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ABSTRACT

This learning packet, one in a group of eight, was developed by the Crowders Mountain State Park in North Carolina for Grades 5-7 to introduce students to the geology of the Kings Mountain range in the park. Loose-leaf pages are presented in nine sections that contain: (1) introductions to the North Carolina State Park System, the Crowders Mountain State Park, the park's activity packet, and the geological history of Crowders Mountain; (2) a summary of the activities that includes major concepts and objectives covered; (3) a pre-visit activity to introduce the sedimentary, metamorphic, and igneous rock classifications and explain the rock cycle; (4) an on-site activity to enable students to identify two rocks and four minerals; (5) a post-visit activity to enable students to understand how daily materials come from the earth's resources; (6) a list of 66 related vocabulary words; (7) necessary park and parental permission forms for the visit; and (8) blank pages for taking notes. Contains 26 references. (MDH)

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TWIN PEAKS

MONADNOCKS

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Crowders Mountain State Park

An Environmental Education Learning Experience

Designed for Grades 5-7

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"The earth, from the time of the chalk to the present day, has been the theater of a series of changes as vast in their amount as they were slow in their progress. The area on which we stand has been first sea and then land for at least four alternations and has remained in each of these conditions for a period of great length."

Thomas Huxley, 1868, "On a Piece of Chalk"

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CP&L

This Environmental Education Learning Experience
was developed by

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The N.C. Division of Water Resources;

The N.C. Department of Environment, Health and Natural Resources;

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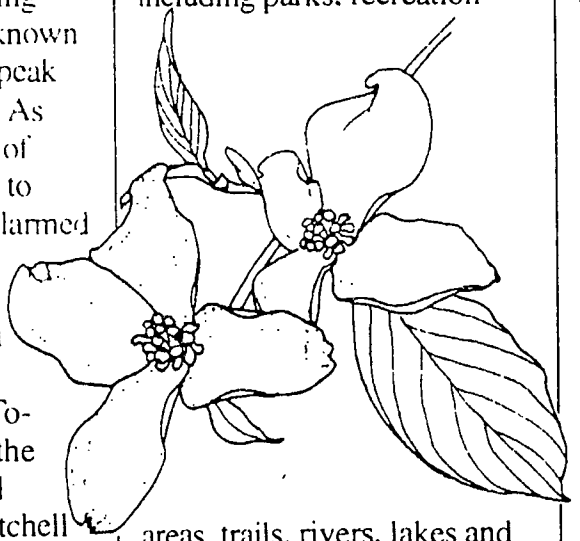
Introduction to the North Carolina State Parks System

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 125,000 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:

NC Division of Parks and Recreation
P.O. Box 27687
Raleigh, NC 27611-7687
919/ 733-4181

Introduction to Crowders Mountain State Park

Hidden amongst the sprawl of urbanization and located in the sixth most populated county in North Carolina is Crowders Mountain State Park. Many first-time visitors come upon the park by chance. As they drive along Interstate 85, they notice the rocky peaks of the park towering above the surrounding countryside. Curiosity brings them into this park of over 2,500 acres of hills, trees and rocks. The towering twin peaks: Crowders Mountain and Kings Pinnacle, lure more than 150,000 visitors a year. Park visitors can enjoy many outdoor activities such as hiking, rock climbing, nature study, backpack camping, fishing, canoeing and picnicking as they enjoy nature's beauty.

Early in the 1970s, the beauty and solitude of Crowders Mountain was threatened by mining companies. Local citizens remembered what had happened twenty years earlier at Henry's Knob, a rounded, tree-covered knoll in nearby York County, South Carolina. A mining firm started stripping it for a mineral deposit used in making porcelain (kyanite). Today the knoll is gone and in its place is a lifeless hole in the ground. Citizen and conservation groups banded together to draw the governor's attention to the fact that the mountain's natural beauty was in danger of being destroyed. In response, the exploratory mining was halted and the first section of the park opened in 1974.

Crowders Mountain and Kings Pinnacle are the tallest peaks in the Kings Mountain range. This mountain range was formed over 570 million years ago, and was once taller than the Alps. Today, the harder, more weather resistant basement rock is what stands above the rolling piedmont landscape. The Kings Mountain Range begins in Gaffney, South Carolina and runs in a northeastern direction for approximately 50 miles to the Catawba River northeast of Gastonia.

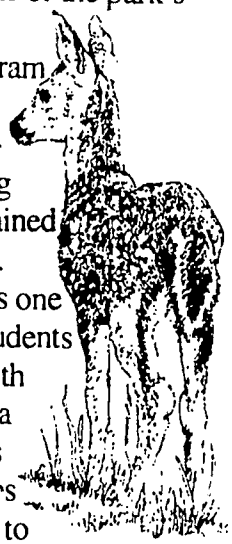
With their vast areas of exposed rock, Crowders Mountain and Kings Pinnacle offer an exceptional opportunity for the student interested in geology to study using a "hands-on" approach. Many areas of exposed rock can be seen while hiking along park trails. Five types of rocks are abundant in the park, and many others can be found in smaller quantities. Rock cliffs over 100 feet tall at the summit of the two peaks are a rock-lover's "dream come true." These weathered monadnocks tell the story of the changes that have occurred in the last 250 million years.

The Park As An Outdoor Classroom:

Crowders Mountain State Park abounds with natural history. The park is rich with cultural resources and provides a wonderful outdoor classroom for learning about the geological formation of the Kings Mountain range and many other themes.

A wide variety of outdoor educational programs are available at Crowders Mountain State Park. Leaders may choose to design and conduct their own activities, or to make use of the park's Environmental Education Activity Packets or this Environmental Education Learning Experience, "Twin Peaks Monadnocks." The park's primary themes are geology, plant communities, water quality, cultural history and resource management. Programs in these and other areas are available to groups.

The emphasis of the park's environmental education program is to provide learning opportunities utilizing resources contained within the park. Our approach is one in which the students deal directly with the resource in a way that relates to them. Groups are encouraged to



visit the park during all seasons of the year for hikes, exploration, environmental education programs and activities. However, as an alternative, we do have an outreach program in which the park staff will come to the schools.

Planning a Field Trip to Crowders Mountain State Park:

Before You Make the Trip:

1. Please contact the park at least two weeks in advance to make a reservation.

2. Complete the scheduling worksheet provided at the back of the activity packet.

3. Group coordinators should visit the park without the participants prior to the group trip. This will enable you to become familiar with the facilities and park staff, and to identify any potential problems.

4. Group coordinators should discuss park rules and behavior expectations with adult leaders and participants. Safety should be stressed.

5. Everyone should wear a name tag. Please color-code tags (for groups) and establish a buddy system.

6. Encourage everyone to wear appropriate, comfortable clothing and walking shoes.

7. The group leader is responsible for parental permission forms, located at the back of this packet, and the group's medical and health needs.

8. *If you will be late or need to cancel your trip, notify the park immediately.*

9. Research activity permits may be required for activities which require samples to be taken from the park.

10. Complete the pre-visit activity "Hard Rock Crayola".

While at the Park:

Complete the on-site activity "Read A Rock" if your class is doing the Environmental Education Learning Experience.

When hiking and studying the rocks of Crowders Mountain State Park, please be safety conscious. Some sections of the trails are fairly strenuous and may require a minimal amount of "scrambling," which should be done slowly and with care. It is recommended that proper footwear and water are brought. Also, hazards such as bees, snakes, ticks, poison ivy and extreme weather conditions do exist. These hazards can cause problems if you are not prepared. Students with any medical conditions should be monitored closely by the adult leaders.

As you enjoy the natural setting of the park, hike the trails, picnic or fish in the nine acre lake, remember that the park is for your enjoyment. Please follow all safety concerns and obey the park rules and regulations.

Please obey the following rules:

1. Be as quiet as possible while at the park. This will help you get the most out of the experience, while increasing the chance of observing wildlife.

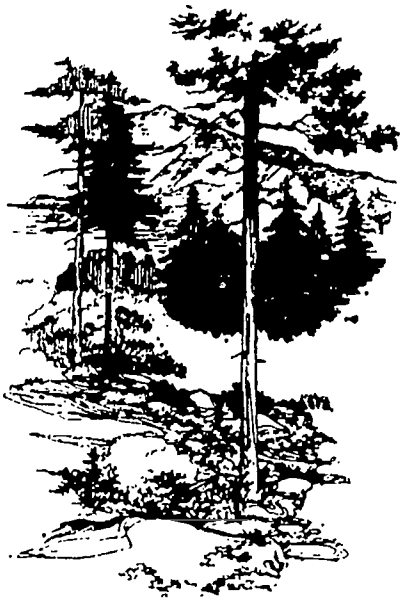
2. On hikes, the group should walk behind the leader at all times. Running is not permitted. Please stay on the trails!

3. All plants and animals are protected within the park. Injuring or removing plants or animals is prohibited in all state parks. This allows others in the future to be able to enjoy our natural resources.

4. No rocks should be taken from the park.

5. Picnic only in the designated picnic areas. Help keep the park clean and natural by not littering and by properly disposing of any litter you find.

6. In case of accidents or emergencies, contact the park staff immediately.



Following the Trip:

1. Complete post-visit activity "Geo-Scavenge".

2. Build upon the field experiences and encourage participants to seek answers to questions and problems encountered while at the park.

3. Relate the experience to classroom activities through reports, projects, demonstrations, displays and presentations.

4. Give tests or evaluations, if appropriate, to determine if students have gained the desired information from the experience.

5. Write a follow-up note to the park informing the park staff of positive aspects of the experience and any suggestions for improvements.

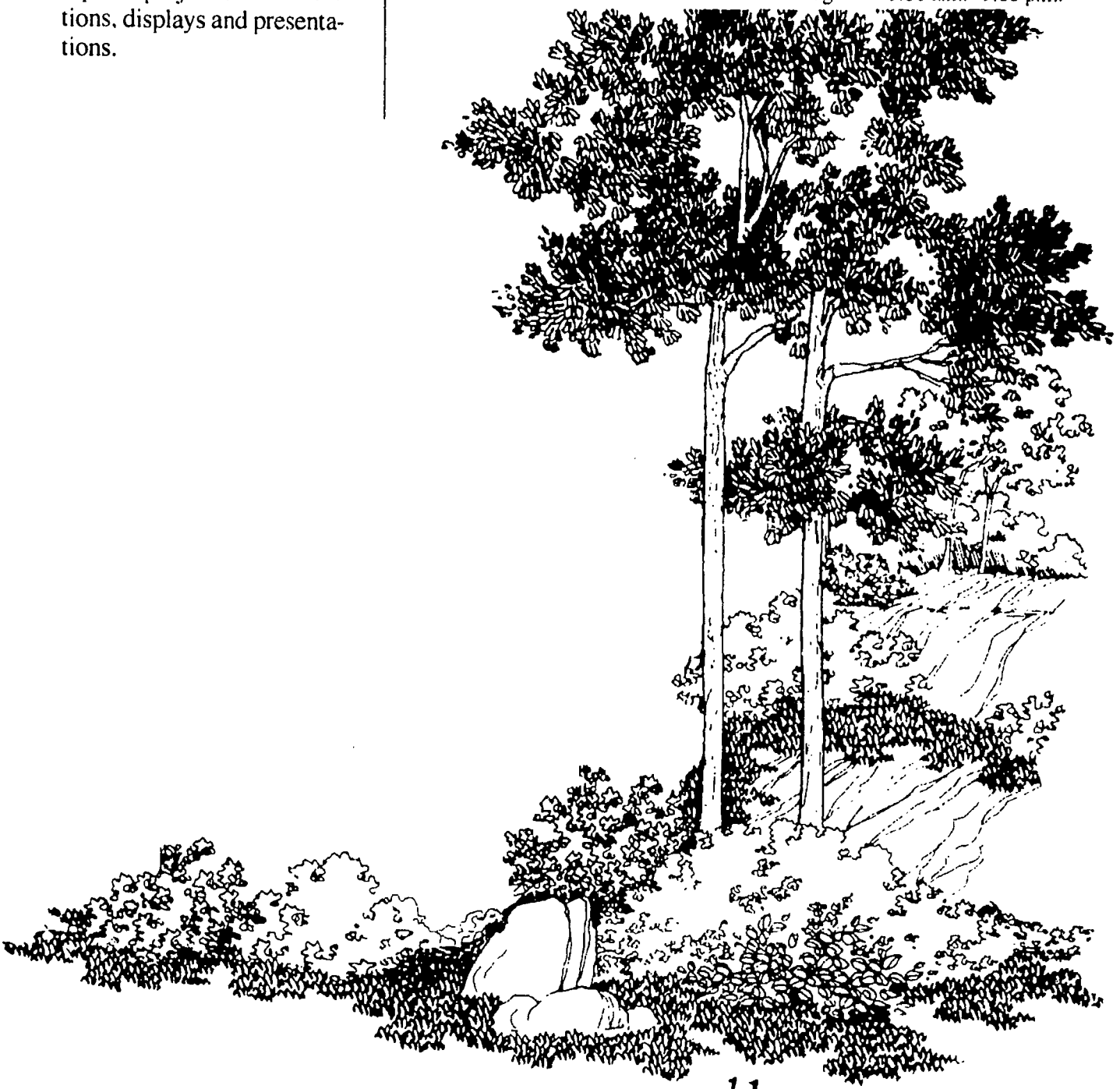
Park Information:

Address:

Crowders Mountain State Park
Route 1, Box 159
Kings Mountain, N C 28068
Tel: 704-853-5375

Hours of Operation:

Nov - Feb	8:00 a.m. - 6:00 p.m.
Mar. Oct	8:00 a.m. - 7:00 p.m.
Apr. May. Sep	8:00 a.m. - 8:00 p.m.
Jun - Aug	8:00 a.m. - 9:00 p.m.



