehension, writing
- Guidance: group cooperation
- Science: earth science, environment
- Mathematics: measurement, probability
- Social Science: organize and analyze information, draw conclusions, participate effectively in groups

Grade 6
- Communication Skills: listening, reading and viewing comprehension, study skills, writing
- Guidance: group cooperation
- Mathematics: measurement, probability
- Science: earth science, environment
- Social Studies: gather, organize and analyze information, draw conclusions

Grade 7
- Communication Skills: listening, reading and viewing comprehension, study skills
- Guidance: being responsible in a group
- Mathematics: measurement, probability
- Science: soils
- Social Studies: gather, organize and analyze information, draw conclusions

Location:
Classroom; students may do this activity at home if a freezer is not available at school.

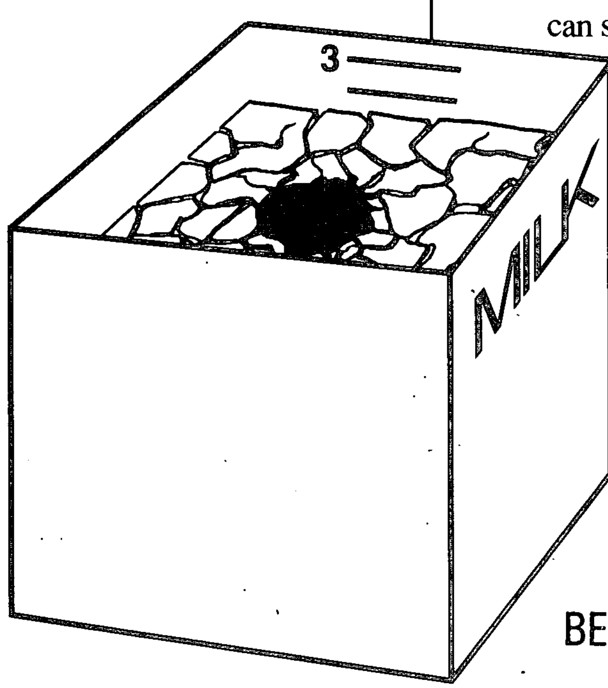
Group Size: Any size

Estimated Time: Overnight

Credits:
This activity was adapted with permission from the National Wildlife Federation's Naturescope: Geology, The Active Earth.

Materials:
Provided by the educator:
Per group: one clean, empty, plastic or cardboard pint milk carton (bottom half only), one ruler, waterproof marking pen, one small balloon, plaster of Paris, two ice cube trays, two paper towels, water, a mixing container, sand, several flat pieces of slate (borrowed from the park)
Per student: "Cracking Up" worksheet, pencil

Special Considerations:
Do not use any type of glass container.



Educator's Information:

This activity has two parts. The first part simulates the process whereby water, through freeze-thaw activity, cracks and then breaks rocks apart. The second part simulates how water and ice abrade and erode rocks over which they travel.

Major Concepts:
- Weathering
- Environmental changes
- Erosion
- Hypothesis testing

Objectives:
- Write and test hypotheses on what happens to water when it freezes.
- State what happens to water when it freezes and how the freezing of water can shape the land.
- Explain how sediments suspended in water or ice shape the land.

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Student's Information:

You might be surprised to discover that temperature variations can cause rocks to break as surely as someone hitting them with a hammer. Water is a major factor in the weathering and erosion of rocks. The strength of water, especially freezing water, can be a very powerful force. Freezing water is probably more responsible for the crumbling and splitting of rocks than any other factor.

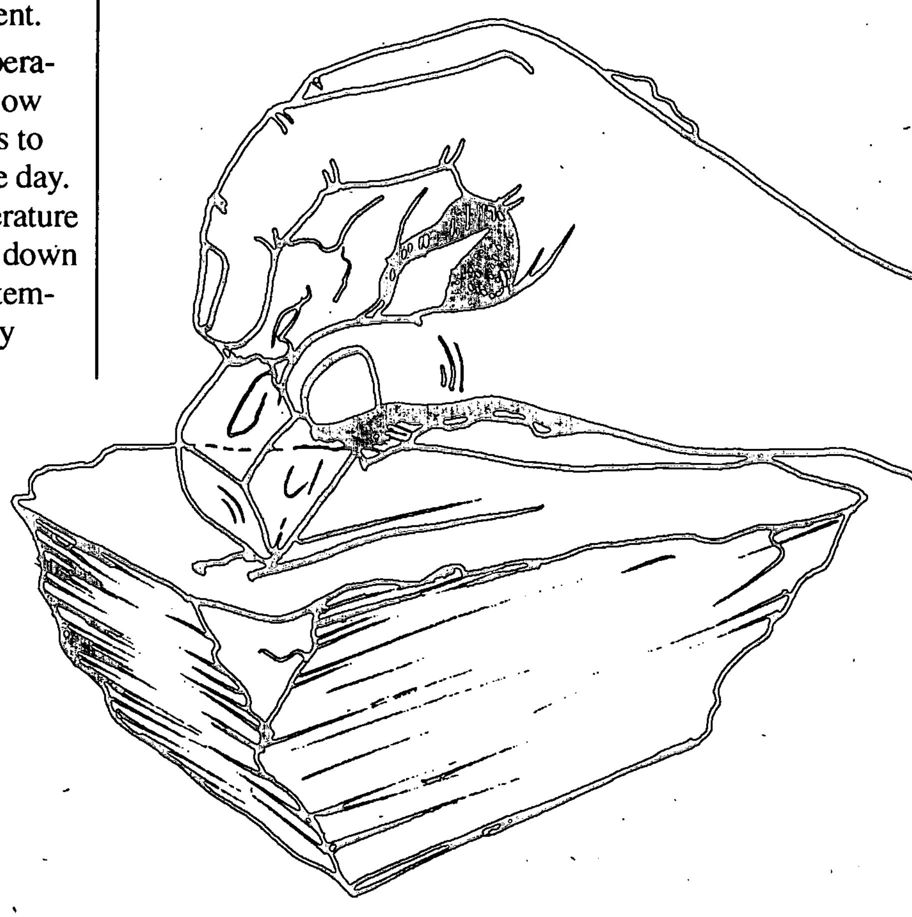
Water, upon freezing, expands its volume by 9%. When water seeps into cracks in a rock and freezes, the expansion widens the cracks. Eventually this process, known as ice wedging, breaks the rock apart. Ice wedging is a very important weathering agent.

In the winter, the temperature sometimes drops below freezing at night and rises to above freezing during the day. This fluctuation in temperature will cause rocks to break down more quickly than if the temperature were consistently above or below freezing.

Glacial movement can have significant effects on rocks as the ice flows move across the land, picking up and re-depositing rock materials. As the rocks trapped on the bottom of the glacier scratch and gouge the earth's surface, they are also worn down by this grinding action.

During the last ice age, this type of glacial activity may have occurred in the upper ends of north-facing valleys in the Appalachian mountains. However, there is no indication that glaciers ever existed in the Uwharrie Mountains.

In the last century, winters in North Carolina were colder than they are today. The Yadkin and Uwharrie rivers, and many others, froze over so thick that local farmers could cut ice blocks from the river and store them in ice houses for summer. The thick ice on the rivers helped break down rocks in and along their banks. As the ice expanded in the winter and broke apart in the spring, it would grind rocks together in the same way glaciers did tens of thousands of years ago.



Instructions:
Day 1 - Part A

1. Divide the students into groups of four and have each group label a milk carton with their group name and two ice cube trays.

2. Have each group of students take a balloon and fill it with water until it is about the size of a ping-pong ball. Tie a knot in the end of the balloon.

3. Have each group mix water with plaster of Paris until the mixture is about as thick as yogurt and pour the mixture into a milk carton. Have one student push the water balloon into the plaster in the carton until it is about 1/4 inch under the surface of the plaster. He or she should hold the balloon down until the plaster sets enough so that the balloon doesn't rise to the surface.

4. Have the students write their hypotheses on what they think will happen to the balloon and the plaster of Paris when they are frozen. Set the milk carton aside until later.

Part B

5. Have each group fill one ice cube tray with clean water. Then have them mix several teaspoons of sand with water and fill the second tray with the sandy water.

6. Have the students write hypotheses on what they think will happen when they rub the "clean" ice cubes and the sandy ice cubes against the slate.

7. Have each group place their milk carton and ice cube trays in the freezer overnight. Note: The plaster should harden at least one hour prior to going in the freezer.

Day 2 - Part A

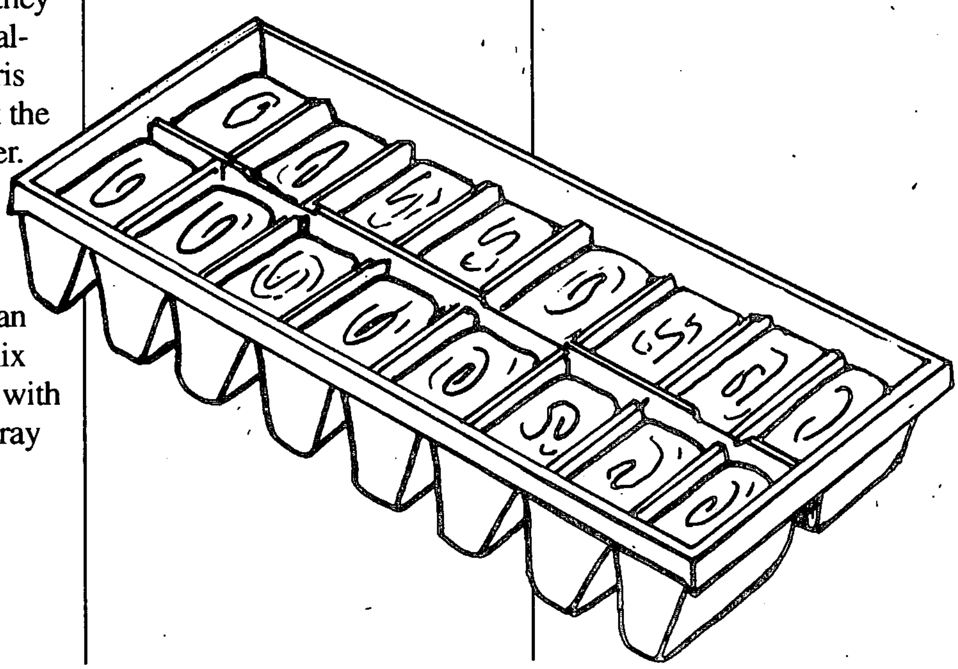
8. The next day, have the students remove the milk carton from the freezer and observe what happened. Have them write down their observations and compare them to their hypotheses. (The plaster was cracked as the water in the balloon froze and expanded.)

9. Have the students speculate what would have happened if the milk carton had been sealed. (The top and/or sides would have burst or swelled outward. This is what happens when water freezes where it has no room to expand, such as in cracks in rocks or in unprotected water pipes in winter. Then, when it freezes, it breaks the rocks apart or bursts the pipes. This process can easily be seen in the park on Tater Top and Mill Mountains.)

Part B

10. Have the students remove the ice cube trays from the freezer.

11. Using a paper towel, have the students pick up the "clean" ice cubes. Holding the "clean" ice tightly against a piece of slate have them slowly rub the ice cube across the rock several times.



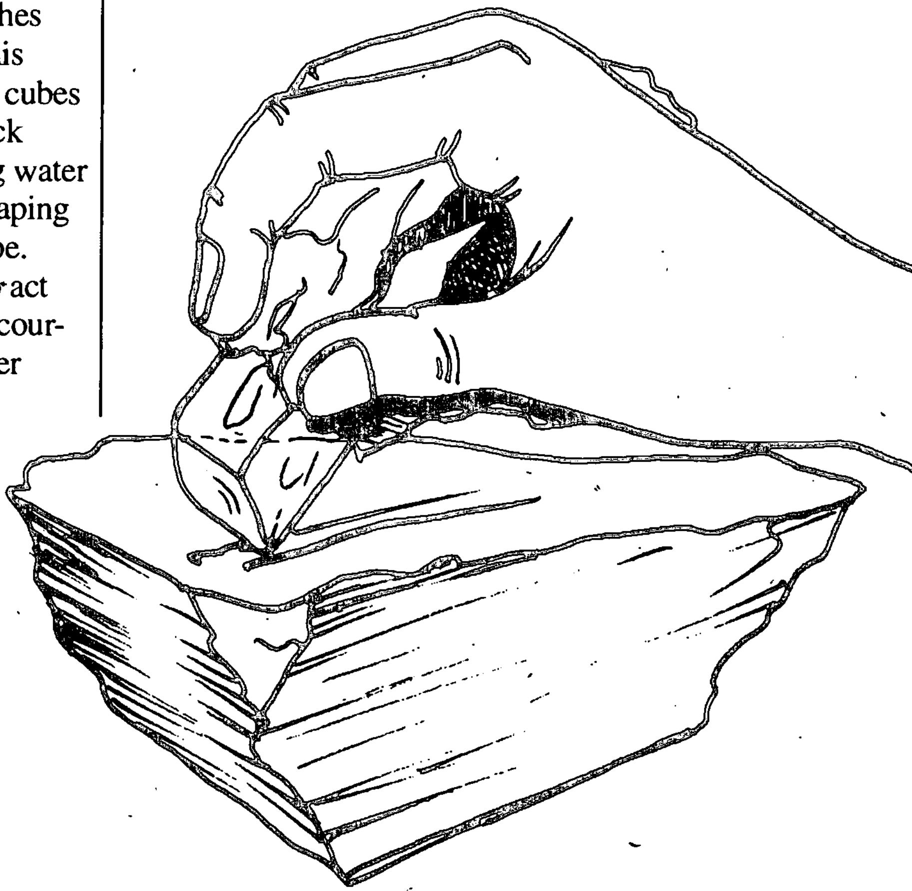
12. Have them do the same with the sandy ice cube on another piece of slate (or a different portion of the rock).

