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AUTHOR Pittman, George K., II
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ABSTRACT

This activity packet was designed to introduce students in grades 5-7 to the geology of the Blue Ridge Mountains through hands-on activities for the classroom and the outdoor setting of Mount Jefferson State Park (Jefferson, North Carolina). Previsit activities introduce students to the different rock types: sedimentary, igneous, and metamorphic. Students learn how rocks are formed, how to recognize them, and how they erode. On-site activities familiarize students with the actual rock types of Mount Jefferson State Park, their characteristics, and where they are found in the park. Postvisit activities broaden student understanding of geology by clarifying how rocks and minerals are used in our daily lives. Each activity includes curriculum objectives, location, group size, estimated time, materials, special considerations, major concepts and objectives, teacher instructions, information for students, and student worksheets. The guide also includes an overview of the North Carolina State Parks System and Mount Jefferson State Park, information on the geology of Mount Jefferson State Park, vocabulary words, references, and forms to schedule park visits. (LP)

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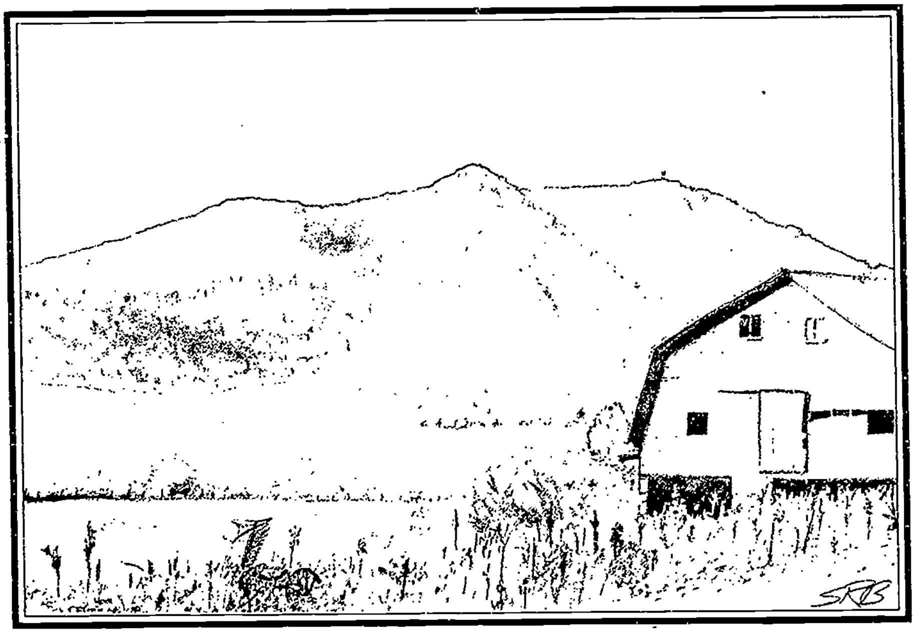

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Mount Jefferson State Park

An Environmental Education Learning Experience

Designed for Grades 5-7

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"Geology is something most of us do not think about as we go about our daily activities. Yet all of us are affected by the powerful geologic processes that formed our continent."

- A Geologic Guide To North Carolina's State Parks

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This Environmental Education Learning Experience
was developed by

George K. Pittman, II
Lead Interpretation and Education Ranger
Mount Jefferson State Park

N.C. Division of Parks and Recreation
Department of Environment, Health and Natural Resources

DEHNR

James B. Hunt, Jr.
Governor

Jonathan B. Howes
Secretary

ERIC

Other Contributors . . .

Park volunteers;

Leonard S. Wiener, N.C. Geological Survey, Division of Land Resources;

The N.C. Department of Public Instruction;

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

The N.C. Geology Survey Section, Division of Land Resources;

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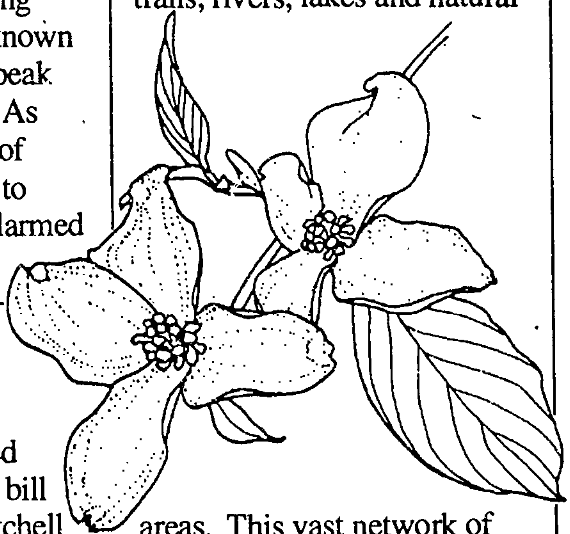
Introduction to the North Carolina State Parks System