Introduction to the Activity Packet for Crowders Mountain State Park

The Environmental Education Learning Experience, "Twin Peaks Monadnocks," is designed to introduce students to the geology of the Kings Mountain range through hands-on activities for the classroom and the outdoor setting of Crowders Mountain State Park. The packet is targeted for grades 5, 6 and 7, and meets established curriculum objectives of the N.C. Department of Public Instruction. Three types of activities are included:

- Pre-visit activity
- On-site activity
- Post-visit activity

The on-site activity will be conducted at the park, while the pre-visit and post-visit activities are designed for the classroom environment. The pre-visit activity should be done prior to the park visit so the students will have the necessary geologic background and vocabulary for the on-site activity. We encourage you to use the post-visit activity to reinforce concepts, skills and vocabulary learned in the pre-visit and on-site activity.

This Environmental Education Learning Experience, "Twin Peaks Monadnocks," will expose the student to the following major concepts:

- **Weathering**
- **Erosion**
- **Environmental changes**
- **Rock formations**
- **Rock composition**
- **Rock and mineral identification**
- **Land forms**

The first occurrence of a vocabulary word used in these activities is indicated in **bold type**. Definitions are listed in the back of this Environmental Education Learning Experience. A list of the reference materials used in developing the activities follows the vocabulary list.

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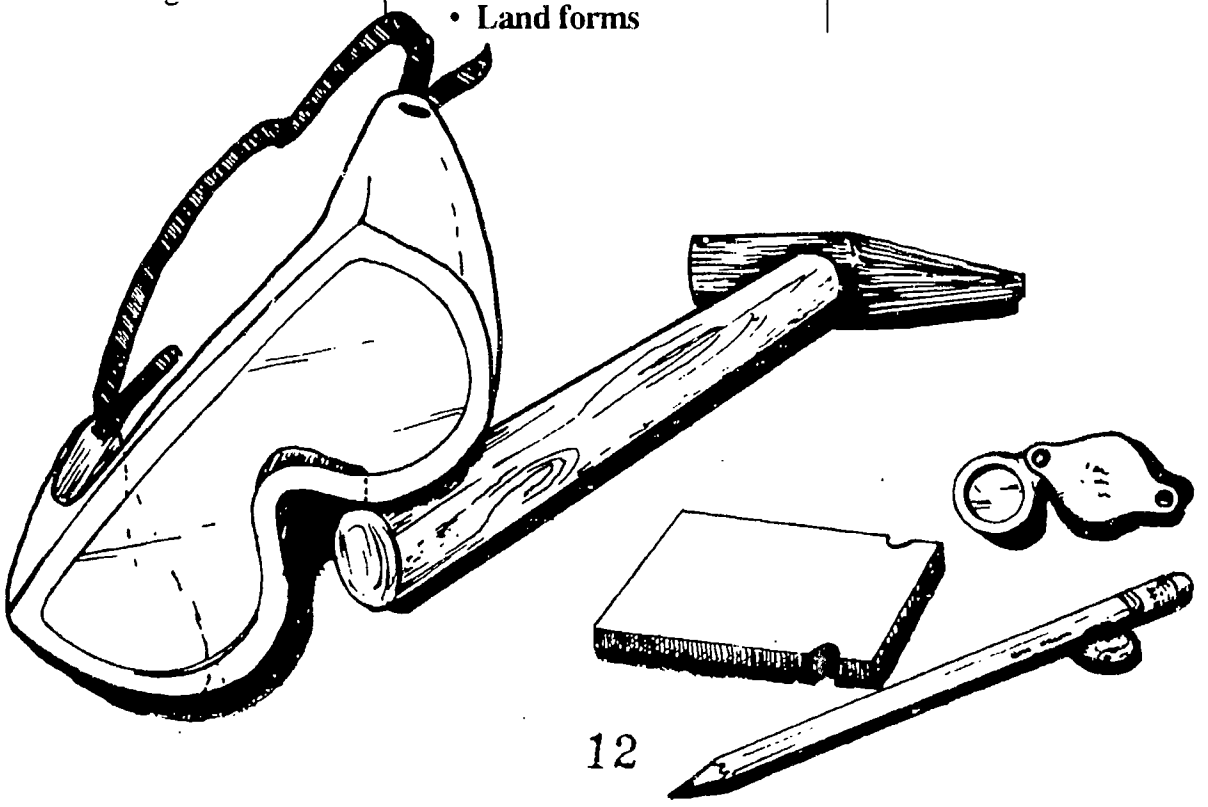
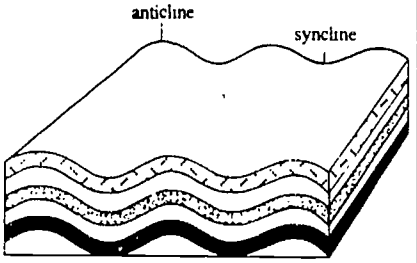


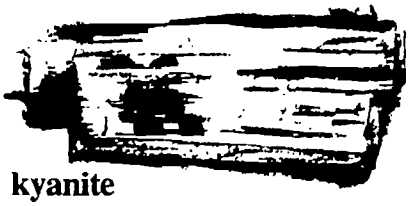
Introduction to the Geologic History of Crowders Mountain

About 540 million years ago, the **sediments** and volcanic materials which formed the **rocks** of the Crowders Mountain area were being deposited in a shallow basin or sea. This process continued for millions of years, burying the successive layers of sediment miles beneath the surface of the Earth. Then, approximately 250 million years ago, the North American and African continents collided, pushing the land upwards, forming the Appalachian Mountains, and closing the shallow sea. The deeply buried layers flowed like putty, forming large upward folds (**anticlines**) and downward folds (**synclines**).



Evidence of this can be seen in the buckled and **folded** rocks along the ridge tops in Crowders Mountain State Park. The intense heat and pressure not only folded and metamorphosed the rocks of our area, in some instances it actually melted the rock, forming pockets of **magma** which cooled beneath the surface, forming the **igneous rock**, **granite**. Granite **outcrops** can also be seen along the ridges in the park. The tremendous heat and pressure caused by the collision of the **continental plates** also formed **metamorphic rocks**, changing the **shales** into **schist** and **gneiss**, and **sandstone** into massive **quartzites**, creating the rocks which formed Crowders Mountain and Kings Pinnacle.

Further evidence of the intense heat and pressure (**compaction**) caused by this collision is seen in the presence of **metaconglomerates**, and in the presence of **kyanite** crystals in the quartzite which forms the mountains. **Conglomerates** are **sedimentary rocks** composed of chemically cemented pebbles and sand. Metaconglomerates are metamorphosed conglomerates which still contain identifiable pebbles. The pebbles in the metaconglomerates of our area are deformed and elongated, due to the forces of the collision. Kyanite is a **silicate mineral** which forms under pressure and heat deep within the earth. Its abundance in the Crowders Mountain area is due to the massive forces involved in the building of the southern Appalachians.



kyanite

The Appalachian mountain building episode was the last

quartzite

major geologic event to affect the east coast of the North American continent. During this event, the rocks which form Crowders Mountain and Kings Pinnacle were pushed closer to the surface. It was another 200 million years before the tops of the rocks were exposed on the surface of the earth by the processes of **weathering** and **erosion**. At that time, the summits of Kings Pinnacle and Crowders Mountain were part of a broad **peneplain** which stretched from Tennessee to the coastal plain of North Carolina. A peneplain is a gently rolling landscape created by the effects of weathering and erosion.

Over the next 25 million years, continued erosion created the land surface in North Carolina as we know it today. Steeper gradients on the eastern slopes of the peneplain resulted in rapid erosion. The rushing waters almost destroyed the surface of the peneplain, while creating the new surface we know today as the piedmont. Remnants of the old surface still dot the

piedmont. Today people recognize names like Kings Mountain, Crowders Mountain and Kings Pinnacle, but few realize that these landmarks are not mountains, but the remains of an older and higher land surface. These erosional remnants are called **monadnocks**. They have persisted because they are composed of harder material than the surrounding landscape. In the case of Crowders Mountain and Kings Pinnacle, this material is quartzite.

From sand to sandstone, from sandstone to quartzite, to the mountains we see today, the rocks of Crowders Mountain have endured for over 400 million years. They are now set aside as a park, for the enjoyment of our generation and generations to come.

Activity Summary

The following outline briefly summarizes each activity of this Environmental Education Learning Experience, the major concepts introduced and the objectives met by completion of the activity.

I. Pre-Visit Activity

#1 Hard Rock Crayola (page 3.1.1)

In this interesting hands-on activity the processes of sedimentary, metamorphic and igneous rock formation will be "created" by the students. The activity will introduce the students to the different rock classifications: sedimentary, igneous and metamorphic. Students will learn how the different rock classifications are formed and how to recognize them.

Major Concepts:

- Rock cycle
- Mechanical weathering
- Formation of sedimentary rock
- Formation of metamorphic rock
- Formation of igneous rock

Objectives:

- List the three main rock classifications.
- Describe how these rock classifications are formed.
- Explain the rock cycle.

II. On-Site Activity

#1 Read a Rock (page 4.1.1)

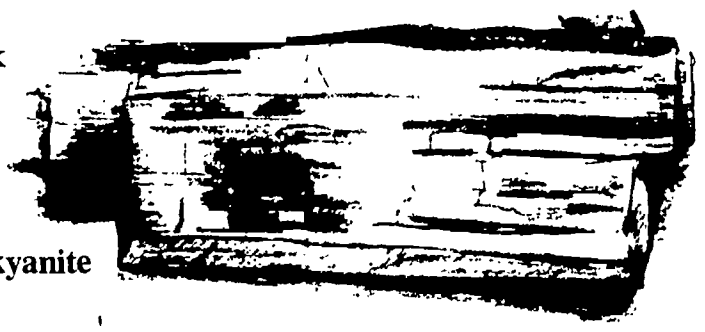
The on-site activity will familiarize the student with the specific rock types at Crowders Mountain State Park, their classification and characteristics, and where they are found. The results should render a basic knowledge of rock and mineral identification.

Major Concepts:

- Rock formation and characteristics
- Mineral formation and characteristics
- Sedimentary, metamorphic and igneous rocks

Objectives:

- List and identify two major rock types and four major minerals found at Crowders Mountain State Park.
- Describe the difference between a rock and a mineral.
- List five characteristics that geologists use in identifying rocks and minerals.



kyanite

III. Post-Visit Activity

#1 Geo-Scavenge (page 5.1.1)

The Geo-Scavenge hunt will broaden the student's understanding and appreciation of the Earth's "ingredients," which are found in ordinary objects that are used by all of us every day. The post-visit activity is designed for review, and to broaden the student's understanding of geology.