13. Have the students examine the surface of the rocks and write down their observations. (The ice cube with the sand acted like sandpaper. It should have left scratches on the rock's surface. This means that the sandy ice cubes acted like particles of rock suspended in the flowing water of streams and rivers scraping and shaping the landscape. The sandy ice cubes also act like miniature glaciers, scouring the land's surface over which they pass.

The clean ice cube left only a wet smear but no scratches. If streams and rivers were only pure water with no suspended sediments, they would not scour the earth's surface as much as they actually do. The cleaner the flowing water or ice, the less the scouring action that occurs.)

Suggested Extension:

Consider adding another milk carton to the activity. This second milk carton would contain only plaster of Paris. It would act as a control in this experiment. The plaster in this carton should not crack when frozen.



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Part A

1. With the milk carton, write a hypothesis on what you think will happen to the balloon and the plaster of Paris when the water is frozen.

Part B

1. Write a hypothesis on what you think will happen when you rub the "clean" ice cubes and the sandy ice cubes against the slate.

Day 2 Worksheet for Pre-Visit Activity #4 Cracking Up

Part A

1. Remove the milk carton from the freezer and observe what happened to the balloon and plaster of Paris. Write down your observations and compare them to your hypothesis.

2. Speculate what would have happened if the milk carton had been sealed.

Part B

3. Remove the ice cubes from the freezer. Rub the "clean" and sandy ice cubes on the rocks, then examine where the rocks were rubbed. Write down your observations.

On-Site Activity #1 — Rock ID

Curriculum Objectives:

Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills
- Guidance: group interaction
- Healthful Living: recreational safety
- Science: earth science, environment
- Social Studies: organize and analyze information, draw conclusions, participate effectively in groups

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills
- Guidance: group interaction
- Healthful Living: recreational safety
- Science: earth science, environment
- Social Studies: gather, organize and analyze information, draw conclusions

Grade 7
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills
- Guidance: group cooperation, develop an awareness of alternative points of view
- Science: earth science, earth forms, natural phenomena
- Social Studies: gather, organize and analyze information, draw conclusions

NOTE: Before arriving at the park for the on-site activities, teachers and students should read the Appendix, Summary of the Uwharrie Mountains Geology.

Location: Lower picnic area

Group Size:
30 or less, seven groups of about four students each

Estimated Time: 50 minutes

Materials:
Provided by the park:
large rock identification worksheet for the instructor
Per group: index card, hammer, safety goggles, streak plate, penny, steel file, hand lens, "Rock and Mineral" fact sheet, specimens (argillite, weathered argillite, basalt, rhyolite and quartz)
Provided by the educator:
Per student: "Rock ID" worksheet, pencil

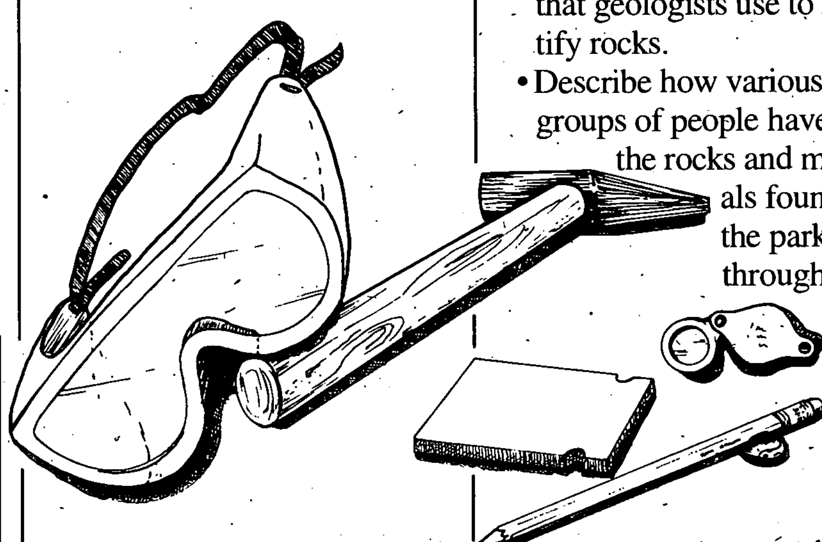
Special Considerations:
During part of this activity, students will break rocks apart to determine the rock's color. Rock fragments can be very sharp and may fly off and hit the student breaking the rocks or other students. It is important for all students to wear safety goggles during this activity.

Educator's Information:

In this activity, the students will identify four **rocks** and one **mineral** found at Morrow Mountain State Park. Some of these same rocks and minerals can probably be found around the students' home and school. The students will complete a worksheet at the park. For each of the five samples, they will determine color, streak color, hardness, whether it is layered, texture and name.

Major Concepts:
- Rock formation
- Rock characteristics
- Sedimentary, metamorphic and igneous rocks

Objectives:
- Identify three common rocks found at Morrow Mountain State Park and explain their origins.
- List three characteristics that geologists use to identify rocks.
- Describe how various groups of people have used the rocks and minerals found at the park through time.



Student's Information:

There are three basic **rock** classifications: igneous, sedimentary and metamorphic. **Igneous rocks** are formed when **magma** (molten rock) cools under the earth's surface or when the magma flows out on the earth's surface as **lava** and cools there. Most of the rocks at Morrow Mountain State Park have an igneous origin. As a matter of fact, 95% of the earth's crust to a depth of ten miles is made up of igneous rock.

Sedimentary rock is formed when loose mineral particles, or **sediment**, are deposited on land or water. With enough pressure from the weight of the layers above and the deep water, the particles get pressed into sedimentary rock. For example, if large amounts of volcanic ash build up on the bottom of lakes or oceans, the ash will be eventually pressed into a type of rock called **shale**. Sedimentary rock is always formed in layers, which is the easiest way to identify this type of rock. About 75% of the exposed surface rocks of the earth are sedimentary. These sedimentary rocks make up a relatively thin covering over the underlying igneous rocks. Shale, sandstone and limestone make up almost 99% of the sedimentary rocks, with shale being more common than sandstone and sandstone being more common than limestone.

Metamorphic rock is formed when either igneous or sedimentary rocks are put under enough heat and pressure over a long period of time to change the rocks both physically and chemically. For example, by this metamorphic process shale is changed to **argillite**, limestone to marble, and sandstone to quartzite. Argillite can be seen along most of the park's streams.

Geologists have identified about 2,000 rocks, each having its own characteristics. To identify a rock, geologists look at **texture**, layering, **minerals** and many other characteristics.

Since each rock is made up of one or more minerals, geologists try to determine the type of minerals found in a rock and the ratio of minerals to one another. The relationship between a rock and its minerals can be compared to a fruit cake's relationship to its ingredients. If the rock is like the fruit cake, the minerals would be the raisins, nuts, cherries, candied fruit, sugar, flour, eggs, etc.

Each mineral always has the same chemical composition and its own particular crystalline structure. A mineral is a combination of one or more elements. **Quartz**, a common mineral in the park, is a combination of two elements: silicon and oxygen. It has a chemical formula of SiO_2. Gold is a mineral of just one element with the chemical formula (and symbol) of Au. Gold has been found in several locations in Stanly County but not in the park.

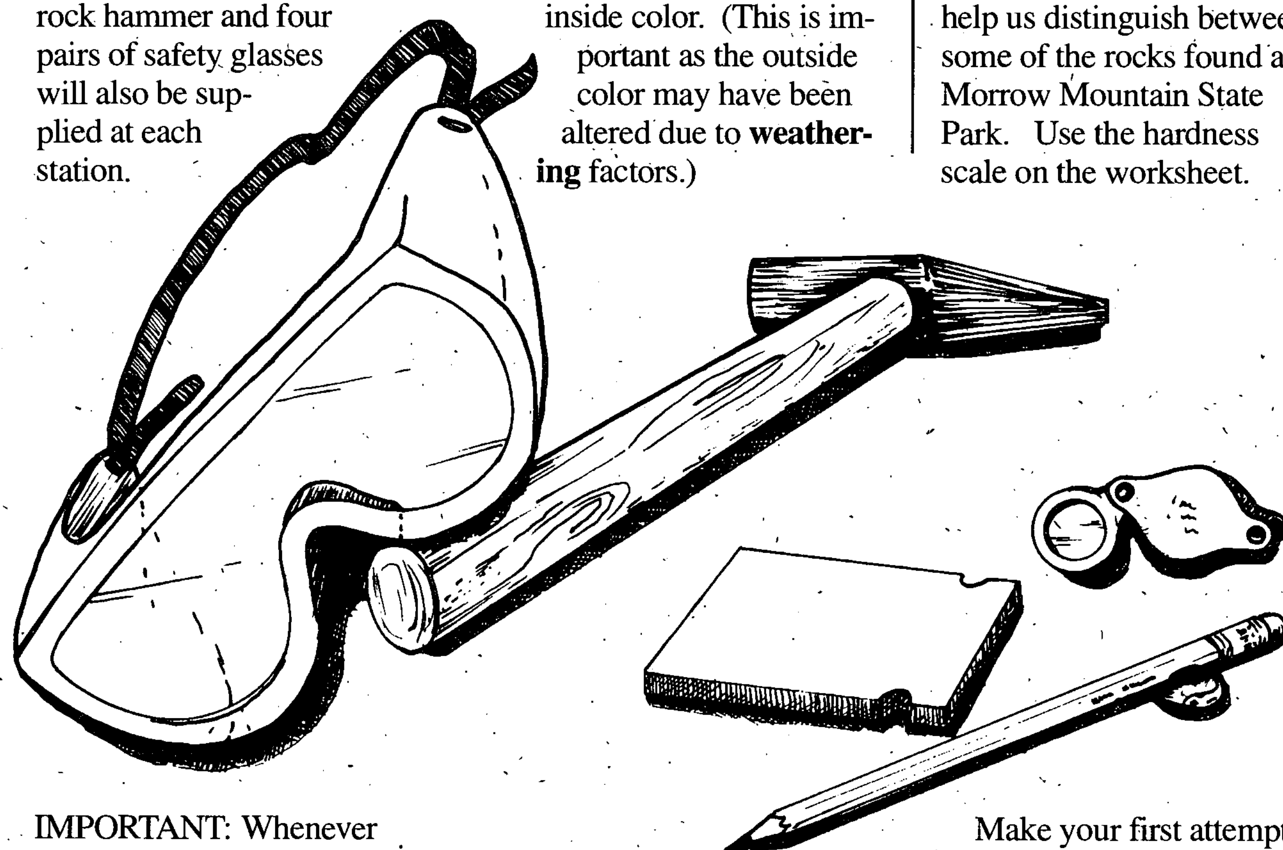
Most minerals are made up of a combination of only eight elements. The following is a list of these elements with the percentage figure indicating their abundance in the earth's crust, and hence their approximate abundance in the rocks and soil around us.

Element	Symbol	Percentage by Weight
Oxygen	O	46.7%
Silicon	Si	27.7%
Aluminum	Al	8.1%
Iron	Fe	5.1%
Calcium	Ca	3.7%
Sodium	Na	2.8%
Potassium	K	2.6%
Magnesium	Mg	2.1%
		98.8%

All other elements total less than 2%.

Instructions:

1. Divide the students into seven groups, one group placed at each station. At each station will be a pencil, streak plate, hand lens, penny, steel file, a copy of the Rock and Mineral Fact Sheet, a copy of the Worksheet for On-site Activity #1, and five different specimens to be identified. A rock hammer and four pairs of safety glasses will also be supplied at each station.



IMPORTANT: Whenever anyone at a particular station is breaking rock with a hammer, ALL members at that station should be wearing safety glasses. Chips of rock can just as easily strike an on-looker as the person who is using the hammer.

2. Using the mineral specimen (#1), have the students work through the characteristic tests below. The leader should demonstrate each test and fill in the answers on the large identification worksheet. Following the leader's example, a recorder in each group should fill in the answers on the group's worksheet.

a) **Color:** Determine the specimen's overall color. The rock hammers can be used to break the specimen to see the inside color. (This is important as the outside color may have been altered due to **weathering** factors.)

IMPORTANT: EVERYONE wears safety glasses! *Answer for mineral specimen (#1) = white; also notice the jagged edges when the specimen breaks. This is called fracture.*

b) **Streak color:** Although this test is reserved for minerals and is not normally used with rocks, it can help us see the color of the minerals in the rocks more clearly. Note: Sometimes a rock or mineral will be so hard that it does not leave a mark on the streak plate. *Answer for mineral specimen (#1) = no streak; this mineral is harder than the streak plate.*

c) **Hardness**: Again this test is primarily used with minerals only. However, it will help us distinguish between some of the rocks found at Morrow Mountain State Park. Use the hardness scale on the worksheet.

Make your first attempt to scratch the specimen with your fingernail. Then progress to the penny and finally the steel file. *Answer for mineral specimen (#1) = hard (can not be scratched by the file).*

d) **Layers**: Observe the specimen to see if it has layers. Make this observation on rocks only; the mineral specimen will not have layers.

Answer for mineral specimen #1 = If this were a rock, we would say "no layers."

e) **Texture:** Observe the specimen and describe its texture. Again, make this observation on rocks only. The mineral has the same chemical composition throughout so texture will not apply here. Use the descriptions of texture on the worksheet when describing the other specimens. *Answer for mineral specimen (#1) = If this were a rock, we would have to say "fine-grained" or "very fine-grained" as grains can not be seen with the naked eye. Note: Some extrusive igneous rocks such as obsidian, which form when lava cools extremely rapidly, look a lot like this mineral!*

3. Now have students use the Rock and Mineral Fact Sheet along with their observations of color, hardness and texture to determine the name of the specimen. *Answer for mineral specimen (#1) =* ***Quartz***

4. Have the students follow the demonstrated procedure with the four rocks labelled specimens #2 through #5. Remind them to wear their safety glasses whenever anyone at their station is breaking rock.

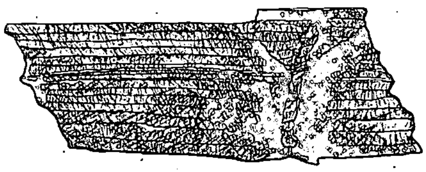
5. When all the groups have finished the tests and filled in the worksheets, review the answers.

6. Discuss how people have used each of these rocks or minerals throughout history. (Refer to the Rock and Mineral Fact Sheet for answers.) Rocks and minerals are called nonrenewable resources because, unlike some trees and animals, they can not be easily replaced. Some minerals such as quartz are so common that we will probably never run out. Other minerals such as gold are rare; that is one reason why they are so valuable. We can ensure that these minerals will last longer if we use them wisely and recycle whenever possible.

Assessment:
Back in the classroom, ask students to perform the identification tests on unknown rocks and minerals. Note: If you are using mineral specimens, substitute luster for texture. Can students tell the difference between rocks that have an igneous origin and rocks that have a sedimentary origin?

Extension:
Discuss the following statement with your students: "If it can't be grown, it must be mined." Use Activity 2 or 3 from the *Mineral and Rock Kit Guide* (found in the "North Carolina Rocks" kit) to help students learn more about mineral and rock products from North Carolina. If your school does not have the "North Carolina Rocks" kit, call N.C. Geological Survey at (919) 733-2423 and ask to speak with their education specialist.

Rock and Mineral Fact Sheet



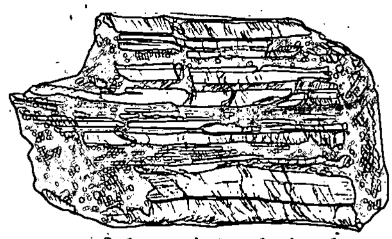
Argillite

Argillite is found along many of the park's streams and at a few mountainside locations. It is gray to black in color and makes a grey streak on the streak plate. Its surface is dull, but is somewhat shiny if wet. It is harder than its weathered form shown on this page, but not as hard as basalt or rhyolite. Many of the park's buildings and curbs have been constructed from the argillite that came from a quarry located within the park.

Argillite originated from **sediments** in an ancient ocean over 500 million years ago. Volcanic ash mixed with other silty sediments to form layers on the bottom of this ocean. The pressure of the water and layers above eventually compacted the sediments into **sedimentary rocks** such as **shale** and **mudstone**. Later, due to movements in the earth's crust, the ancient sea closed and the rocks were deeply buried. Heat and pressure caused the shale and mudstone to metamorphose to the harder rock, argillite. You can still see the original layers or beds of sediment in the argillite.

Weathered Argillite

Don't be fooled! Although weathered argillite may look like shale, it is really just "rotten" argillite, a **metamorphic rock**. Water and oxygen in the air have chemically changed



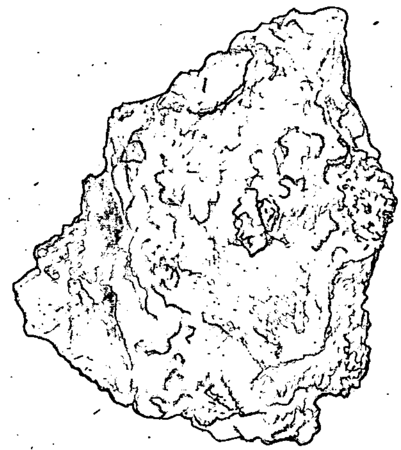
some of the minerals in the argillite so that it has weathered to a yellow or brownish yellow color. (Compare this to the gray color of "fresh" argillite.) Weathered argillite is much softer than argillite; you should be able to scratch it with your fingernail. This rock is really falling apart!

Not all rocks are as easily weathered as argillite. Rhyolite contains a lot of silica or quartz, which is very resistant to both chemical and mechanical **weathering**. Basalt is somewhere between argillite and rhyolite in terms of its resistance to weathering.

Basalt

A fine-grained rock, basalt is dark gray with a greenish cast, which comes from the green mineral **chlorite.** It will leave a gray streak on the streak plate and has a medium **hardness**. Originating from **lava** that flowed out of volcanic cones or cracks in the earth, the basalt found in the park is over 500 million years old. After it formed, this old volcanic rock was deeply buried and metamorphosed. Therefore, it is classified as **metavolcanic** – a metamorphic rock that came from a volcanic rock.

In the park, basalt is found as round boulders at the bottom of hills and on hillsides.



Early European settlers in this area used this rock to build walls and fences. Some of these structures can still be seen today.

Rhyolite

Rhyolite is usually described as being very fine-grained; however, some of the rhyolite found in the park has an uneven **texture**. You can often see white dots (feldspar crystals) in this grayish rock.

It will leave a black streak on the streak plate. Like basalt, the rhyolite comes from ancient volcanic activity. After formation, these volcanic rocks were deeply buried and slightly metamorphosed. They are classified as metavolcanic.

Although layers, or **bedding** planes, are usually associated only with sedimentary or metamorphosed sedimentary rocks, rhyolite can sometimes have layers too. On the Fall Mountain Trail, bedded rhyolite can be seen in some locations. Look for thin parallel lines in the rock which indicate thin layers of volcanic ash that were deposited on top of one another. Because rhyolite comes from very thick, viscous **magma**, it is often blown out of a **volcano** explosively as hot gases and glass fragments. When this cloud of material cools, it forms a rock.

Found on hilltops throughout the Uwharries, rhyolite is a hard rock that is resistant to weathering and **erosion**. Native Americans used rhyolite to make a variety of tools including scrapers, knives, axes, and spear and arrowhead points. A popular trading item, rhyolite tools made from the rock of the Uwharrie Mountains have been found from Florida to Maine.

Minerals: Quartz and Gold

Milky (white) quartz is found in veins and, in this area, gold is often associated with it. Millions of years ago, superheated water containing silica (quartz) as well as other minerals such as gold, was forced into cracks in the rocks. As the water cooled, the quartz and other dissolved minerals precipitated out and filled the cracks. Later, when the surrounding rock was eroded away, the quartz was left behind in the soil.

Quartz is a very hard mineral with a glassy luster. Because quartz is harder than the streak plate, it will not leave a streak. Quartz is very resistant to weathering and erosion. Early European settlers in this area used quartz boulders to build walls and fences. Some of these structures can be seen in the park today.

Gold is a very soft mineral with a golden yellow color. In 1799, the discovery of a 17-pound gold nugget in Cabarras County started the first true gold rush in the United States. Small scale gold production, where gold was extracted from quartz-bearing rocks, continued until the 1940s. New mining technology may make it economically possible to mine for gold again.

Some people enjoy panning in the streams for gold flakes that have been washed away along with weathered rock fragments. Because gold is heavier than most other minerals, it will sink to the bottom of the gold pan. Lighter materials will stay near the top and can be removed during the panning process. Remember that all natural resources in the park are protected. If you want to pan for gold, you need to get permission from the park rangers.

Worksheet for On-Site Activity #1 — Rock ID

Specimen	Color	Streak	Hardness	Layered	Texture	Name
Mineral 1				XXXX	XXXX	
Rock 2						
Rock 3						
Rock 4						
Rock 5						

Color - The color of a fresh or broken piece.

Streak - Color of the mark left on the streak plate, if any.

Hardness - Use the scale below. Start with your fingernail.

If the specimen can be scratched by:	*Then the hardness is:*
a fingernail	very soft
a penny but not a fingernail	soft
a file but not the penny	medium
can not be scratched by file	hard

Layered - Does the rock have layers, yes or no?

Texture - Use the terms below.

Fine-grained:	Can NOT see individual mineral grains with naked eyes
Medium-grained:	Mineral grains are about the size of sand particles
Coarse-grained:	Mineral grains are very obvious, over 2 mm in diameter
Uneven:	Some mineral grains are large enough to be seen, but other grains are too small to be seen with the naked eyes

Name - Use your observations and the Rock and Mineral Fact Sheet to identify each specimen.

Answer Sheet for On-Site Activity #1 — Rock ID

Specimen	Color	Streak	Hardness	Layered	Texture	Name
Mineral 1	white, clear pink	none	hard	X	X	quartz (mineral)
Rock 2	brown to light yellow	yellow to brown	very soft	yes	fine-grained	weathered argillite
Rock 3	gray to black	gray	soft	yes	very fine-grained	argillite
Rock 4	gray w/ white specks	black	hard	no	uneven, OR very fine-grained	rhyolite
Rock 5	grayish green	gray	medium	no	fine-grained	basalt

Color - The color of a fresh or broken piece.

Streak - Color of the mark left on the streak plate, if any.

Hardness - Use the scale below. Start with your fingernail.

If the specimen can be scratched by:	*Then the hardness is:*
a fingernail	very soft
a penny but not a fingernail	soft
a file but not the penny	medium
can not be scratched by file	hard

Layered - Does the rock have layers, yes or no?

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Coarse-grained:	Mineral grains are very obvious, over 2 mm in diameter
Uneven:	Some mineral grains are large enough to be seen, but other grains are too small to be seen with the naked eyes

Name - Use your observations and the Rock and Mineral Fact Sheet to identify each specimen.

Water Over The Rocks

Curriculum Objectives:

Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills, writing
- Guidance: group interaction
- Healthful Living: recreational safety
- Science: living things, plants, earth science, environment
- Social Studies: organize and analyze information, draw conclusions, map use, participate effectively in groups

Grade 6
- Visual Arts: understand the role creativity plays in producing art
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills
- Guidance: group interaction, occupations
- Healthful Living: how people affect the environment, recreational safety
- Mathematics: measurement
- Science: ecology, earth science, environment
- Social Studies: gather, organize and analyze information, draw conclusions, map use

Grade 7
- Visual Arts: understanding the role creativity plays in producing art
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills
- Guidance: group cooperation, develop an awareness of alternative points of view
- Mathematics: measurement
- Science: characteristics of plants, soils, interactions of people and the environment, earth science, earth forms, natural phenomena
- Social Studies: gather, organize and analyze information, draw conclusions

Locations:
Lower picnic area and Quarry Trail

Group Size:
30 or less, one adult per 10 students

Estimated Time: 1 hour

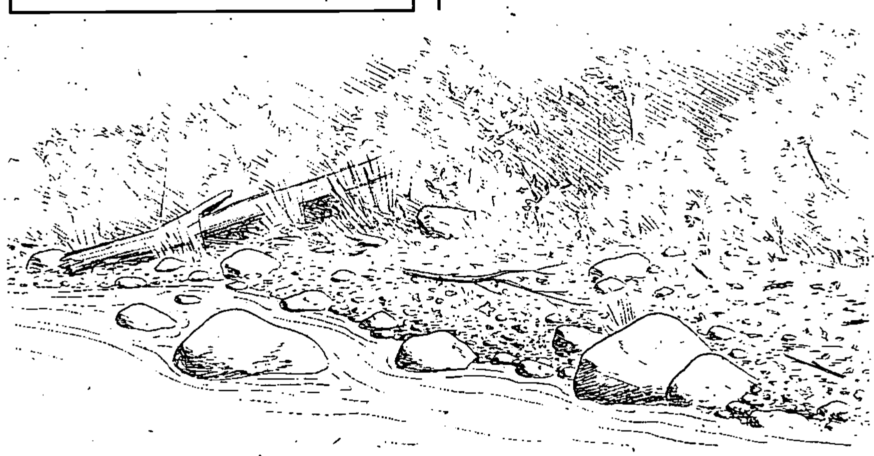
Appropriate Season:
Warm weather

Materials:
Provided by the park:
15 magnifying glasses, 8 gold pans
Provided by the educator:
Per student: "Water Over the Rocks" worksheet, clip board, paper, pencil, "Rock and Mineral Fact Sheet" from on-site activity #1.

Special Considerations:
Safety of students as well as protection of the stream area should be considered. The trail is rated as easy but does have several creek crossings and several short steep hills to climb and descend.

Major Concepts:
- Erosion
- Water cycle
- Rock cycle
- Use of stone

Objectives:
- Name one natural and one unnatural thing that have greatly affected the weathering of the rocks in the park.
- Explain how metamorphic rocks are formed and name one common to this area.
- Explain how sedimentary rocks are formed and how they are layered.
- Explain why rocks found in this area are no longer in a horizontal plane.
- Identify two geologic formations found in the quarry.
- Observe and record the effects of moving water on rock surfaces.
- Name the type of stone used for building material in the park and explain why it was used.



Educator's Information:

Of all the land-shaping factors, water has the greatest effect. Large rivers, as well as small streams, work to shape the earth's surface, as you will see in the park. Flowing water, from the smallest trickle coming out of the hillside to huge, roaring waterfalls, is a sculptor of great power. Yet surprisingly, streams and rivers make up less than one one-thousandth of the earth's land surface and contain only .005 percent of the earth's liquid fresh water.