Major Concepts:

- Uses of rocks and minerals

Objectives:

- Differentiate between 10 objects, determine whether they are derived from rocks, minerals, fossil fuel or organic materials.
- Explain the importance of geologic products in our daily lives.

Pre-Visit Activity #1 Hard Rock Crayola

Curriculum objectives:
Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension, writing
- Guidance: competency for interacting with others
- Healthful Living: safe school environment
- Science: earth science
- Social Science: gather, organize and analyze information, draw conclusions, participate effectively in groups

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension, writing
- Guidance: competency and skill for interacting with others
- 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
- Healthful Living: school safety
- Science: earth science, natural phenomena
- Social Studies: know the importance of natural resources, gather, organize and analyze information, draw conclusions

Location:
Classroom/science lab

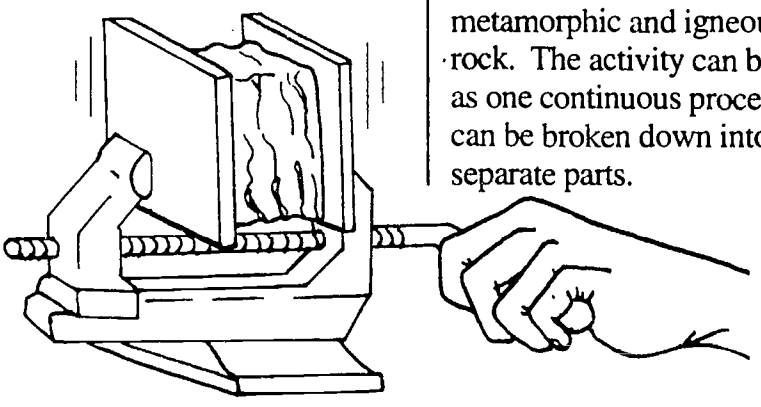
Group Size:
30 students or less, divided into groups of four

Estimated Time:
Two to four hours

Appropriate Season: Any

Materials:
Provided by educator:
Per student: safety goggles, large pocket pencil sharpener, 4 wax crayons of the same color (either red, green, blue, or yellow), envelopes
Per group: hot plate, 2 oven mittens, petri dish, aluminum foil, 3 disposable aluminum foil pie pans, wax paper, wooden or metal trivet, newspaper (enough to cover lab surfaces - have lots of newspapers handy)
Per class: one or more vises with 2 board pieces (3 cm x 13 cm x 20 cm), samples of real sedimentary, metamorphic and volcanic rocks (contact the park if you need to borrow a rock set), crushed ice, water

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



Major Concepts:
- Rock cycle
- Mechanical weathering
- Formation of sedimentary rock
- Formation of metamorphic rock
- Formation of igneous rock

Objectives:
- List the three main rock classifications.
- Describe how these rock classifications are formed.
- Explain the rock cycle.

Educator's Information:

Many students have a difficult time understanding the abstract concept of the rock cycle. 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 is extremely effective in giving students the opportunity to "see" the rock cycle through a series of simulation activities: mechanical weathering and erosional processes, 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:

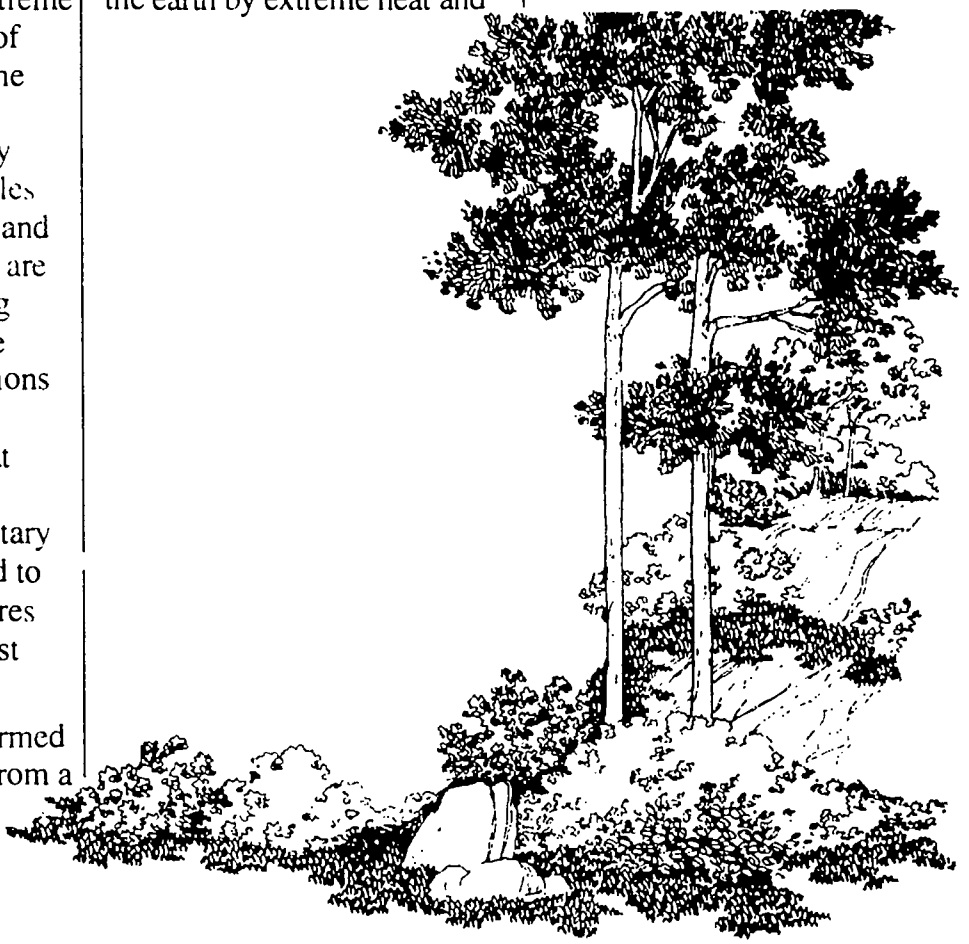
The **rocks** of the **earth's crust** are classified according to origin. There are three basic rock classifications. Of these three, two (igneous and metamorphic) are formed by geological processes occurring deep within the earth. The other, sedimentary, is formed closer to the earth's surface. The relationship between these three rock classifications is what is generally called the **rock cycle**.

1) **Sedimentary rock** - rock that is composed of tiny particles of sand, clay or other **sediments** that are deposited in layers on land or on the bottom of lakes, rivers and oceans. Over time, the extreme pressure from the weight of the layers above pressed the materials below into rock, cementing the sedimentary particles together. Examples are **limestone**, **sandstone** and **shale**. Sedimentary rocks are important when discussing the rock cycle and also the metamorphic rock formations at Crowders Mountain. The **metamorphic rock** at Crowders Mountain was formed when the sedimentary rock layers were subjected to extremely high temperatures and pressure during the last 540 million years.

2) **Igneous rock** - rock formed from **magma**, solidified from a molten state. It can be **extrusive** or **intrusive**. Extrusive igneous rock is formed when magma spews out onto the earth's surface from cracks or **vents** in the earth's crust. This type of magma is called **lava**. Intrusive igneous rock is formed when magma finds its way into cracks in the rock and solidifies within the earth. The igneous rock formations at Crowders Mountain are intrusive igneous rocks. Granite **outcrops** are a good example of the intrusive igneous rock found at Crowders Mountain.

3) **Metamorphic rock** - sedimentary or igneous rock that has been changed deep inside the earth by extreme heat and pressure over a long period of time into a harder rock, with different qualities. An example of sedimentary rock which was changed to a metamorphic rock is quartzite. Quartzite, made from sandstone, is a major rock type found at Crowders Mountain.

The word **metamorphosis** means a transformation, a marked change in appearance or condition. A more familiar example of metamorphosis is a caterpillar changing, or metamorphosing, into a butterfly (although this is not accomplished by applying extreme heat and pressure to the caterpillar).



The Earth's History & the Rock Cycle

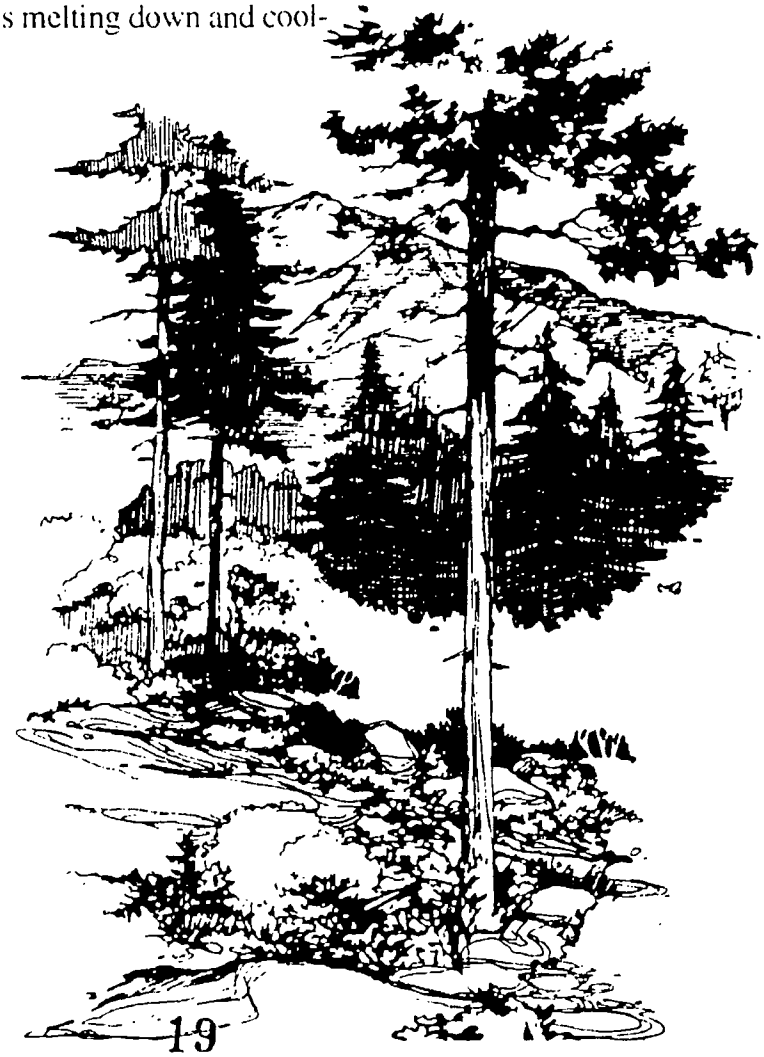
Geologists believe the earth was at one time a ball of molten magma and gasses. Slowly, the earth cooled, forming a crust of igneous rock. This rock floated on the **mantle**, the geologic term for the layer between the crust and the core. The crustal rock was immediately subject to **weathering**.

For over three billion years the weathering forces of gravity, wind and water worked on the bare rock of the continents, eroding it into sediments. Wind and rain deposited these sediments, the first soils, into the oceans at the edges of the continents. These soils traveled quickly, since there were no plants to slow them down or stabilize them.

The sediments continued to build up as the continents wore down. Underlying layers of sediments became rock again as the pressure and heat cemented the particles back together. Often, as the continents eroded, they became lighter and rose up on the mantle, exposing the sedimentary rocks to the air, where they started to erode away once again. Though most of the earth's crust is made up of igneous rock, the most common class of rock found on the earth's continental surface is sedimentary, which lies on top of the igneous crust.

The continents are not stationary as they float on top of the molten mantle. The North American continent is drifting westward. Where two continental plates collide, one will often slide beneath the leading edge of the other, pushing the crust down far enough that it melts, turning into magma. This collision of continental plates pushed up the Rocky Mountains. Sedimentary and igneous rocks caught in such collisions are subjected to tremendous heat and pressure, forming a third class of rock known as metamorphic. Eventually the metamorphic rock will reach the earth's surface and will be exposed to weathering as well.