Particles of soil and sand suspended in the flowing water act as an abrasive agent, scouring rocks in the river or stream channel. This, in turn, creates more particles. This scouring explains why **rocks** in a stream or river bed have smooth edges. The edges have been worn away, not by the water but by the suspended particles of soil and sand in the water. Over time, the force of these streams and rivers shapes the landscape, cutting narrow gorges in steep mountains and wide flood plains in the piedmont and coastal areas.

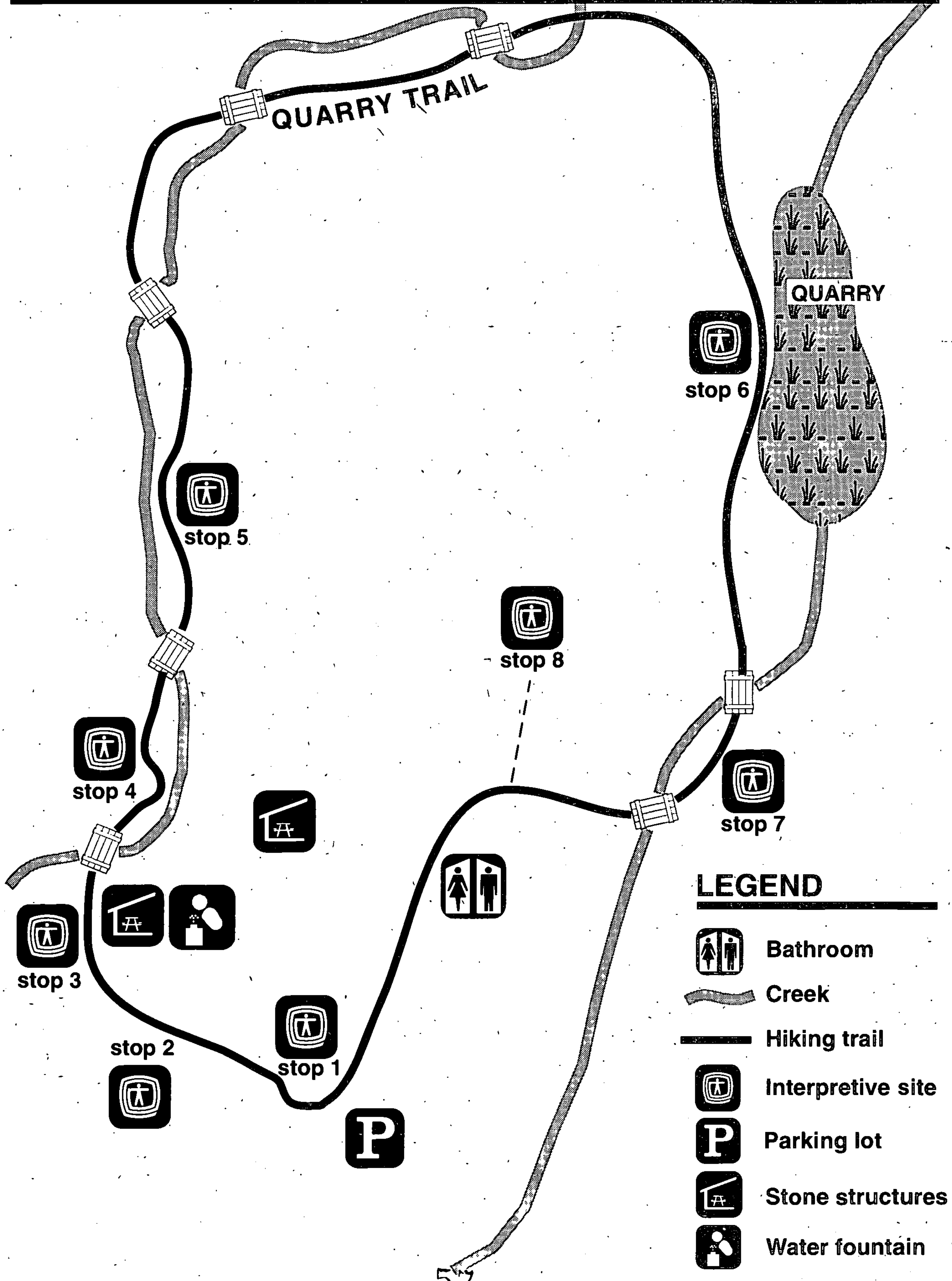
The streams in the park have shaped their surroundings. The level flood plain along the Yadkin River was formed by deposits of sand eroded from rocks upstream and **sediment** that was washed into the stream and then carried onward by the river's current.

Another way flowing water shapes the landscape occurs during floods. With the increase of water power during floods, large and small rocks roll and tumble, grinding against each other and scouring the river's bed. The rising waters wash soil and sand, trees and shrubs out from one location and deposit them further downstream.

It is estimated that a grain of sand takes a million years to travel 100 miles down a river like the Yadkin. This progress toward the ocean has been slowed even further by the construction of dams. But rocks have a different time perspective than you and I. Whether it takes a million or a billion years, the **rock cycle** still circles through its different phases.

Water is recycled by evaporation from the land and ocean. It returns to the earth in the form of rain, snow, hail and mist. Much of the water falling from the sky runs off into our streams and rivers or filters through the soil and through **joints** and cracks in the bedrock into the groundwater. The groundwater connects with the rivers, lakes, and oceans. These waters are eventually evaporated, beginning the cycle once again.

Water Over the Rocks Trail Map



Trail Guide for Water Over the Rocks

Trail Description:

The activity "Water Over the Rocks" will take you on a trail approximately 1/2 mile long, called the Quarry Trail. It starts in the picnic area, follows a winding creek around the base of a hill, and crosses the creek several times before leaving it. The trail then crosses a small hill and travels down to another creek that passes through the old quarry site. The trail leads you around the quarry and back up the hill to the picnic area.

The quarry is a good example of **bedding** in **argillite**. The bedding is inclined at a steep angle, indicating that the **rock** has been tilted from its original horizontal position. Fractures developed parallel to the bedding planes and also at angles to it.

First Things First

Before going on the trail, have the students take a break and use the restrooms. The students will not be hiking far, but the hike will take approximately one hour due to the amount of material being covered.

Stop 1

When the group has reassembled, show them a large topographic map of the park area, and trace on the map where the students will be hiking. Explain the map's symbols. Hand out the "Water Over the Rocks" worksheets, if the students don't already have them, and have the students answer the questions on them at the appropriate stops. Use the answer sheet to facilitate questions and discussion.

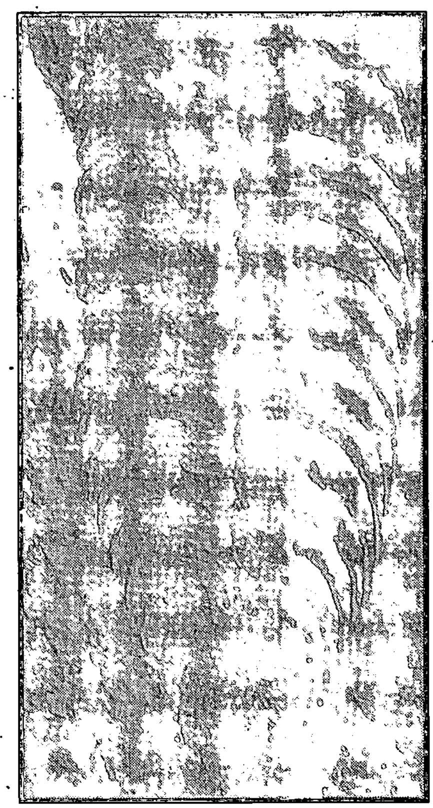
Stop 2

The type of forest located in a particular area is directly related to the area's geology and how the land has been shaped over time. The soil type, elevation, latitude, slope, and compass direction the slope faces all affect the type of plant communities that will grow in a given location. For example, certain plant species prefer an acidic soil, while others thrive in a neutral or alkaline soil. Some species grow only at a certain elevation; others grow at specific latitudes, slopes, or cliff faces. Plant communities can often tell a trained scientist a lot about the soil, the base rock and the geologic history of an area.

Stop 3

Notice the argillite (blue-gray rock) that was used to construct the structures around you. The picnic shelter, water fountain, and barbecue pit grill were all constructed by the **Civilian Conservation Corps**, (known as the CCC), during the late 1930's and early 1940's. Farther down the trail, you will pass through the quarry where the argillite was dug. Discuss other places you might have noticed in the park where this rock was used. Parking lots, retaining walls, the swimming pool, the bathhouse, and many other park facilities are constructed of this same type of rock. Argillite was also used as head and foot markers at grave sites located in the park. Discuss the worksheet questions and answers.

Choose one piece of argillite used in the construction of the barbecue pit, water fountain or picnic shelter and draw its edge, showing the layers. Be sure to look for fossils in the rock. Fossils are extremely rare but three have been found in Stanly County–you might find a fourth!



Pteridinium fossil

Stop 4

A. Situate the students at a stream location and ask them to make the following observations while completing their worksheet. Are there exposed rock **outcrops** in the water? in the stream bank? What type might they be and why are they located here? What are their shapes?

B. Observe the rock that was uncovered on this hillside due to the **erosion** of the loose soil. This is weathered argillite. It was formed from argillite that has weathered back to a softer state. The weathered argillite is much softer than argillite and is not suitable for building material. Take a piece of this weathered rock and experience how soft it is by crumbling it in your hands.

C. Have the students examine and draw the stream **sediments** as seen through a magnifying glass. Discuss the sediments' colors and shapes, the types of rocks they came from, why they are here, and where they are going.

D. Have the students draw a rock found in the stream and one located away from the stream. Have them describe these two rocks.

E. Discuss with the students how floods roll and sort rocks in the streams. Have them answer the worksheet questions, looking for clues to flood heights such as scouring and debris deposited in the flood plain along the stream.

Stop 5

Look along the inside bend of the stream. Discuss how as the current slows, heavier material is deposited, forming a sandbank. This sandbank is made up of rocks and minerals. Using the gold pans, have the students "pan" for rocks and see how many different types of rocks they can identify using the "Rock and Mineral Fact Sheet" from On-Site Activity #1.

Stop 6

Argillite was mined from this quarry years ago. It was used for structures like the ones you saw at the beginning of the trail. You can also see weathered argillite on the right side of the quarry at the highest point on the quarry walls. Its location on top of the argillite usually means that it was deposited at a later date and is a younger rock than that at the bottom of the quarry. The argillite exposed at the surface has "**decayed**" back to the softer rock, weathered argillite.

Walk over to the outcrops on the left side of the quarry. Notice how tilted the layers are. Have the students answer the worksheet questions, and then discuss their answers. Have the students identify and draw the following geological formations: breaks or **joints** and bedding or layers.

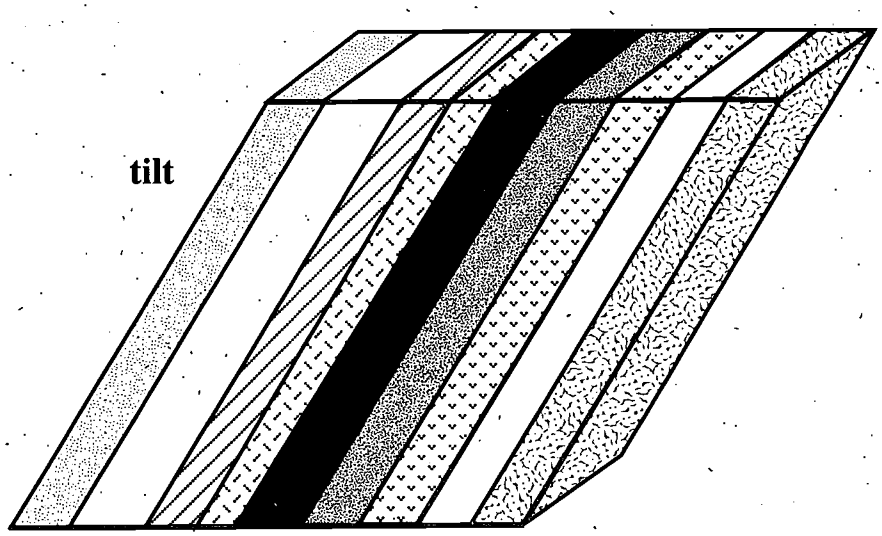
Stop 7

Notice the channels cut by the running water where the water runs over the exposed rock at the bridge. Answer the worksheet questions and discuss them.

Stop 8

At this highest point on the hill, look back at where you've been. Review with the students the erosional processes, the effects the stream and humans have had on shaping the landscape, the types of rocks you have seen, and what **geologic processes** caused the rocks to tilt and break.

Be sure to mention that **rhyolite** and **basalt**, two of the



major rocks in the park, are not found along this trail. Rhyolite forms the higher hills in the Uwharries. Basalt can be found scattered about the park on and below the surface, with the largest concentration being in the northwestern section of the park.

Also mention that North Carolina State Parks were set aside to protect unique natural areas throughout the state. Our state parks are true sanctuaries. All resources in the park are protected and may not be removed, molested or harmed. This includes all wildlife, all plants and even the rocks we are studying today. After the discussion, head back to the picnic area and trail head.

Suggested Extensions:

1. You may wish to visit the following places:

A) The top of Morrow Mountain is a good place to see rhyolite, how it weathers and how it protects the mountain from wearing down. There is also a geological display located in the picnic area on top of the mountain;

B) Basalt fields may be seen on the way to the top of Morrow Mountain. Fields of basalt can also be seen by parking at the trail head of the Sugarloaf Trail and walking a short distance down the trail. There is also a quartz outcrop approximately 100 yards down the Sugarloaf trail;

C) Reed Gold Mine is located on NC Route 200 in Cabarrus County.

2. Come back to the park for a plant community hike on this same trail. This hike will relate the plant communities, geology, soils and geography.