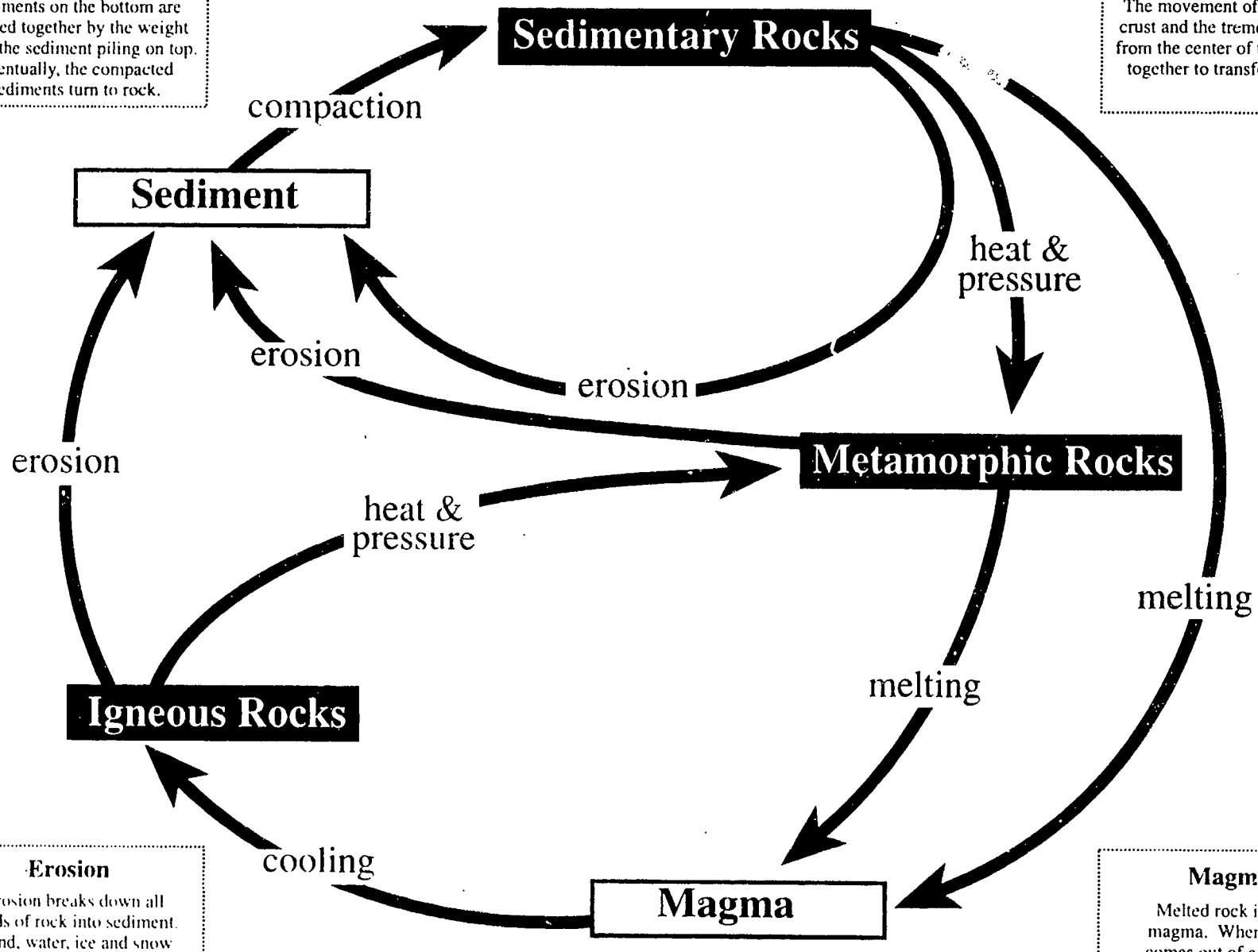
The continuing cycle of rocks melting down and cooling into rocks again or breaking down and then being pressed into rocks again has happened many times. It is hard to imagine that all the rocks you see around you were once sediments at the bottom of the sea, and that one day the particles in these rocks will be washed there again. It is also difficult to imagine something as hard as a rock breaking down and the time it takes for this to happen. The particles in the rocks making up Mt. Everest, the highest mountain in the world, are estimated to have eroded to the sea at least three times.



Rock Cycle Worksheet

Compaction
As sediments pile up, those sediments on the bottom are packed together by the weight of all the sediment piling on top. Eventually, the compacted sediments turn to rock.

Heat and Pressure
The movement of the earth's crust and the tremendous heat from the center of the earth act together to transform rocks.



Erosion
Erosion breaks down all kinds of rock into sediment. Wind, water, ice and snow all cause erosion.

Magma
Melted rock is called magma. When magma comes out of a volcano, it is called lava.

Instructions:

Set the stage by asking students to describe local rocks and/or rock formations, or ones that they have seen during walks along a lake or river's edge, near or on a mountain, or during drives along roads that were built through road cuts. Be sure to have several rock samples distributed around the room.

Ask the students questions such as, "Have you ever wondered just how these rocks form?" and "Are new rocks forming at this moment?" You might ask each student to write down one rock-related question they would like to have answered in class. Discuss with the students the three classifications of rock: sedimentary, metamorphic and igneous.

Part A: Weathering

Give each student a "Hard Rock Crayola" worksheet to complete as they do the activity. Cover all desk tops with newspaper. Give each student a sheet of wax paper, a pocket pencil sharpener and four crayons of the same color. The crayons represent rock material, and the pencil sharpeners represent weathering agents. Students should remove and discard the paper from the outside of their crayons. Next, they should carefully shave the crayons with the pencil sharpener, keeping all of the fragments (which represent rock sediments) in a small pile.

As the students are "weathering" their crayons on to the wax paper, call their attention to the size and shape of the fragments. Discuss with them the following questions:

"Are the weathered fragments all the same?" Answer: No.

"Why or why not?" Answer: The process of weathering can be either mechanical (breaking up a rock into smaller fragments), or chemical (rearranging the elements into new **minerals**). Many factors are involved within each of the two types. As a result, rock will show a characteristic size and/or shape, depending on which kind of weathering is taking place.

"What are some of nature's weathering forces?" Answer: Mechanical weathering forces can include water, ice, wind, growing roots, worms and burrowing animals, lightning, expansion and contraction caused by heating and cooling, human activity and expansion of rock caused when **erosion** removes weight on top and produces cracks under the surface of the rock. **Chemical weathering** forces include oxygen, carbon dioxide, water, etc., reacting with a rock or mineral resulting in change.

"Where do rock fragments tend to collect?" Answer: On the downhill side of the rock.

"Why?" Answer: Gravity

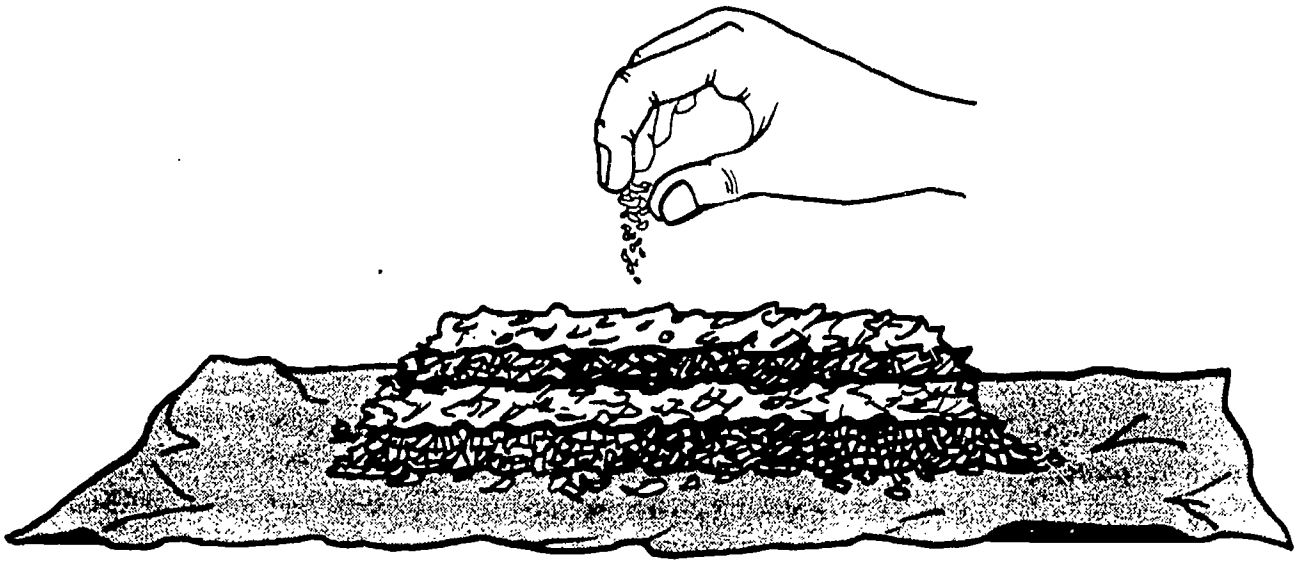
"Why do similarly sized fragments seem to be found together?" Answer: Because similar weathering processes will usually take place in one particular area. Also smaller, lighter rock fragments will be carried away in a winnowing effect.

When the "weathering" is complete, the students should wrap their fragments in their wax paper and place each color in a separate envelope, unless you plan to do Part B immediately. Label each package for proper distribution when the activity is resumed.

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 as they move the envelopes containing the fragments within the room. Ask the students what this force of movement is called, and to name some of its causes. (Answer: erosion, caused by wind and water such as streams, rivers and waves.)

Place all the weathered "rock" fragments in four separate piles, one color to a pile. Divide the class into groups of four and give each group a sheet of aluminum foil (45 cm x 45 cm). A student from each group should carefully transfer some "weathered" fragments to the center of their aluminum foil. Spread the fragments into a 1 cm thick layer. Repeat with the remaining colors, layering the colors one on top of another (see illustration).



Students should record their observations of their "weathered" fragments on the "Hard Rock Crayola" worksheet. Fold the foil over the fragment 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, stop here and label each package for proper distribution later.

Part C: Sediments/ Sedimentary Rock Simulation

Instruct the groups to place their folded foil package between two boards. This "sandwich" should then be placed in the vise. Apply very light pressure with the vise to compress the "rock" fragments. Once the "rock sandwich" has been lightly compressed, remove it 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; they should lift this portion from the non-compressed fragments and carefully break it into two parts. Look at the broken edges and describe the layers. How do they compare with the original layers? What happened to the spaces between the fragments? (Answer: The layers are thinner and the space between the crayon fragments is now smaller.)

If possible, compare real sedimentary rock with the sedimentary "crayon rocks." Explain to the students that, in this area, sediments were laid down in a shallow basin or sea around 540 million years ago. These sediments were buried within the earth's crust, forming sedimentary rock. Then, when the North American and African continental plates collided, the buried sedimentary rock was changed into metamorphic rock. These rocks were the core, or basement, of the mountain range that resulted from the collision. Later, as the rock above was eroded away, the landscape that we see around us today was exposed.

There is not much sedimentary rock left in its original layered form at Crowders Mountain when compared to the amount of metamorphic rock. This is due to the age of the rocks and the changes the rocks underwent as the fragments were buried, heated, folded and pressed together. As "Hard Rock Crayola" demonstrates, the original fragments are hardly recognizable after the pressure and heat processes.

If available, have the class examine a sedimentary rock with **fossils** embedded within

it. Almost all fossils are found in sedimentary rock. Fossils are not found in igneous rock since the tremendous heat necessary to melt rock would obliterate any fossils. The same is true for metamorphic rock. Due to the heat, folding and pressure required to create metamorphic rock, any fossils that might have been present are usually destroyed. Since almost all the rock at Crowders Mountain State Park is metamorphic, no fossils have been found.

Each group should transfer a few of their loose fragments and the smaller piece of the "sedimentary rock" into one of their pie pans. Place the rest of the fragments in an envelope (for Part E). The pieces in the pie pan will be used for comparison 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 and label each package for proper distribution later.