Worksheet for On-Site Activity #2 Water Over The Rocks

Stop 3

What type of rock is **argillite**?____________________

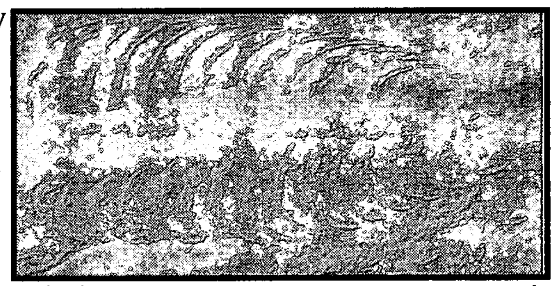
Why does it make such good building material?____________________

____

____

Choose one piece of argillite used in the construction of the barbecue pit, water fountain or the picnic shelter and draw its edge, showing the layers or **bedding**.

Be sure to look for fossils in the rock. They are extremely rare but three have been found in Stanly County in rocks just like these. You might get lucky and find a fourth.



Pteridinium fossil

Stop 4

A. Are there exposed rock **outcrops** in the water? _____Yes _____No

In the stream bank? _____Yes _____No

If so, what type(s) of rock do you think they are? ____________________

Why are they located there? ____________________

____

____

What shapes do these outcrop rocks have? are they smooth edged? rounded? jagged? sharp?

____

____

____

____

C. Draw the **sediments** as seen through the magnifying glass.

Describe the colors and shapes you see. Which type of rock do you think these sediments come from? Why do you think they are here, and where do you think they are going?

____

____

____

____

____

____

D. Draw a rock found in the stream and one located away from the stream. Describe each rock.

stream rock	non-stream rock
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

E. Can you tell how high the last flood was (by the scouring along the stream)? ____Yes ____No

How high was it above the current water level? __________ feet __________ meters

Can you tell how high the highest flood was (by the height of debris piled in the flood plain along the stream)? ______Yes ______No ______Maybe

How high was it above the current water level? __________ feet __________ meters

Stop 5

Use the "Rock and Mineral Fact Sheet" from On-Site Activity #1 and see how many rocks you can identify as you pan the sandbank at the stream bend.

____

____

____

Stop 6

Notice the tilted bedding (or layers) in these outcrops. What do you think caused this?

____

____

What angle were the layers at originally? ______________________

Draw two types of geologic formations in the outcrops found in the quarry and label them as **joints** (breaks) and **bedding** (layers).

Stop 7

Notice the channels cut into the rock that the water is running over. How did these channels form?

____

____

____

____

What type of rock is the stream cutting through? ______________________

____

What type of rock is along the stream bank? ______________________

____

How do you think this rock was originally formed?

If the channel is being cut by small particles in the water, what happens to these suspended particles and those worn from the rocks? Where do they go?

Stop 8

At a high point on the hill overlooking the quarry, look back over where you have been. Write a paragraph that describes what you have learned today about the types of rocks you have seen, how water (the stream) and humans have changed the landscape, and the **geologic processes** that have caused the rock layers to tilt and break.

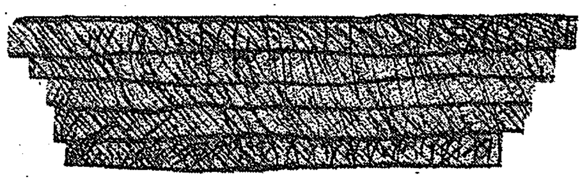
Answer Sheet for On-Site Activity #2 Water Over the Rocks

Stop 3

What type of rock is argillite?
(ANSWER: Argillite is a metamorphic rock.)

Why does it make such good building material?
(ANSWER: The layers in this metamorphosed sedimentary rock will break along the planes in which the sediments were laid down. This results in a flat surface, which makes argillite a great building material as the rocks can be stacked on top of one another.)

Choose one piece of argillite used in the construction of the barbecue pit, water fountain, or the picnic shelter and draw its edge, showing the layers or bedding.



Be sure to look for fossils in the rock. They are extremely rare but three have been found in Stanly County in rocks just like these. You might get lucky and find a fourth.

Stop 4

A. Are there exposed rock outcrops in the water? __X__ Yes ______ No

In the stream bank? __X__ Yes ______ No

If so, what type(s) of rock do you think they are?
(ANSWER: metamorphic rock - weathered argillite.)

Why are they located there?
(ANSWER: the stream exposed the rock.)

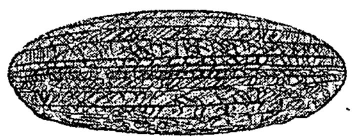
What shapes do these outcrop rocks have? are they smooth-edged? rounded? jagged? sharp?
(ANSWER: smooth, rounded edges for in-water outcrops; jagged, sharp edges for stream bank outcrops.)

C. Draw the sediments as seen through the magnifying glass. Describe the colors and shapes you see. Which type of rock do you think these sediments come from?
(ANSWER: mineral - quartz; metamorphic - argillite; and maybe igneous - basalt and/or rhyolite.)

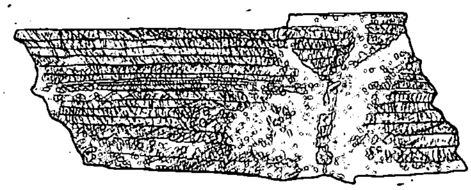
Why do you think they are here, and where do you think they are going?
(ANSWER: They were eroded from the streambed and bank here and farther upstream. They are on their slow way to the ocean.)

D. Draw a rock found in the stream and one located away from the stream. Describe these two rocks.
(ANSWER: The rocks found in the stream have been worn down by the stream and will probably have smoother, rounded edges compared to the rocks found away from the stream.)

stream rock



non-stream rock



E. Can you tell how high the last flood was (by the scouring along the stream)? _X_ Yes ____ No.

How high was it above the current water level? ________ feet ________ meters

Can you tell how high the highest flood was (by the height of debris piled in the flood plain along the stream)? _____ Yes ______ No ______ Maybe.

How high was it above the current water level? __________ feet __________ meters

Stop 5

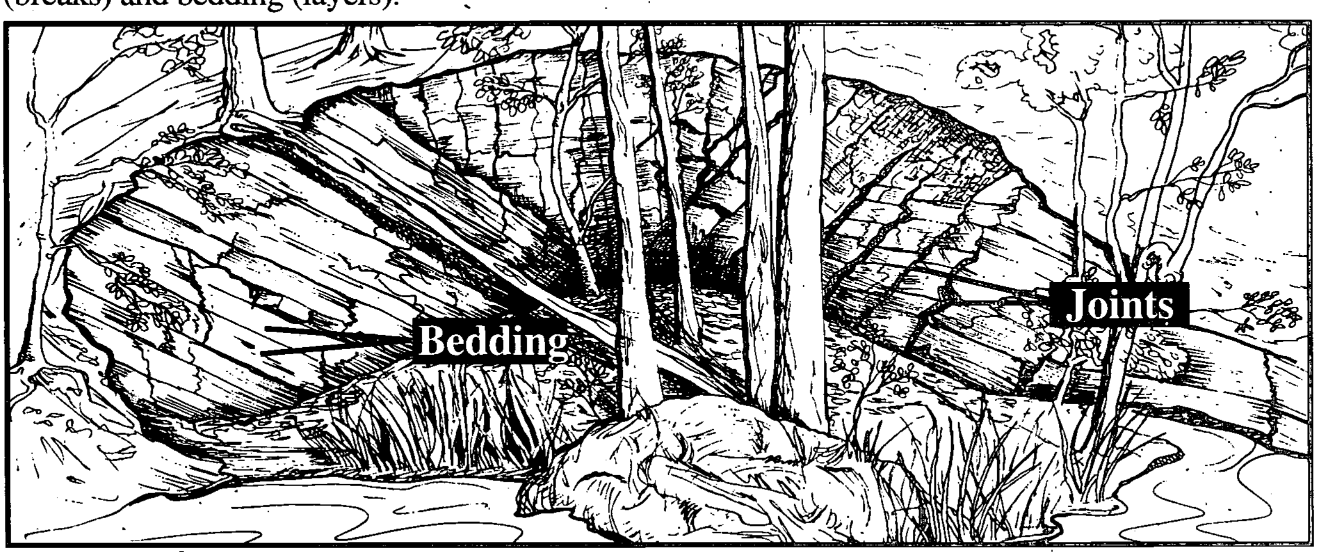
Use your Rock and Mineral Fact Sheet from On-Site Activity #1 and see how many rocks you can identify as you pan the sandbank at the stream bend.
(ANSWER: Likely rocks are argillite, rhyolite, quartz, weathered argillite and basalt.)

Stop 6

Notice the tilted bedding or layers in these outcrops. What do you think caused this?
(ANSWER: The tilt of the argillite is the result of crustal upheavals that occurred after the argillite was originally formed.)

What angle were the layers at originally?
(ANSWER: The layers were originally horizontal with the ground.)

Draw two types of geologic formations in the outcrops found in the quarry and label them as joints (breaks) and bedding (layers).



Stop 7

Notice the channels cut into the rock that the water is running over. How did these channels form?
(ANSWER: They were cut by the particles suspended in the water acting as sandpaper, wearing down the rock, day and night, over a very long period of time. It is a long, slow process but the earth's life is measured in millenniums and not in years.)

What type of rock is the stream cutting through?
(ANSWER: Argillite.)

What type of rock is along the stream bank?
(ANSWER: Argillite or weathered argillite)

How do you think this rock was originally formed?
(ANSWER: It was formed when volcanic ash and silt were deposited in an ancient sea millions of years ago. As layers of these sediments built up, they were eventually compressed into a sedimentary rock, such as shale or mudstone. Later, pressure and heat during deep burial, transformed the sedimentary rock into a metamorphic rock, argillite.)

If the channel is being cut by small particles in the water, what happens to these suspended particles and those worn from the rocks? Where do they go?
(ANSWER: They are washed downstream and become part of the erosional process. Some settle in deeper and quieter areas of the stream.)

Stop 8

At a high point on the hill overlooking the quarry, look back over where you have been. Write a paragraph that describes what you have learned today about the types of rocks you have seen, how water (the stream) and humans have changed the landscape, and the geologic processes that have caused the rock layers to tilt and break.
(Note: For assistance in the discussion, review the worksheet questions.)

Post-Visit Activity #1 What's Your Crystalline Structure?

Curriculum Objectives:
Grade 5
- Communication Skills: reading and vocabulary comprehension, study skills
- Science: earth science, environment

Grade 6
- Communication Skills: reading and vocabulary comprehension, study skills
- Science: earth science, environment

Grade 7
- Communication Skills: reading and vocabulary comprehension, study skills
- Science: scope of earth science, earth forms, natural phenomena

Location:
Classroom

Group Size:
Approximately 30 students plus teacher

Estimated Time:
30 minutes

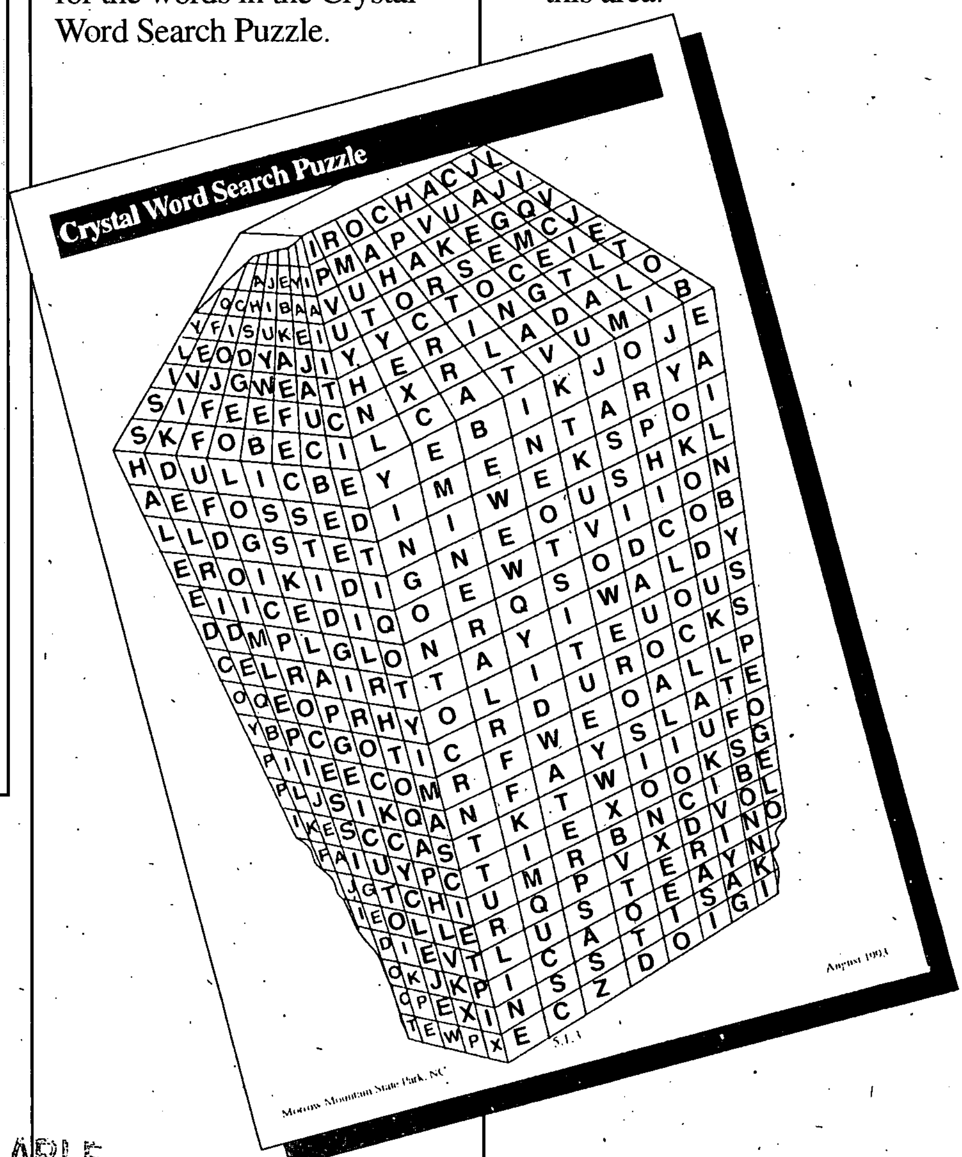
Materials:
Provided by the educator:
Per student: "What's Your Crystalline Structure" worksheet, "Crystal Word Search Puzzle," pencil

Educator's Information:

This activity is a review of the vocabulary and major concepts used throughout the whole packet. The students will first fill in the blanks with the appropriate word suggested by each definition or example. When the worksheet has been completed, the students will then search for the words in the Crystal Word Search Puzzle.

Major Concepts:
- Geologic processes
- Geologic cycle
- Vocabulary

Objectives:
- Name the three basic rock types and explain how they are formed.
- List two geologic processes.
- Describe what a rock is and name two rocks common to this area.



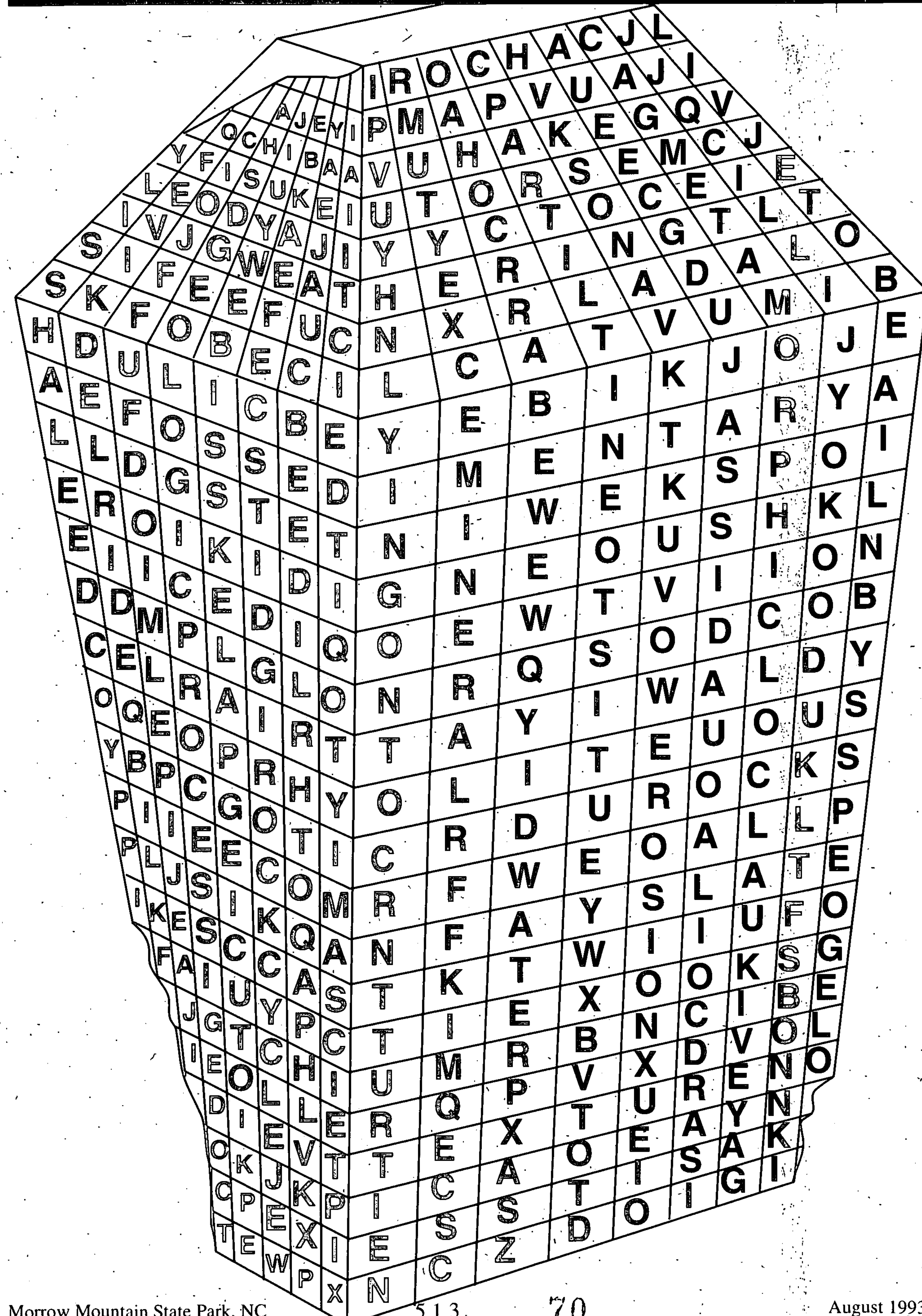
Worksheet for Post-Visit Activity #1 What's Your Crystalline Structure?

Fill in the blanks with the appropriate word suggested by each definition or example. When all words have been placed, find the words in the crystal word search puzzle.

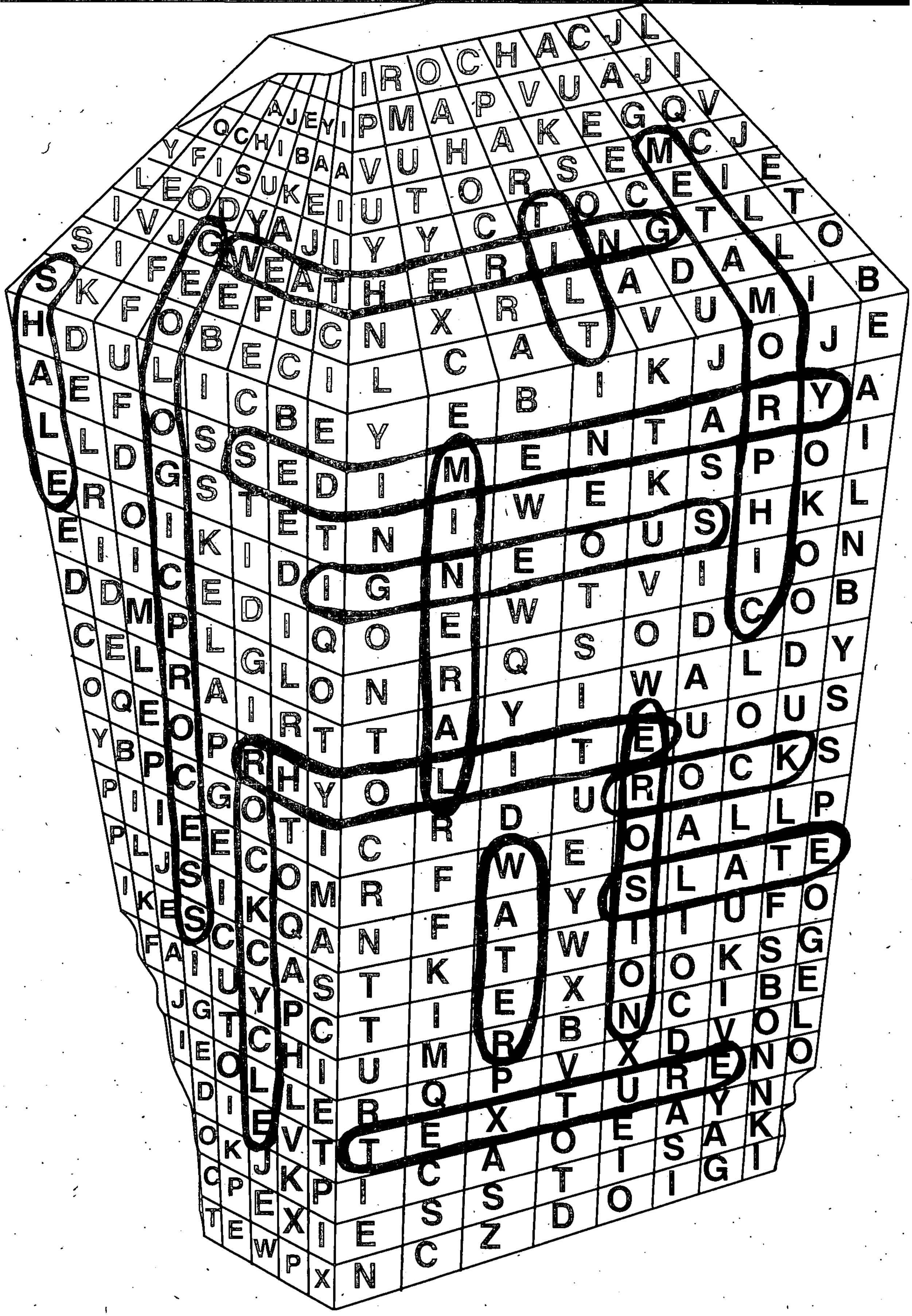
1. Substance made up of one or more minerals. _ _ _ _
2. Rocks exposed on the higher peaks and ridges of the Uwharrie Mountains. _ _ _ _ _ _ _ _
3. Metamorphosed sedimentary rock that looks like argillite but breaks into thin, flat plates. _ _ _ _ _
4. Naturally occurring substance with its own crystal shape. _ _ _ _ _ _ _
5. Rock type formed when heat and pressure change an existing rock. _ _ _ _ _ _ _ _ _ _ _
6. Term used when water carries away rock debris. _ _ _ _ _ _ _
7. Rock type formed when sand, silt, clay, or ash settles and is pressed together. _ _ _ _ _ _ _ _ _ _ _
8. Process whereby sedimentary rocks become metamorphic rocks, metamorphic become igneous, igneous become sedimentary, etc. _ _ _ _ _ _ _ _ _
9. Used to describe the size of mineral grains in a rock. (Example: fine-grained.) _ _ _ _ _ _ _
10. Destructive process that wears down rocks. _ _ _ _ _ _ _ _ _ _
11. The phenomena of how the earth is shaped. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
12. Rock type formed by volcanoes. _ _ _ _ _ _ _
13. Change in a bedding angle due to upheavals of the crust. _ _ _ _
14. A major factor in the weathering and erosion of rocks. _ _ _ _ _
15. The sedimentary rock type from which argillite is formed. _ _ _ _ _

ROCK	RHYOLITE	SLATE
MINERAL	METAMORPHIC	EROSION
SEDIMENTARY	ROCK CYCLE	TEXTURE
WEATHERING	GEOLOGIC PROCESS	IGNEOUS
TILT	WATER	SHALE

Crystal Word Search Puzzle



Crystal Word Search Puzzle Answer Sheet



Answer Sheet for Post-Visit Activity #1 What's Your Crystalline Structure?

Fill in the blanks with the appropriate word suggested by each definition or example. When all words have been completed, find the words in the crystal word search puzzle.

1. Substance made up of one or more minerals. R O C K
2. Rocks exposed on the higher peaks and ridges of the Uwharrie Mountains.
   R H Y O L I T E
3. Metamorphosed sedimentary rock that looks like argillite but breaks into thin, flat plates.
   S L A T E
4. Naturally occurring substance with its own crystal shape. M I N E R A L
5. Rock type formed when heat and pressure change an existing rock.
   M E T A M O R P H I C
6. Term used when water carries away rock debris. E R O S I O N
7. Rock type formed when sand, silt, clay or ash settles and is pressed together.
   S E D I M E N T A R Y
8. Process whereby sedimentary rocks become metamorphic rocks, metamorphic become igneous, igneous become sedimentary, etc. R O C K C Y C L E
9. Used to describe the size of mineral grains in a rock. (Example: fine-grained.)
   T E X T U R E
10. Destructive process that wears down rocks. W E A T H E R I N G
11. The phenomena of how the earth is shaped. G E O L O G I C P R O C E S S
12. Rock type formed by volcanoes. I G N E O U S
13. Change in a bedding angle due to upheaval of the crust. T I L T
14. A major factor in the weathering and erosion of rocks. W A T E R
15. The sedimentary rock type from which argillite is formed. S H A L E

ROCK	**RHYOLITE**	**SLATE**
MINERAL	**METAMORPHIC**	**EROSION**
SEDIMENTARY	**ROCK CYCLE**	**TEXTURE**
WEATHERING	**GEOLOGIC PROCESS**	**IGNEOUS**
TILT	**WATER**	**SHALE**

Post-Visit Activity #2 Geology Jeopardy

Curriculum Objectives:

Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension, speaking techniques
- Guidance: group interaction
- Science: earth science, environment
- Social Science: organize and analyze information, draw conclusions, participate effectively in groups

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension, speaking techniques
- Guidance: group interaction
- Science: earth science, environment
- Social Studies: organize and analyze information, draw conclusions

Grade 7
- Communication Skills: listening, reading, vocabulary and viewing comprehension, speaking techniques
- Guidance: group cooperation
- Science: earth science, earth forms, natural phenomena
- Social Studies: organize and analyze information, draw conclusions