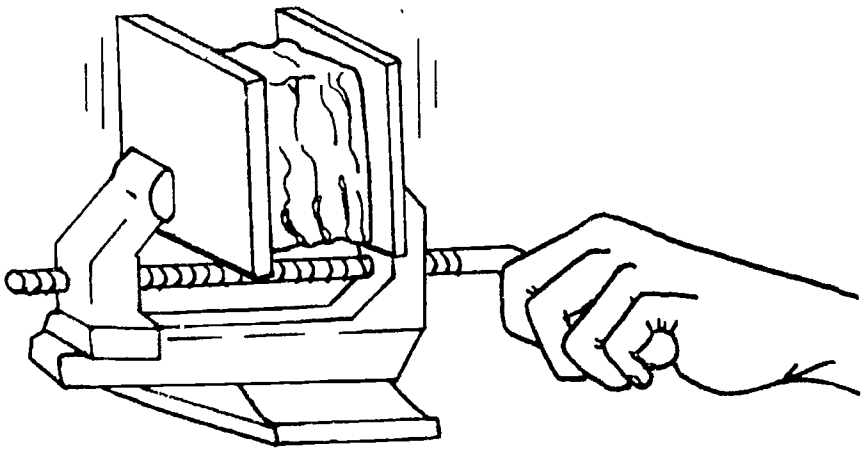
Part D: Metamorphic Rock Simulation

Place the foil package with the "sedimentary rock" between the two boards and in the vise again. Tell the students to tighten the vise as much as they can this time. This part of the activity demonstrates the need for greater pressure to cause a rock to metamorphose. In reality, as the pressure deep within the earth increases, the temperature increases as well. A temperature change is probably occurring in this activity but the change cannot be measured - the chemical activity associated with the formation of metamorphic rock is not a part of this activity. It is important for the students to understand that metamorphic rock may become contorted in appearance - and actually flow like a plastic material - in response to the pressure that is caused by the over-riding rock load and continental 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, fragment shape and surface. The students should write down their observations on their worksheet. (The different colored "rock fragments" will be squeezed together.)

If possible, examine a real metamorphic rock and compare to the metamorphic "crayon rock." Also compare the real metamorphic rock with the real sedimentary rock. Have the students examine the texture, the edges and overall appearance of these rocks. Remind the class that the rocks at Crowders Mountain State Park are almost all metamorphic, and that as the basin or sea opened and closed due to two continents colliding about 250 million years ago, the sedimentary rock was turned into metamorphic rock by heat and pressure.

Place the smaller piece of "metamorphic rock" into the pie pan with the fragments and the first sedimentary "rock" sample the students made. If you are breaking the activity into sections, stop here and label each package for proper distribution later.



Part E: Igneous Rock Formation

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

Each group should line their remaining two pie pans with aluminum foil and do the following:

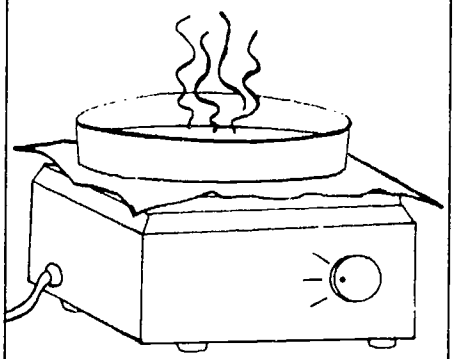
Groups 1 and 2 should fill one of their pie pans with crushed ice.

Group 3 should fill one of their pie pans halfway with warm water.

Group 4 should place half of their set aside "weathered elements," their "sedimentary rock" and the smaller piece of their "metamorphic rock" into one of their pie pans. (Groups 1, 2 and 3 will save their "sediments" and "rock" pieces for everyone to use to compare with the four types of "igneous rocks" that will be made in this part of the activity.)

For the "igneous rock" simulation, Groups 1, 2 and 3 should place the "weathered sediments" they set aside in envelopes, and the larger piece of "metamorphic rock", into the second of their foil lined pie pans. Group 4 should place the second half of their set aside "weathered sediments" and their large piece of "metamorphic rock" into their second foil-lined pan.

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 pie pan of "weathered sediments" and "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 "weathered sediments" are in the molten state, turn the hot plate off and carefully remove the pie pan,



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, representing magma, a student from each group or the teacher, should CAREFULLY do the following:

Group 1 - Form a trench in the ice in the pie pan. Using the oven mittens, pour the melted wax into the ice trench, then cover the "magma" with more crushed ice. This simulates intrusive igneous rock, which is formed by magma flowing into rock cracks deep inside the earth.

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.

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 water region, i.e. a **volcano** that forms under the ocean.

Group 4 - Using the oven mittens, pour the melted wax over the "weathered sediments" and the small pieces of "sedimentary" and "metamorphic" rock. This simulates lava flowing over sediments, sedimentary and/or metamorphic rock, as would happen in a **volcanic eruption**. Some of the fragments will melt quickly, while the sedimentary and the metamorphic "rocks" partially maintain their integrity. During a volcanic eruption, lava will flow over and around rocks in its path, causing some to melt, while others remain as they were originally. These rocks that are surrounded by lava are called **xenoliths**.

Allow the pie pans and wax to cool thoroughly (about 5 to 10 minutes). After the "lava" wax has cooled, the students should carefully remove their "igneous rocks" from the pie pans. Students should make comparisons between the igneous rocks in each groups' pie pans, then draw and write down their observations on their worksheets. For instance, comparisons should be made between the crystal sizes and shapes formed. Comparisons should also be made between these "igneous rocks" and the "weathered sediments" and the "sedimentary and metamorphic rocks" students created in the previous sections of this activity.

As a class be sure to discuss the following:

Using Group 1's pie pan, discuss the effect of the "magma" on the "metamorphic rock" which the ice represents.

Using Group 2's pie pan, discuss the effect of "lava" on the "surface sediments and rocks" which the ice represents.

Using Group 3's pie pan, discuss the effect of the warm water on the "lava."

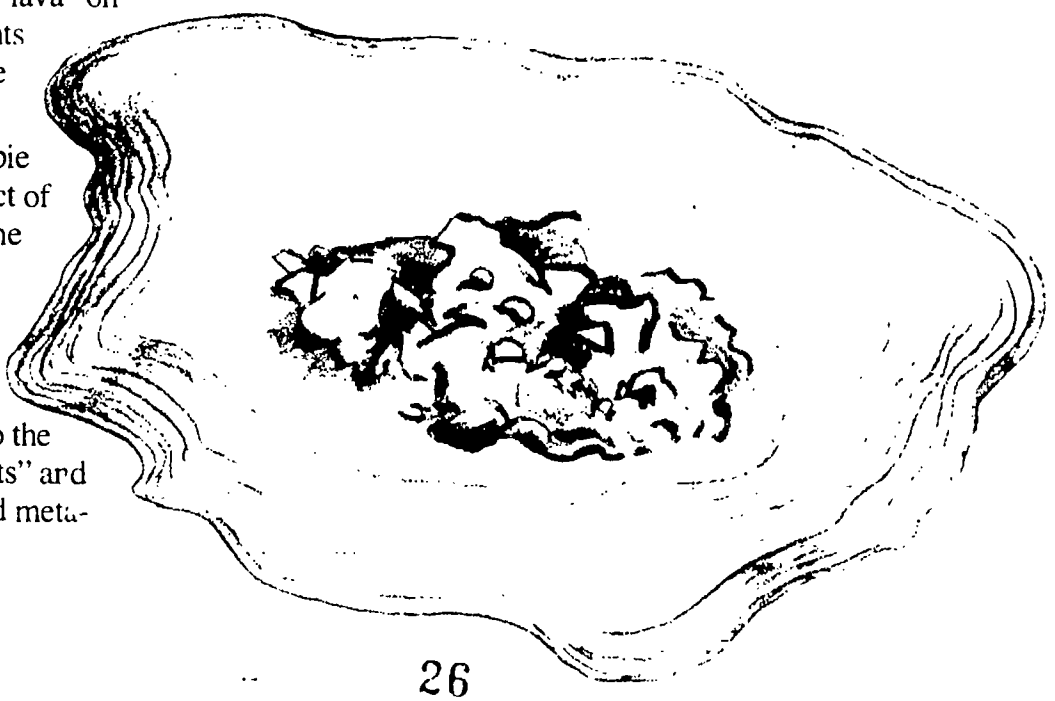
Using Group 4's pie pan, discuss the effect of the "lava" flowing directly onto the "weathered sediments" and the "sedimentary and metamorphic rock."

If possible, show the students various examples of real volcanic rocks and compare the real rocks with their igneous "crayon rocks." Explain to the students that there are few igneous rocks visible here at Crowders Mountain State Park. They have formed deep within the earth and the process of weathering and erosion has not eroded down to them except in a few scattered granite outcrops. The rocks the students will see at Crowders Mountain State Park are almost all metamorphic.

While the students are looking at the three classes of rocks, lead a discussion on the rock cycle, focusing on the processes they observed in transforming one rock into the next. Have the students discuss the differences and similarities between their "crayon rocks" and the real rock samples. Talk about the questions your students had when the activity first started.

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

It is important for everyone to understand 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.



Worksheet for Pre-Visit Activity #1 Hard Rock Crayola

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

2. Do a colored drawing of the "rock fragments" after light pressure has compacted these "sediments" into "sedimentary rock." Describe the broken edge and the layers that were formed.

3. Do a colored drawing of the "sedimentary rock" after heavy pressure has compacted it into "metamorphic rock." Describe the broken edge and the layers that were formed. How have they changed with the addition of heavy pressure?

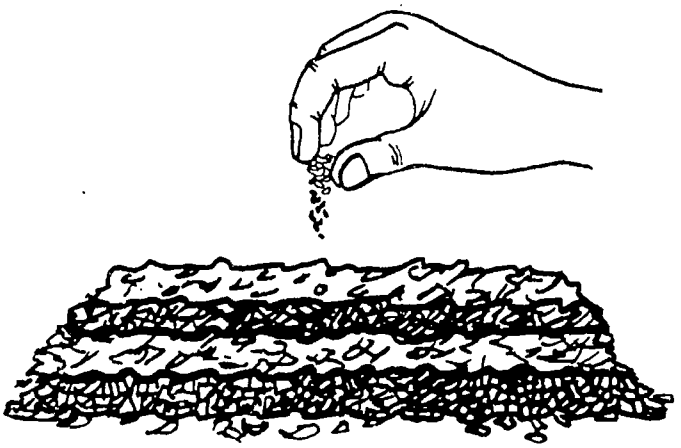
4. Do a colored drawing of each of the four igneous rocks created. Compare and contrast the formation of the intrusive with the extrusive igneous rocks.

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. Describe their similarities and differences as to color, texture, etc.

Answer Sheet for Pre-Visit Activity #1 Hard Rock Crayola

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



2. Do a colored drawing of the "rock fragments" after light pressure has compacted these "sediments" into "sedimentary rock." Describe the broken edge and the layers that were formed.

3. Do a colored drawing of the "sedimentary rock" after heavy pressure has compacted it into "metamorphic rock." Describe the broken edge and the layers that were formed. How have they changed with the addition of heavy pressure?

4. Do a colored drawing of each of the four igneous rocks created. Compare and contrast the formation of the intrusive with the extrusive igneous rocks.

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. Describe their similarities and differences as to color, texture, etc.

The "weathered rock fragments" will vary in size and shape, depending on the implement used and how it is used. The "rock fragments" can be oriented (up/down or right/left) in any direction. In "metamorphic rocks" the space between the 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 due to the melting and mixing of different "rock fragments" and has a variety of forms, depending on how the separate groups' rocks were cooled.

Note: 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.

On-Site Activity #1 "Read a Rock"

Curriculum Objectives:
Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: competency for interacting with others
- Healthful Living: recreational safety
- Science: earth science
- Social Science: gather, organize and analyze information, draw conclusions, participate effectively in groups

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: competency and skill for interacting with others, variety and complexity of occupations
- Science: how science helps us
- 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: earth science, natural phenomena
- Social Studies: know the importance of natural resources, gather, organize and analyze information, draw conclusions

Location: Picnic shelter

Group Size:
30 or less, 4 students per group

Estimated Time: 50 minutes

Appropriate Season: Any

Special Considerations:
During part of this activity, students will be breaking rocks apart. Very sharp fragments can fly off, causing injury. It is important that students wear safety goggles at all times.

Materials:
Provided by the park: index cards, hammers, safety goggles, streak plates (pieces of unglazed porcelain), window glass, pennies, steel files, hand lenses, and examples of quartz, quartzite, talc, barite, mica schist and kyanite
Provided by the educator: "Rock and Mineral" fact sheet (one per student), "Rock and Mineral Identification" worksheets (one per student), poster-size "Rock and Mineral Identification" worksheet

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

Objectives:
- List and identify two major rock types and four major minerals found at Crowders Mountain State Park.
- Describe the difference between a rock and a mineral.
- List five characteristics that geologists use in identifying rocks and minerals.

Educator's Information:

In this activity, the student will identify two rocks and four minerals. Each one is found at Crowders Mountain State Park and most could probably be found around the student's home and school.

Each student will complete a "Rock and Mineral Identification" worksheet. This will require that they examine each rock and mineral to determine the following: the color of a newly exposed surface of the rock or mineral, the color the rock or mineral leaves on a porcelain streak plate, its luster, the approximate hardness of the rock or mineral and whether or not it is layered. After determining the characteristics of each rock or mineral and by using the written descriptions from the "Rock and Mineral Fact Sheet", the students will be able to name each rock and mineral sample and give its classification.

Barite

Student's Information:

There are three basic **rock** classifications: igneous, sedimentary and metamorphic.

Igneous rocks are formed when molten **magma** 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 Crowders Mountain State Park do not have an igneous origin.

Sedimentary rocks are formed when loose **mineral** particles, or **sediment**, are deposited on land or in water. Sedimentary rocks usually form in layers, which is the easiest way to identify this type of rock. Very few of the rocks at Crowders Mountain are sedimentary; however, most of the metamorphic rocks at Crowders Mountain were formed from sedimentary rocks.

Metamorphic rock is formed when either igneous or sedimentary rocks are put under enough heat and pressure over a long period of time. The rock is changed both physically and chemically. Most of the rocks at Crowders Mountain State Park are the result of metamorphic action. The Kings Pinnacle **monadnock** is a good example of the most common metamorphic rock found in the park; **quartzite**. The second most common metamorphic rock found here is **mica schist**.

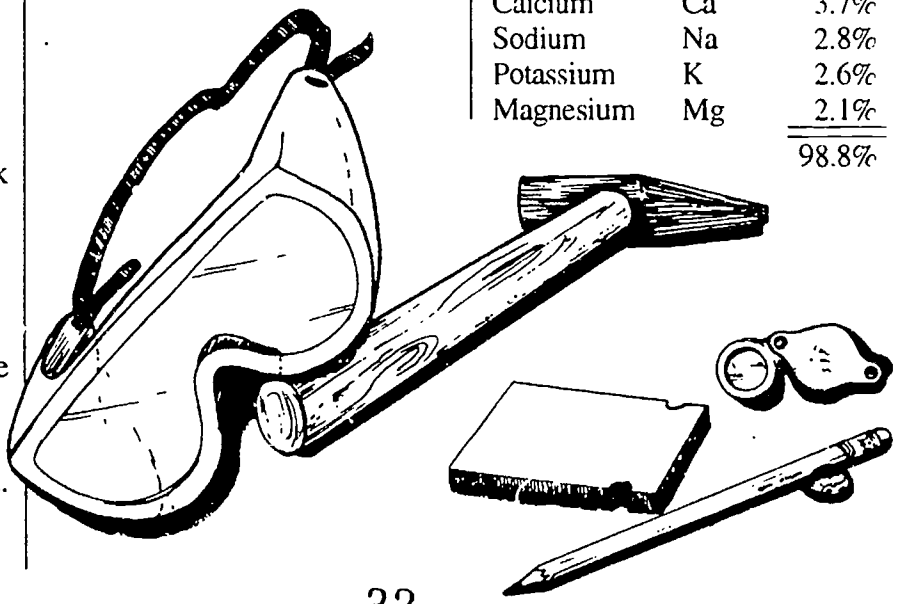
Geologists have identified about 2000 kinds of rocks, each with its own distinctive characteristics. To identify rocks, geologists look at hardness, color, crystalline arrangement, layering, types of minerals and many other characteristics.

Geologists also look for the ratio of minerals in a rock. A rock is a collection of one or more minerals. A mineral is a combination of one or more elements. Each mineral has its own chemical composition and particular crystalline structure. **Quartz**, for example, a common mineral in this area, is a combination of two elements, silicon and oxygen, and has a chemical formula of SiO_2. Its **crystal** shape is hexagonal (six-sided).

The elements in the chart below account for almost 99% of the earth's crust, and most minerals are composed of some combination of these eight elements. Oxygen is the most abundant element in the Earth's crust and is always found in combination with other elements. Look at the chemical formulas of the minerals listed on the "Rock and Mineral" fact sheet and you will see that each of them contain oxygen. Three of the minerals, **talc**, quartz and **kyanite**, contain silicon, the second most abundant element. Together, oxygen and silicon make up almost 74% of the Earth's crust. This means that most minerals contain either or both of these elements.

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, etc.

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%



Instructions:

1. Remind the students that they must wear their safety goggles at all times during this activity and that they should be careful to break only a small part of the rock/mineral.

2. Tell the students that in this activity they will use the same tests a field geologist would to determine what rocks and minerals are found at Crowders Mountain State Park. They will travel from station to station to identify the six rocks or minerals, using their previously learned geologic knowledge, the identification tests of a professional geologist, and the "Rock and Mineral" fact sheet.

3. Divide the students into groups of 4 to 6, one group per station, except station #1.

4. Using rock at station #1 (quartz), lead the students through the tests below to learn the characteristics of mystery rock #1 and its identity.

Determine the rock's overall color. Use the hammer to carefully break a small part of the rock/mineral to see the color inside. This is important, as the outside color may be altered due to **weathering** factors. (The color of example #1 is white to pinkish.)

List the color of the rock/mineral's **streak** when scratched across the unglazed porcelain plate. (The streak color for example #1 is white.)

Determine the **luster**, which is classified as glassy, dull, pearly or metallic. (The luster of example #1 is glassy.)

The hardness of a rock or mineral is determined by what is able to scratch its surface or whether the rock or mineral can scratch another object, such as glass. Use fingernails, pennies, porcelain streak plates and the steel files to help establish the rock's hardness. (The hardness of example #1 is classified as hard, 5.5 to 6.5 on the scale; a metal file will barely scratch its surface.) The "Rock and Mineral Identification" worksheet contains a hardness scratch scale designed to explain this identification concept to the students.

Does the rock or mineral have layers? Put yes or no in this column. (Example #1 does not have layers.)

Have the students try and guess the name of the rock or mineral. Use the "Rock and Mineral" fact sheet to help with this question, as well as its classification as mineral, or as igneous, sedimentary or metamorphic rock. (The name of example #1 is quartz. It is a mineral because if it is given space, it will develop a specific hexagonal crystal. It is sometimes classified as igneous rock.)

5. Have the students test the remaining rocks/minerals using the same set of criteria to identify them.

6. After each rock/mineral identification worksheet is complete, place the large answer sheet where everyone can see it.

7. Lead the students through the answers, comparing their group answers with those listed on the large "Rock and Mineral Identification" worksheet. Discuss any discrepancies with the answers. This is especially important for streak, luster and hardness, as these characteristics can vary from specimen to specimen.

Suggested Extensions:

1. The "Rock and Mineral Identification" worksheet can be used to try and identify other rock and mineral types. Have students bring rocks/minerals to class to try and identify.

2. Hike to the top of Kings' Pinnacle to see the effects of **erosion** and weathering on the mountain. Try to identify rocks and minerals found on the Pinnacle.

Rock and Mineral Fact Sheet

Talc

Talc is a mineral composed of a magnesium **silicate**, $Mg_3Si_4O_{10}(OH)_2$. Often called soapstone, its color ranges from apple green to white with a pearly luster. It is greasy to the touch and streaks white when struck on a streak plate. It has no layers. Native Americans often carved talc into lamps, pipes, large pots and other vessels. Today, talc is commonly used in baby powder. The easiest way to distinguish talc is by its greasy feel and softness. It can be scratched with a fingernail. Hardness: 1.

Quartz

Quartz is the most common of all minerals. It is classified as a mineral because it can form a specific hexagonal crystalline structure. Its chemical formula is SiO_2, or silicon oxide. In its pure form quartz is clear, but usually contains impurities which can give it a variety of colors including white, red, purple, pink, smoky black, black, yellow, green and gray.

Quartz is classified as hard, because a file will barely scratch it. It has a glassy luster and does not have layers. Quartz produces a white streak on a scratch plate.

Many times quartz functions as a rock "glue." When rocks develop cracks, and if the crack goes deep enough into the earth, molten silicon oxide (quartz) will often be forced into the crack, "gluing" the rocks back together. If the cavity does not fill completely and a space is left, the quartz will develop into hexagonal crystals.

Two interesting things come to mind about this rock glue called quartz. First, the glue is usually harder than the rocks it glues back together. This results in quartz being found on top of or in the soil after the rocks it has glued back together have weathered to soil. Second, when the silicon oxide is being pushed upward by the pressure from deep in the earth, other minerals will sometimes be carried along with it. One of those minerals is gold. Tons of gold have been found in the southern Piedmont of North Carolina and it is primarily found in association with quartz. Gold has been mined in Gaston County.

There are many uses for quartz today. It is used in radio, radar and optical apparatus (rock crystal). Purple quartz (amethyst), in the form of sand, is used in glassmaking and smoky quartz is used for pottery and porcelain as well as an abrasive. Hardness: 5.5 - 6.5.

Mica schist

Schists are metamorphic rocks. They characteristically form from sedimentary shale rocks under temperature and pressure conditions which can range from low to high. "Schist" is a descriptive term used when mica grains are large enough to show definite layering. The presence of mica is an obvious clue in identifying this rock, which is the second most common rock at Crowders Mountain State Park. Mica schist is flaky and layered in appearance. Luster is sparkling in a new specimen but dulls with time. Its color can vary depending on its mineral content, ranging mostly from silvery white to gray. The color of its streak can vary also. Hardness: 1 to 7.5.

Barite

Barite is a mineral composed of barium sulfate, $BaSO_4$. Found in veins, barite resembles quartz but has a pearly luster. Its color can vary from white to gray to clear, with shades of yellow, brown, red or blue. Barite streaks white on the porcelain streak plate. It commonly occurs as a secondary mineral in veins with gold, silver, copper, lead and cobalt ores. Barite is used as an aid in well drilling (where it is used as a lubricant and sealant), as a paint pigment and a filler in making glossy paper and cloth. Hardness: 3 to 3.5.

Kyanite

Kyanite is an aluminum silicate mineral, Al_2SiO_5, and is a product of the regional metamorphism which occurred at Crowders Mountain State Park. It is found in **gneiss** and **schist**. Kyanite can be blue, white, gray, green, nearly black or colorless. In a pure form, kyanite can be identified by its blade-like crystals that range from white to blue-gray. It has a greasy feel and a glassy luster. It leaves a white streak when struck on a streak plate. Kyanite is capable of resisting high temperatures and is used in the making of high temperature porcelains such as spark plugs and high temperature brick. Before Crowders Mountain became a state park, the ore kyanite was mined from this area. Hardness: 4 to 7.

Quartzite

Quartzite is a rock composed of a variety of minerals, with quartz being the dominate one. Quartzite is the predominate rock making up both Kings Pinnacle and Crowders Mountain. Quartzite is usually a hard metamorphic rock that is extremely resistant to weathering and erosion. The hardness and color of quartzite can vary greatly depending on the type of minerals found in the rock. It comes from sedimentary quartz sandstone that has been metamorphosed. It sometimes shows layers and occasionally ripple marks from waves that formed in the parent sandstone. The quartzite found at Crowders Mountain State Park is grainy in appearance and has a peculiarly dull, sugary luster. Hardness: 2.5 - 7.