Locations:
Inside or outside, depending on the weather

Group Size:
30 or less, larger groups can be accommodated

Estimated Time:
30 minutes

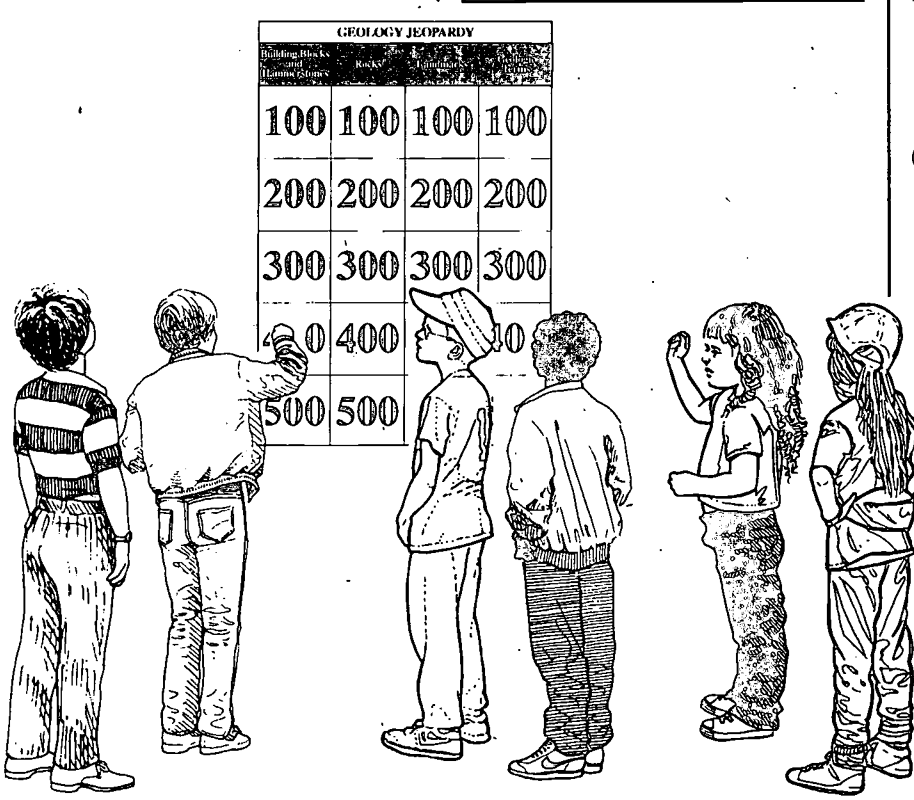
Materials:
Provided by the educator:
"Geology Jeopardy" board

Educator's Information:

This game is adapted from the television game show, Jeopardy. Before starting the game be sure to briefly review the geologic history of the park in the Appendix (8.1). This is a fun way for the students to evaluate themselves on what they have learned through the previous activities. The game also provides good factual information on geology and the Uwharrie Mountains, in particular. You may wish to award prizes or recognition to the participants with the highest score.

Major Concepts:
- Rock formations
- Landforms
- Rock composition
- Use of native stone

Objectives:
- List the three most common types of rock found in the park and state which rock type is highly resistant to erosion.
- Explain how sedimentary, metamorphic and igneous rocks are formed.
- Name two rock types and how they have been used by humans in this area.



BEST COPY AVAILABLE

Instructions:

Divide the class into three teams. Put each team in a line facing the Jeopardy Board. Ask one of the three students at the head of the lines to pick the first number amount and category column to be revealed. The amounts do not have to be selected in any particular order.

When the category and the amount have been selected, uncover the "answer" and read it aloud to the group. The first of the three students at the head of the lines to raise a hand gets a chance to respond. (It is extremely helpful to have someone familiar with the group to watch for the first hand raised, since the leader will be reading the "answers".)

The correct response must be in the form of a question. If the first student answers incorrectly, the other two students are given a chance to raise their hands and respond. The student who correctly responds by asking "What is ________?," receives the point value card and gets to select the next category and amount to be revealed. If no correct response is given, the leader gives the response.

All three participants now move to the back of the lines and the next three students have a chance to answer the next question.

After all columns have been uncovered, each team adds up their point cards to determine who has the most points. If any prizes are to be awarded, that is done at this time.

Suggested Extensions:

Play another television game called Win, Lose or Draw. Geological terms or processes are written on index cards which are placed face down on a table close to the chalkboard where the drawings will be done. Try to have different colors of chalk available.

Divide the class into two groups. Each group will chose someone to draw for that group. One point is given for each correct guess. The first group's "artist" has one minute to convey a geological term or process in pictures to their group. If the group doesn't guess the correct answer in one minute then the other group has a chance to guess what was being drawn. If neither group gets the correct answer, the moderator (usually a teacher) gives the answer.

It is now the second group's turn. A new index card is taken from the stack and the second group's "artist" draws a picture to convey the term to their group. Suggestions for geological terms or processes that could be used are: **erosion**, **weathering**, glaciers, **sedimentary rock**, **igneous rock**, **metamorphic rock**, fossils, **volcanoes**, etc.

GEOLOGY JEOPARDY

Building Blocks and Hammerstones	Rocks and Minerals	Landmarks	Geologic Terms
100	100	100	100
200	200	200	200
300	300	300	300
400	400	400	400
500	500	500	500

GEOLOGY JEOPARDY

Building Blocks and Hammerstones	Rocks and Minerals	Landmarks	Geologic Terms
This 17-pound nugget was discovered nearby in 1779.	A sedimentary rock formed from volcanic ash and silt.	The place where building stone was mined.	The rock type formed when sediments are compacted or cemented.
The rock the CCC mined in the park and used to construct buildings.	A metavolcanic rock, very resistant to erosion and found on all the higher hills in the Uwharries.	The park is part of this mountain range.	The rock type (such as slate) created by heat and pressure on rocks.
Early settlers used this dark-colored rock to make fences and walls.	A weathered rock that can be scratched by your fingernail.	936 feet above sea level	Rocks formed by the cooling of hot, molten rock on or below the earth's surface.
A white, very hard mineral sometimes used to make fences and walls.	Crystals of this mineral can sometimes be seen in rhyolite.	A river that borders Morrow Mountain State Park.	Movement of weathered rock by water, wind and glacial action.
The stone Native Americans used to make tools such as knives, spear points and arrowheads.	The mineral that gives basalt its green color.	This rock created the "Great Falls of the Yadkin."	A term for the layering found in rock of sedimentary origin.

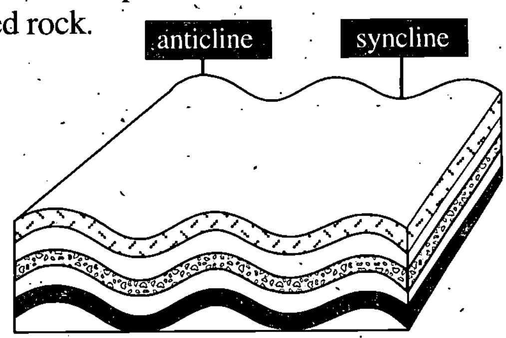
GEOLOGY JEOPARDY - Correct Responses

Building Blocks and Hammerstones	Rocks and Minerals	Landmarks	Geologic Terms
What is gold?	What is shale or mudstone?	What is the quarry?	What is sedimentary rock?
What is argillite?	What is rhyolite?	What is the Uwharrie Mountain range?	What is metamorphic rock?
What is basalt?	What is weathered argillite?	What is the elevation of Morrow Mountain?	What is igneous rock?
What is quartz?	What is feldspar?	What is the Yadkin, Pee Dee or Uwharrie?	What is erosion?
What is rhyolite?	What is chlorite?	What is rhyolite? OR What is a dike?	What is bedding?

VOCABULARY

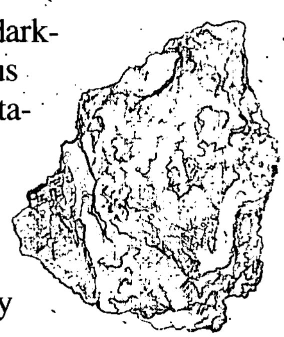
Aggregate - Composed of a mixture of minerals that may be separated by mechanical means.

Anticline - An upfold or arch of stratified rock.



Argillite - A slightly metamorphosed shale or mudstone found at Morrow Mountain State Park. (For further information, see the Rock and Mineral Fact Sheet in On-Site Activity #1 - Rock ID.)

Basalt - A hard, dense, dark-colored extrusive igneous rock. When slightly metamorphosed, it is called greenstone. (For further information, see the Rock and Mineral Fact Sheet in On-Site Activity #1 - Rock ID.)



Bedding - The formation of layers or strata in sedimentary and metamorphosed sedimentary rock.

Civilian Conservation Corps (CCC) - A federal government program of the 1930's and 1940's that was established to provide jobs and develop public properties.

Chlorite - A green or black mineral found in basalt that has been slightly metamorphosed.

Compaction - The process or state of being pressed together; compacted.

Crustal plates - Granitic plates on which the continents ride. When these plates collide they push up mountains and create metamorphic rock due to the pressure of their collision.

Decay - To decompose; rot.

Decomposition - The chemical breakup of rock at or near the earth's surface. The mineral components of the rock are altered and new compounds are produced.

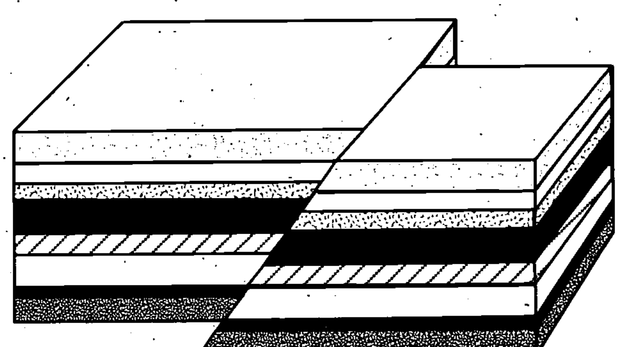
Dike - An intrusive, more or less vertical, thin sheet of igneous rock.

Earth's crust - A rigid shell only about 30 miles thick, less than one hundredth of the distance to the center. Eight elements account for almost 99% of the earth's crust - oxygen (46.7%), silicone (27.7%), aluminum (8.1%), iron (5.1%), calcium (3.7%), sodium (2.8%), potassium (2.6%), and magnesium (2.1%).

Erosion - The movement of bits of weathered rock by wind, water, gravity and glacial action.

Extrusive igneous rock - Rock formed by the cooling of molten lava on the earth's surface. Examples are rhyolite and basalt.

Fault - In geology, a fracture in the earth's crust where layers of rock slide up or down along the break.



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Folding - To bend over or double up so that one part lies on another part.

Geologic process - The breaking down and building up of rocks, such as weathering, erosion, sedimentation and volcanic action; the phenomena of how the earth is shaped.

Granite - An intrusive igneous rock with very coarse grains composed of quartz, feldspar, and dark minerals such as biotite (mica).

Hardness - A mineral's resistance to scratching; scale from 1 to 10 where talc is the softest and a diamond is the hardest.

Hypothesis - A proposed or possible answer to a problem; a premise from which a conclusion is drawn.

Igneous rock - Rock formed by the cooling of molten rock on or under the surface of the earth; rock formed by volcanoes. The crust of the earth is approximately 95% igneous rock. Examples are rhyolite and basalt.

Intrusive igneous rock - Igneous rock that forms when magma cools inside the earth, usually resulting in coarse-grained mineral crystals.

Joint - A break in rocks along which no movement has occured. (Compare with fault.)

Lava - Molten rock that issues from a volcano or a fissure in the earth's surface; the rock formed by the cooling and solidifying of this substance.

Luster - The appearance of a mineral surface judged by its brilliance and ability to reflect light.

Magma - Molten rock beneath the earth's surface. When it reaches the earth's surface, it is called lava.

Mantle - In geology, the layer of the earth between the crust and the core.

Metamorphic rock - Rock that has been altered chemically and/or physically by heat and pressure. Argillite is a metamorphic rock found in the park.

Metavolcanic rock - Metamorphic rock that originated from volcanoes, but was later changed by heat and pressure.

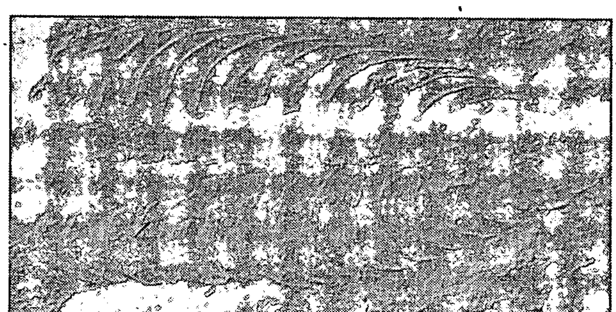
Minerals - One or more chemical elements that make up the earth's rocks. They are inorganic and occur naturally. Each mineral has its own chemical make-up, as well as its own characteristic crystal shape. Quartz is a common mineral found in the park.

Mudstone - A fine-grained sedimentary rock in which the proportions of clay and silt are approximately equal. Mudstone differs from shale in that mudstone lacks fine lamination and can not be easily split.

Outcrop - An area of exposed rock. Examples are road cuts, stream beds and quarries.

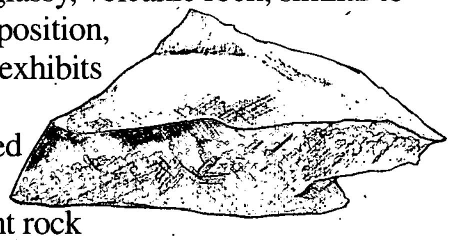
Quartz - A hard crystalline mineral of silicon dioxide, SiO_2. (For further information see the Rock and Mineral Fact Sheet in On-Site Activity #1 - Rock ID.)