Rock and Mineral Identification Worksheet

Rock Sample	Color	Streak	Luster	Hardness	Layered	Classification	Name
1							
2							
3							
4							
5							
6							

Color - the identifiable color. (Quartz may be colorless, white, pink, smoky, yellow or purple, depending on the impurities within it.)

Streak - the color a rock leaves behind when it is scratched across a streak plate or unglazed porcelain. (Quartz leaves a white streak.)

Luster - the way a rock reflects light. (Quartz has a glassy luster. Other minerals may have a dull or metallic luster or no luster at all.)

Layered - a rock either has layers (foliated) or it doesn't (non-foliated). In the space provided put either yes or no, meaning it has layers or it does not. (Quartz does not have layers.)

Hardness - the following scale ranges from one to ten, with one being the softest and ten being the hardest. The objects listed after the numbers are things that can scratch the rock or mineral, or be scratched by the rock or mineral. (Quartz can be scratched by a file, so it is hard: 5.5 - 6.5.)

Hardness:		
1 - 2.5	(very soft)	fingernail
2.5 - 5	(soft)	penny
5 - 6.5	(hard)	steel file
6.5 - 10	(very hard)	porcelain

Classification - A rock is classified as a mineral, or as igneous, sedimentary or metamorphic. (Quartz is a mineral and is sometimes found in all the other rock types.)

ERIC

Rock and Mineral Identification Answer Sheet

Rock Sample	Color	Streak	Luster	Hardness	Layered	Classification	Name
1	white clear pink	white	glassy	7 (hard)	no	mineral	quartz
2	white to gray	white	pearly	3 – 3.5 (soft)	no	mineral	barite
3	apple green to white	white	glassy	1 – 2.5 (very soft)	no	metamorphic	talc
4	blue gray to white	colorless	glassy	4 – 7 (soft to hard)	no	metamorphic	kyanite
5	silvery white to gray	none	sparkling	2 – 8 (very soft to very hard)	yes	metamorphic	mica schist
6	silvery white to gray	varies	dull	2.5 – 7.5 (very soft to very hard)	yes	metamorphic	quartzite

Color - the identifiable color. (Quartz may be colorless, white, pink, smoky, yellow or purple, depending on the impurities within it.)

Streak - the color a rock leaves behind when it is scratched across a streak plate or unglazed porcelain. (Quartz leaves a white streak.)

Luster - the way a rock reflects light. (Quartz has a glassy luster. Other minerals may have a dull or metallic luster or no luster at all.)

Layered - a rock either has layers (foliated) or it doesn't (non-foliated). In the space provided put either yes or no, meaning it has layers or it does not. (Quartz does not have layers.)

Hardness - the following scale ranges from one to ten, with one being the softest and ten being the hardest. The objects listed after the numbers are things that can scratch the rock or mineral, or be scratched by the rock or mineral. (Quartz can be scratched by a file, so it is hard: 5.5 - 6.5.)

Hardness:		
1 - 2.5	(very soft)	fingernail
2.5 - 5	(soft)	penny
5 - 6.5	(hard)	steel file
6.5 - 10	(very hard)	porcelain

Classification - A rock is classified as a mineral, or as igneous, sedimentary or metamorphic. (Quartz is a mineral and is sometimes found in all the other rock types.)

Post-Visit Activity #1 — Geo-Scavenge

Curriculum Objectives:

Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources
- Guidance: competency for interacting with others
- Library/Media Skills: work independently and creatively in preparing assignments
- Science: earth science, environment
- Social Science: gather, organize and analyze information, draw conclusions, participate effectively in groups

Grade 6
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources, writing
- Guidance: competency and skill for interacting with others, variety and complexity of occupations
- Library/Media Skills: work independently and creatively in preparing assignments
- Science: how science helps us
- Social Studies: gather, organize and analyze information, draw conclusions

Grade 7
- Communication Skills: listening, reading, vocabulary and viewing comprehension, study skills using environmental sources
- Guidance: being responsible in a group, develop an awareness of alternative points of view
- Science: interaction of people and the environment, earth science, natural phenomena, meteorology
- Social Studies: know the importance of natural resources, gather, organize and analyze information, draw conclusions

Location:
Classroom and home

Group Size: 30 or less

Estimated Time:
45 to 60 minutes

Appropriate Season: Any

Materials:
Provided by educator:
Scavenger Hunt list, aluminum can, aluminum foil, pencil, metal toy car, mirror, drinking glass, metal scissors, table knife, book, wooden spoon, notebook paper, houseplant, table, paper bag, magazine, brick, gravel, basketball shoe, cotton shirt, nylon book bag, leather shoe, video tape

* These are just some examples. The educator may want to adapt this list to use more convenient materials.

Major Concepts:

- Uses of rocks and minerals

Objectives:

- Differentiate between 10 objects, determine whether they are derived from rocks, minerals, fossil fuel or organic materials.
- Explain the importance of geologic products in our daily lives.

Educator's Information:

In this activity, the student will gain an understanding of how everything we use in our daily lives comes from the earth's resources: rocks, minerals, fossil fuels or living things (organic). The activity is in two parts. In the first part, the students will try to identify items you provide in the classroom (see material list) as derived from rock, mineral, fossil fuel or organic. In the second part, they will take the "Geo-Scavenge Hunt" list home and identify the things on the list, as well as others they find at home. Upon completion of this activity, lead a discussion focusing on these resources, their continued availability (or their unavailability), and changes everyone can make to help conserve our resources.

Student's Information:

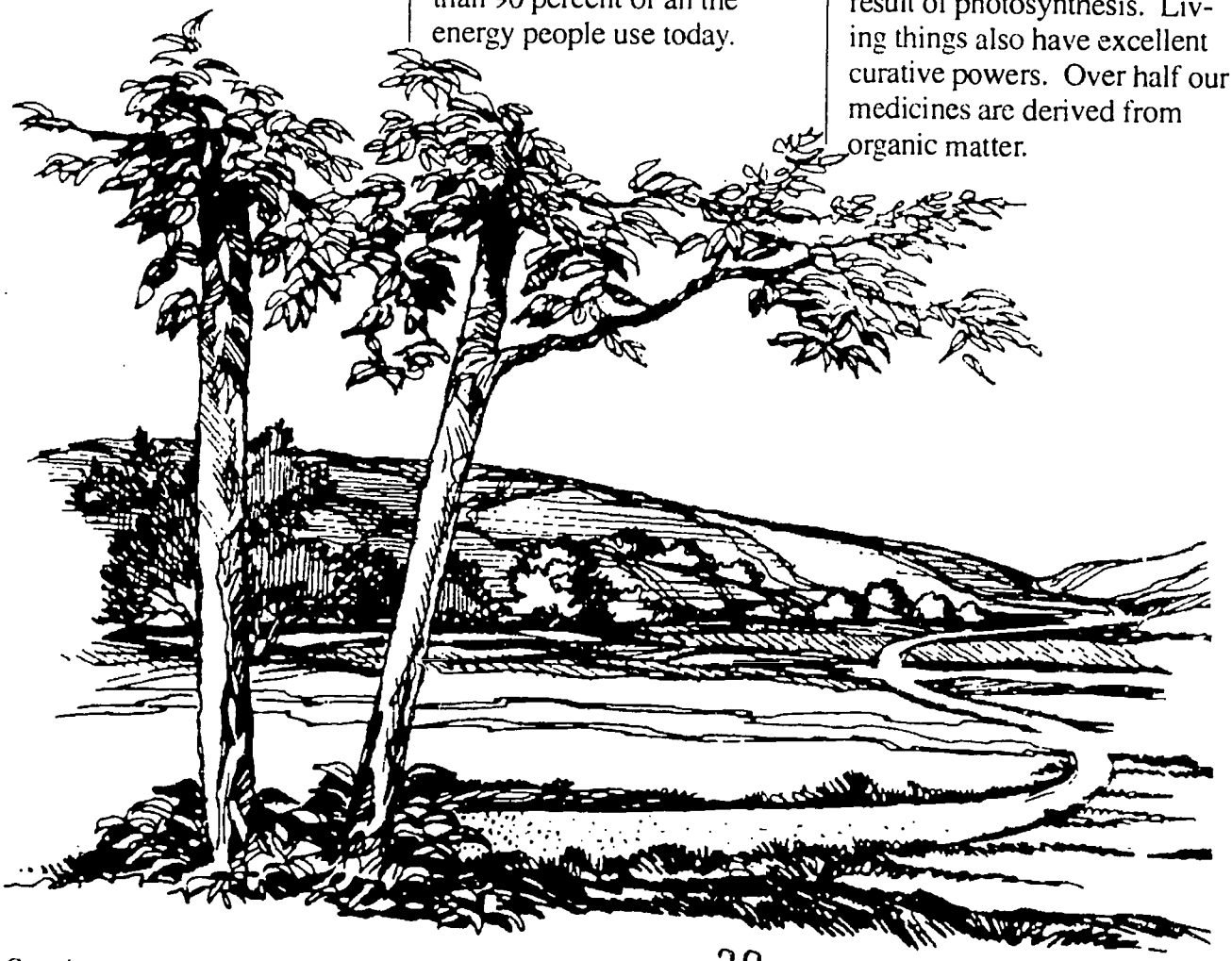
Earth's Energy Storehouse

Crowders Mountain State Park is part of the Kings Mountain belt of rocks, which is an area rich in **rock** and **mineral** deposits. The deposits along this belt have been mined for feldspar, marble, lithium, tin, **mica**, **kyanite**, sillimanite, **barite**, gold, manganese and iron. In this area, quartzites, such as those that make up Crowders Mountain, were prospected for kyanite and have been mined nearby, along with feldspar, spodumene (a lithium-bearing mineral), and mica. North Carolina leads the nation in the annual production of these valuable minerals. The Kings Mountain Mine, the most important gold mine in our area, is just a few miles west of the park. This mine produced as much as $1 million in gold before 1895.

Rocks and minerals aren't the only valuables stored in the Earth's crust. There is also energy, mostly in the form of oil, natural gas and coal. Together, all three "fossil fuels" (they are called fossil fuels because they are formed from the remains of ancient organisms) account for more than 90 percent of all the energy people use today.

Another natural resource we utilize extensively is living things, or **organic** matter. Living things have existed on earth for a very long time. The oldest rock found on earth is 4.1 billion years old; the oldest fossil is at least 3.2 billion years old. Thus life (organic matter) has been a part of the earth's history for 3/4 of its existence.

We could not exist without other living things. We eat them, wear them, build and repair our houses and bodies from them. In addition, without them we could not breathe. Plants produce oxygen as a result of photosynthesis. Living things also have excellent curative powers. Over half our medicines are derived from organic matter.



Crowders Mountain State Park, NC

Instructions:

Part I: Classroom

1. Place all listed items on a table or scatter groups of items on several smaller tables throughout the classroom. Cover the items so that they can not be seen by the students.

2. Discuss with the students the various ways people use rocks, minerals, fossil fuel and living things. Be sure to discuss the differences in these.

Rock - A substance made up of one or more minerals. Rocks are the building blocks of the earth. Geologists have identified over 2000 types of rocks.

Mineral - An inorganic substance occurring naturally in the earth and having a consistent and distinctive crystalline form and a composition that can be expressed as a chemical formula.

Fossil fuel - Fuel such as coal, natural gas and petroleum which is derived from fossils. Plant material and marine and land organisms that lived and died millions of years ago are the source of fossil fuel.

Organic material - Of, or pertaining to, or derived from living organisms.

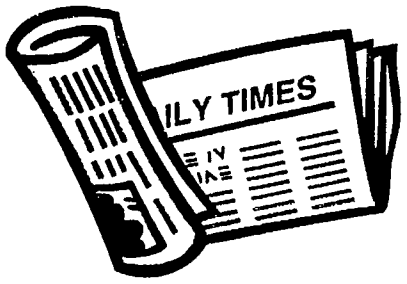
3. Uncover the items for the students to look at and have students decide, as a class, how to classify each item: rock, mineral, fossil fuel or organic. If the students are having trouble deciding, walk the students through some of the following examples:

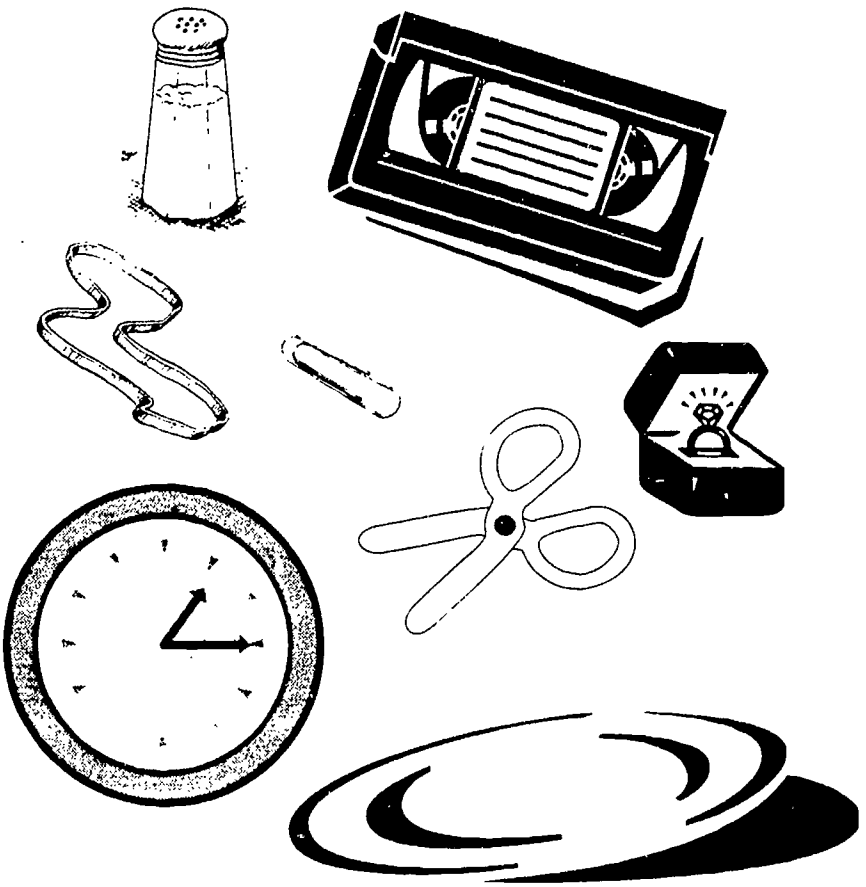
- foil (aluminum, which is made from bauxite, a mineral)
- pencil "lead" (graphite, a mineral)
- drinking glass/mirror (glass is made from the quartz in sand or sandstone, rock)
- wooden spoon (wood, which is organic)
- plastic fork (plastic, comes from petroleum, which is a fossil fuel)

Part II: Homework

1. Give each student a copy of the "Geo-Scavenger Hunt" list and have them check off each item they are able to locate around their home or neighborhood. Classify each item listed as rock, mineral, fossil fuel product or organic product. Items may fit in more than one category, i.e. a metal knife with a wooden handle.

2. After the students complete the scavenger hunt, have them share their answers with the class. After discussing the correct answers, emphasize how rocks, minerals, fossil fuels and organic matter are all a big part of our daily lives and are part of the world's resources we need to conserve and use wisely.





Scavenger Hunt

Locate these objects.

Item	Rock	Mineral	Fossil Fuel	Organic
stone wall				
car or truck				
plastic bag				
cook book				
tombstone				
ink pen				
window pane				
paper clip				
straw basket				
faucet				
cement				
dinner plate				
door mat				
clock				
scissors				
wool blanket				
unglazed pottery				
diamond ring				
chalk				
oil paint				
diaper				
baby powder				
table salt				
rubber band				
newspaper				
birdbath				
spark plug				
chewing gum				
other:				

Scavenger Hunt Answer Sheet

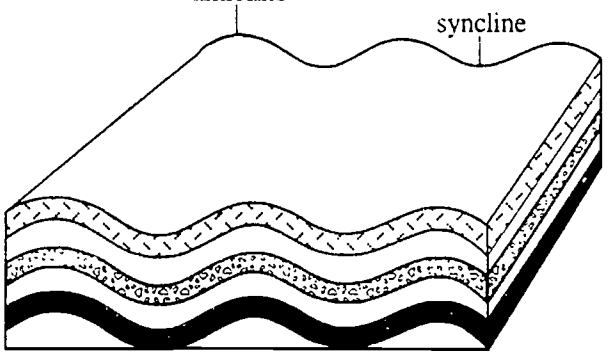
Locate these objects.

Item	Rock	Mineral	Fossil Fuel	Organic
stone wall	X			
car or truck	X		X	
plastic bag			X	
cook book				X
tombstone	X			
ink pen			X	
window pane		X		
paper clip	X			
straw basket				X
faucet	X			
cement	X			
dinner plate	X	or X	or X	
door mat			X	or X
clock	X	or X	or X	or X
scissors	X			
wool blanket				X
unglazed pottery	X			
diamond ring	X	X		
chalk	X			
oil paint	X		X	
diaper			X	or X
baby powder		X		
table salt		X		
rubber band				
newspaper				X
birdbath	X		or X	
spark plug	X	X		
chewing gum				X
other:				

VOCABULARY

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

Anticline (anti-cline) - A geological structure in which rock layers are bent into an upfold or arch; evident in Crowders Mountain and Kings Pinnacle.



Barite (bar-rite) - A mineral usually found in the veins of sedimentary rocks; resembles quartz but barite has a pearly luster whereas quartz has a glassy luster.

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

Chemical weathering - The erosion or wearing down of a rock and its minerals by chemical reactions which change the identities of the minerals.

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

Conglomerate (con-glom-er-ate) - Rounded bits and pieces of rock that have been cemented together by mineral substances.

Continental plates - Granitic (granite) 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.

Crystal - A solid mass of mineral, having a crystalline structure: a regular geometric shape, bounded by smooth, flat surfaces (crystal faces).

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.

Earth's crust - A rigid shell, only about 30 miles thick, less than one hundredth of the distance to the earth's 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 group of natural processes, including weathering, dissolution, abrasion, corrosion and transportation, by which earthy or rock material is removed from any part of the earth's surface to another.

Exfoliation - An erosional process whereby rocks flake or come off in layers.

Extrusive igneous rocks - Rocks formed on the earth's surface by the cooling of molten magma material originating from within the earth's crust. Once magma reaches the surface it is called lava.

Fault - A fracture in the earth's crust along which rocks on one side have been displaced relative to rocks on the other side.

Foliated - Rocks that exhibit a layered appearance or texture.

Folding - The geologic formation created when a strata of rock is bent over or doubled up so that one part of the layer lies on another part of the same layer.

Fossils - The remains or indications of an organism that lived in the geologic past.

Fossil fuel - Fuel derived from fossils. Examples of the fuels include coal, natural gas and petroleum.

Geology - The scientific study of the origin, history and structure of the earth.

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.

Gneiss - A banded or foliated metamorphic rock, usually of the same composition as granite, in which the minerals are arranged in layers.

Granite - An intrusive igneous rock with very course grains composed of quartz and feldspar and other dark minerals; seen as outcrops on the Crowders Mountain summit.

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

Igneous rocks (ig-ne-ous) - Rocks formed by the cooling of molten magma.

Intrusive igneous rocks (in-tru-sive) - Molten igneous rocks that force their way into the surrounding rock and solidify below the earth's surface.

Kyanite (ky-a-nite) - A blue-gray mineral found as blade-like crystals in some metamorphic rocks at Crowders Mountain; used in the making of spark plugs due to its heat resistance.

Lava - Molten rock (magma) that is forced out of a volcano or out of cracks in the earth's crust and onto its surface.

Limestone - A sedimentary rock consisting mainly of calcium carbonate.

Luster (lus-ter) - The quality and intensity of light reflected from a mineral. Luster is one of the characteristics geologists use to identify rocks and minerals.

Magma (mag-ma) - Molten rock deep within the earth from which igneous rock is formed.

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

Mechanical weathering - The erosion or breakdown of rock into particles without changing the identities of the minerals in the rocks; ice is the most important agent.

Metaconglomerate (me-ta-con-glom-er-ate) - Metamorphosed sedimentary rocks composed of chemically cemented pebbles and sand. The result of metamorphic processes (intense heat and pressure) on a sedimentary conglomerate which cause the pebbles within the conglomerate to be melted, fused, stretched and distorted.

Metamorphic rocks (me-ta-mor-phic) - Rocks that have changed both physically and chemically due to increases in pressure and temperature and chemically active solutions.

Metamorphosis (me-ta-mor-pho-sis) - A transformation, a marked change in appearance or condition.

Mica - A mineral family easily recognized by its dark colors and its capacity to easily be split into characteristic thin, pearly sheets.

Mica schist - A layered metamorphic rock generally containing noticeable mica minerals. Appears shiny; the second most common rock type found at Crowders Mountain State Park.

Mineral - A solid naturally occurring blend of elements having a fairly uniform chemical composition and a constant set of physical properties including a crystalline shape.

Monadnock (mo-nad-nock) - A hill or mountain of resistant rock remaining from a former highland, surrounded by a peneplain. Kings Pinnacle and Crowders Mountain summits are both monadnocks made up of quartzite.

Non-foliated - Metamorphic rocks that do not have a directional or layered appearance to their texture.

Ore - Minerals which can be mined at a profit, such as kyanite.

Organic - Of, or pertaining to, or derived from living organisms.

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

Peneplain (pe-ne-plain) - A land surface of considerable size that has been worn nearly flat due to erosion.

Petroleum - A natural, yellow-to-black, thick, flammable, liquid hydrocarbon mixture found principally beneath the earth's surface. It is processed into natural gas, gasoline, naphtha, kerosene, fuel and lubrication oils, paraffin wax, asphalt, plastic and a wide variety of other products.

Quartz - A hard crystalline mineral of silicon dioxide, SiO_2 with a glassy luster.

Quartzite (quartz-ite) - A hard metamorphic rock formed by heat and pressure on sandstone; the main rock type that forms Kings Pinnacle and Crowders Mountain summits.

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

Rock - A naturally occurring consistent mass of one or more minerals; the three rock types are named according to their formation processes: sedimentary, metamorphic and igneous.

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

Sandstone - A sedimentary rock consisting of quartz and sand cemented together.

Schist - Any of various medium to coarse grained metamorphic rocks composed of laminated, often flaky, parallel layers of chiefly micaceous minerals.

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 (sed-i-men-ta-ry) - Bits and pieces of other kinds of rock that have been cemented together under pressure and deposited in layers near the earth's surface; sometimes containing the remains of once-living things (fossils).

Shale - A fine-grained sedimentary rock composed largely of clay, mud or silt and characterized by its tendency to split easily along parallel planes.

Silicate - Any of numerous compounds containing silicon, oxygen and a metal or organic radical, occurring in most rocks except limestone and dolomite, and forming the basis of common glass and bricks.

Streak - The color left behind when the mineral is rubbed across the surface of a piece of unglazed, white porcelain.

Syncline - A downward fold in rocks.

Talc - A soft mineral of magnesium silicate; usually whitish, greenish or grayish with a soapy feel, it occurs in layered, granular or fibrous masses.

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

Volcanic eruption - A generally violent bursting forth of lava, volcanic ash and gases from a volcano's vent.

Volcano - A cone-shaped hill or mountain consisting chiefly of volcanic materials built up around a vent or hole in the earth's crust from which eruptions occur.

Weathering - The chemical alteration and mechanical breakdown of rock materials during exposure to air, moisture and organic matter.

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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SCHEDULING WORKSHEET

For office use only:
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) _____
(Note: A maximum of 30 participants is recommended.)

8) Number of chaperones _____
(Note: One adult for every 10 students is recommended.)

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: _____
_____

12) Are parental permission forms required? _____ If yes, please use the Parental Permission form on page 8.2.

I, _____, have read the entire Environmental Education Learning Experience and understand and agree to all the conditions within it.

Return to: Crowders Mountain State Park
Route 1, Box 159
Kings Mountain, NC 28086

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.

Crowders Mountain State Park
Route 1, Box 159
Kings Mountain, NC 28086