Pteridinium - A Precambrian animal whose fossil is found in argillite in the Stanly County region. There is disagreement about this soft-bodied lobed animal; however, most researchers believe the animal lived a solitary existence on the ocean floor.



Resistant rock - Rock that weathers and erodes more slowly than other rock in the same area.

Rhyolite - A glassy, volcanic rock, similar to granite in composition, which usually exhibits flow lines. Metamorphosed rhyolite is the most prominent rock on the tops of the Uwharrie Mountains; used by Native Americans to make tools and projectile points. (For further information see the Rock and Mineral Fact Sheet in On-Site Activity #1 - Rock ID.)



Rock - A substance made up of one or more minerals. Rocks are an important part of the Earth's crust, mantle, and core. There are three forms of rock: igneous, sedimentary, and metamorphic.

Rock cycle - The process whereby one rock type changes into another.

Sediment - Material that settles to the bottom of a liquid, such as soil being washed into a lake and settling to the bottom.

Sedimentary rock - Rock made by the compaction and/or cementing of sediments.

Shale - A sedimentary rock composed of laminated layers of clay-like, fine-grained sediments, such as volcanic ash. (Compare with mudstone.)

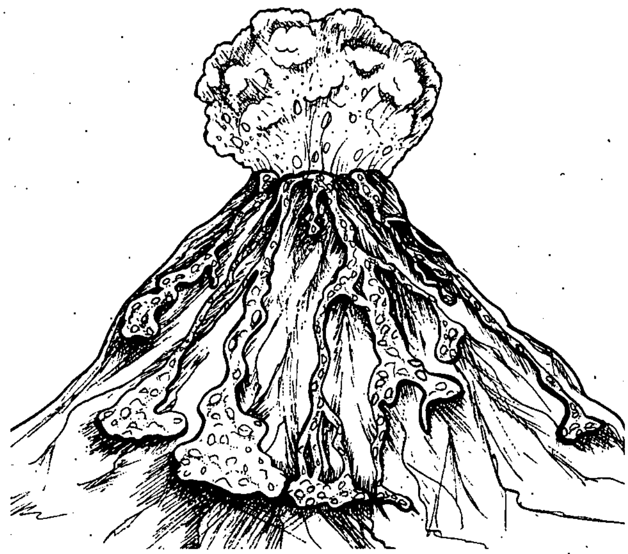
Slate - A fine-grained metamorphic rock that splits easily into thin, flat plates; often confused with argillite, which breaks into chips or blocks.

Texture - The size and arrangement of mineral grains in a rock.

Syncline - A downward fold in sedimentary rocks. (See Anticline.)

Vent - An exit hole for hot gases and lava to flow from a volcano.

Volcanic rock - Rocks produced by or discharged from a volcano.



Volcano - A vent in the earth's crust through which molten lava and gases are ejected; a mountain formed by the materials so ejected.

Weathering - Any of the chemical or mechanical processes by which rocks exposed to the atmosphere decay to soil. In the broadest sense, any of the destructive elements that wear down rocks, causing them to fragment, crack, or crumble. Examples include heat, chemicals, wind, water and ice. (Erosion loosens and carries away debris caused by weathering.)

Xenolith - Literally, a "stranger" rock, which was surrounded during the movement of magma to form an unrelated inclusion within the surrounding igneous rock.

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Summary of the Uwharrie Mountains Geology

The Uwharries, a northeast-tending mountain range, are part of a larger geologic formation called the Carolina slate belt. Composed of slightly metamorphosed **volcanic** and **sedimentary rocks**, the Carolina slate belt extends from central Virginia to central Georgia. Geologists think that this belt was part of a volcanic island chain in a shallow sea off the North American continent about 600 million years ago. Evidence for this theory comes from the three common rocks found at Morrow Mountain State Park – **argillite**, **rhyolite** and **basalt**. Using fossil ages and radiometric dates, geologists have determined the ages of these rocks to be between 550 and 600 million years old.

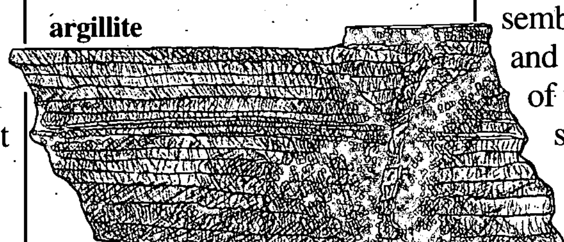
Argillite, which is found throughout the lower elevations of the park, formed in quiet waters where finer **sediments** such as volcanic ash and silt had time to settle to the bottom. Once there, the weight of water and overlying sediments helped to compact and cement these soft muds into a fine-grained sedimentary rock. Later, this **mudstone** was deeply buried and slightly metamorphosed to create the argillite we see today. Argillite contains parallel lines or layers, which represent the layers of ash and silt laid down in the ancient sea.

The layers or **bedding** planes in the argillite also provide evidence of mountain building. Although sediments are usually deposited in horizontal layers, the layers in the argillite are nearly vertical. (A good example of this can be seen in the abandoned quarry at Morrow Mountain State Park.) What could have caused this vertical orientation? Geologists think that between 250 and 500 million years ago, after the argillite had already formed, the **crustal plates** carrying Africa and North America moved together. During several mountain-building episodes, large sections of argillite and other deeply-buried rocks were folded, faulted and tilted. Millions of years of **erosion** removed the overlying rocks, exposing the argillite at the earth's surface. Since argillite is more easily weathered than rhyolite or basalt, argillite is found mainly in the creek beds and lower elevations of the Uwharries.

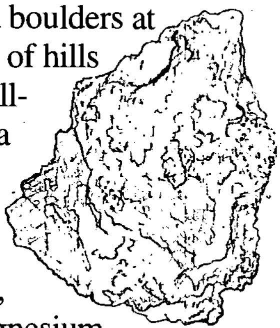
The erosion which revealed the ancient mud beds also uncovered evidence of old volcanic activity. Recall the chain of volcanic islands off the east coast of North America over 600 million years ago. The basalt and rhyolite found in the park can trace their origins back to **lava** flows from these ancient **volcanoes**. When the crustal plates carrying North America and Africa converged, this old volcanic arc became welded to the North American continent. The Uwharrie Mountains were formed sometime during the continental collision. Thus, the Uwharries themselves are not extinct volcanoes, but rather contain rocks that come from ancient volcanoes!

Because the rhyolite and the basalt were slightly metamorphosed, geologists classify them as **metamorphic rocks**, NOT **igneous rocks**. More accurate names for these two rocks are **meta**rhyolite and **meta**basalt (or greenstone). The meta prefix indicates a metamorphic or changed rock. The word following the prefix indicates the parent rock or protolith. Because the basalt and rhyolite formed from lava at very high temperatures, the heat and pressure they experienced during metamorphism did not alter them very much. These ancient rocks still resemble freshly made basalt and rhyolite from other parts of the world. For this reason, geologists prefer to keep the igneous terms, *basalt* and *rhyolite*, even

argillite



though the rocks belong to the metamorphic group.



Basalt is found in the park as rounded boulders at the bottom of hills or along hillsides. It is a fine-grained, grayish green rock, rich in magnesium and iron. The presence of **chlorite** (green mineral) in the basalt indicates that it has been slightly metamorphosed. This kind of metamorphosed basalt is often referred to as "greenstone." Because basalt contains much less silica (**quartz**) than rhyolite, it is less resistant to **weathering** and erosion.

Rhyolite is found on the tops of all the higher mountains in the Uwharries, where it has acted as a hard, protective layer. Due to its high silica content, rhyolitic lava is very thick and viscous. It does not flow very far or form gas bubbles, and it develops an extreme **hardness** upon cooling. The chemical composition of rhyolite is similar to **granite**, but its **texture** is different. Granite has a coarse-grained texture because it formed from **magma** inside the earth that cooled slowly enough for large crystals to form. Rhyolite usually has a glassy texture (with no visible crystals) because it comes from lava that cools rapidly at the earth's surface. However, some of the rhyolite at Morrow Mountain has an uneven or porphyritic texture – there are visible crystals of feldspar surrounded by extremely small grains of quartz (invisible to the naked eye). Remember that this rock was slightly metamorphosed; therefore, geologists classify it as a **metavolcanic rock**.

Because of its hardness and density, rhyolite deposits have resisted the erosion which cut away so much of the softer rock of the region. Nearly all the Uwharrie mountaintops have rhyolite boulders on them. The area's Native Americans broke up some of these rhyolite boulders to make tools, leaving the black, gray and white slivers of rock found on these mountains today. Rhyolite is the best natural material found in the southeastern United States for making stone tools which require a hard, sharp edge, such as spear and arrowheads, knives and scrapers. The first evidence of Native Americans in the area dates back to 10,000 B.C. – a long time ago by human standards but a mere moment in geological time.

Many visitors to Morrow Mountain enjoy the impressive view from the mountain's top. Morrow Mountain is only 936 feet above sea level but stands over 600 feet above the surrounding country side.

Sugarloaf and Hattaway Mountains, lying just north of Morrow Mountain, are well over 800 feet in elevation. Both are quite massive. Sugarloaf is composed of a rounded peak, a spur, and a ridge extending southward to Morrow Mountain. Hattaway is an L-shaped ridge with the shorter axis extending westward. It has no definite summit, but consists of a long ridge formation with occasional dips at stream heads. Rhyolite is less extensive on these mountains.

Fall Mountain, in the northern section of the park, has an unusual rhyolite formation called a **dike**. The dike extends northeast from this summit all the way across the Yadkin River. Such formations are caused by lava seepage through a large crack in the earth.

At the point where this dike of hard, erosion-resistant rock crosses the Yadkin River, the Great Falls of the Yadkin formed. This was the largest waterfall in the state in terms of volume of water. The early European explorer, John Lawson, visited this area in 1701 and described these falls as being very large and beautiful. Dr. Frances Kron, who lived in the house which is now part of the park's historical restoration, reported in his diary that the noise of the falls could be heard from his front porch, which is over a mile away and on the opposite side of Fall Mountain. Today, Alcoa's Falls Dam sits on top of the rhyolite dike and the falls are no longer seen or heard.

SCHEDULING WORKSHEET

Date request received_______________ Request received by_______________________________

1) Name of group (school) ____

2) Contact person _____________________________ ______________________________________
name phone (work) (home)

____
address

3) Day/date/time of requested program ____

4) Program desired and program length ____

5) Meeting place ____

6) Time of arrival at park ________________ Time of departure from park _______________

7) Number of students __________________ Age range (grade) _________________________

8) Number of chaperones ________________

9) Areas of special emphasis ____

10) Special considerations of group (e.g. allergies, health concerns, physical limitations)_________
____

11) Have you or your group participated in park programs before? If yes, please indicate previous programs attended: ____
____

If no, mail the contact person an Educator's Guide.

12) Are parental permission forms required? _________ If yes do you have these forms? ________
If not, mail contact person a Parental Permission form.

I, ______________________________, have read the entire Educator's Guide and understand and agree to all the conditions within it.

Return to: Morrow Mountain State Park
49104 Morrow Mountain Rd.
Albemarle, North Carolina 28001

PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure - an environmental education experience at ______________________________. Studies have shown that such "hands-on" learning programs improve children's attitudes and performance in a broad range of school subjects.

In order to make your child's visit to "nature's classroom" as safe as possible we ask that you provide the following information and sign at the bottom. Please note that insects, poison ivy and other potential risks are a natural part of any outdoor setting. We advise that children bring appropriate clothing (long pants, rain gear, sturdy shoes) for their planned activities.

Child's name ______________________________________

Does your child:

- Have an allergy to bee stings or insect bites?________________________________
  If so, please have them bring their medication and stress that they, or the group leader, be able to administer it.

- Have other allergies? ____

- Have any other health problems we should be aware of?________________________
  ____

- In case of an emergency, I give permission for my child to be treated by the attending physician. I understand that I would be notified as soon as possible.

______________________________________ ______________
Parent's signature date

Parent's name ______________________________ Home phone ____________
(please print) Work phone ____________

Family Physician's name ______________________ phone ______________

Alternate Emergency Contact

Name__________________________________ phone ______________

NORTH CAROLINA PARKS & RECREATION
PROGRAM EVALUATION

Please take a few moments to evaluate the program(s) you received. This will help us improve our service to you in the future.

1. Program title(s) ______________________________ Date __________
   Program leader(s) ______________________________

2. What part of the program(s) did you find the most interesting and useful? ______________________________

____

3. What part(s) did you find the least interesting and useful? ______________________________

____

4. What can we do to improve the program(s)? ______________________________

____

____

5. General comments ______________________________

____

____

____

LEADERS OF SCHOOL GROUPS AND OTHER ORGANIZED YOUTH GROUPS PLEASE ANSWER THESE ADDITIONAL QUESTIONS:

6. Group (school) name ______________________________

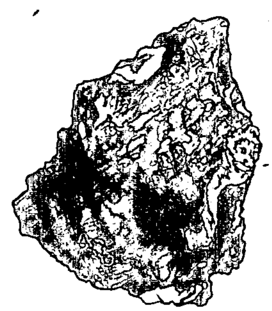
7. Did the program(s) meet the stated objectives or curriculum needs? __________
   If not, why? ______________________________

____

Please return the completed form to park staff. Thank you.

Morrow Mountain State Park
49104 Morrow Mountain Rd.
Albemarle, North Carolina 28001

Notes



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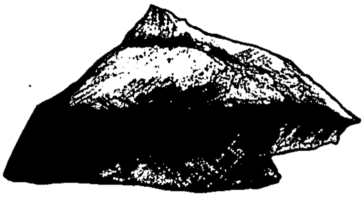

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