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 objections. 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 of North Carolina. 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:

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

Introduction to Mount Jefferson State Park

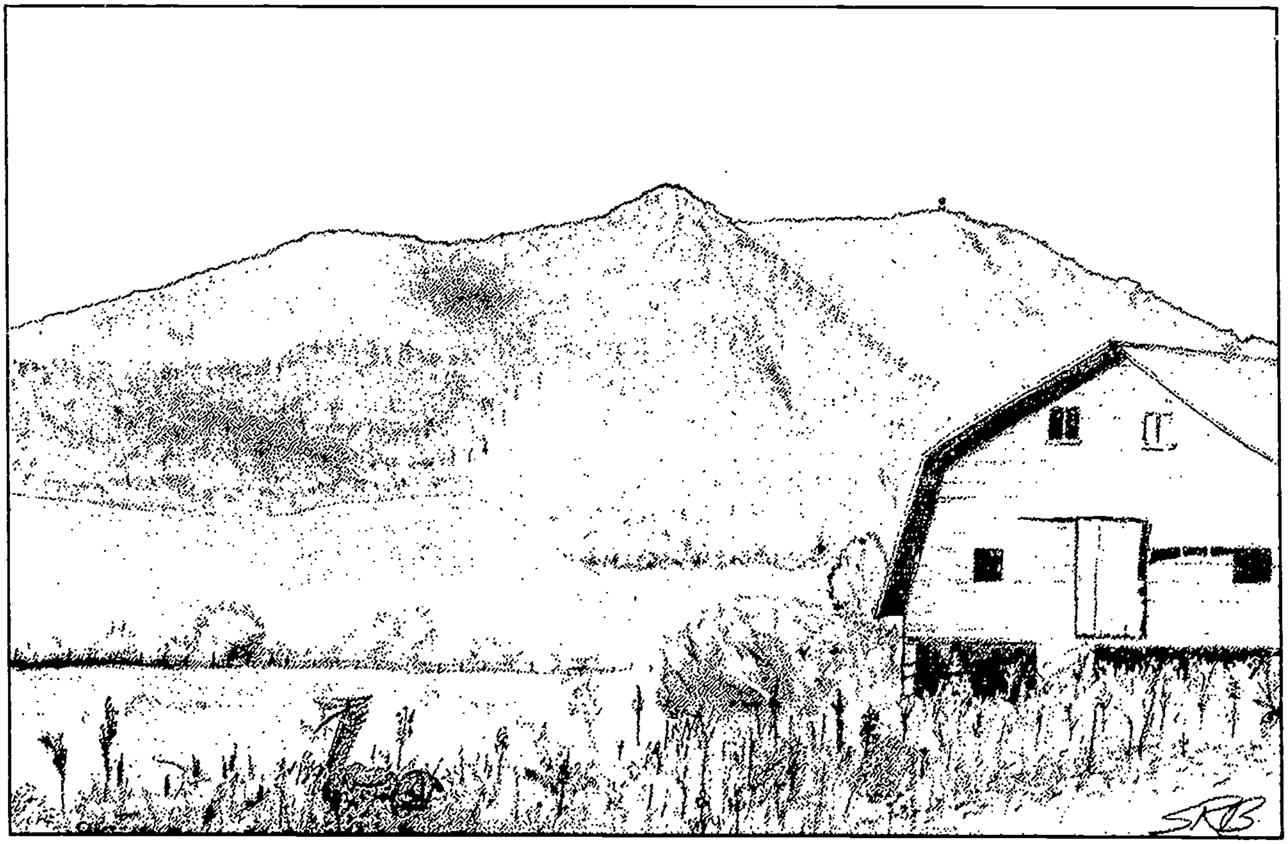
Mount Jefferson State Park, located in the southern Blue Ridge highlands, covers 489 acres, which includes the peak and upper slopes of the mountain. On clear days, Mount Rogers and Whitetop Mountain in Virginia, Grandfather Mountain in North Carolina, and Snake Mountain in Tennessee can be seen from the park's overlooks. Nestled at the foot of Mount Jefferson are the towns of Jefferson and West Jefferson.

Mount Jefferson is a northwest trending mountain that reaches a maximum elevation of 4,683 feet, approximately 1,600 feet above the nearby New River Valley. The mountain is located between the north and south forks of the New River, which have played a tremendous role in eroding Mount Jefferson to its present-day height and shape.

Mount Jefferson and the other high mountains in the area are the remnants of a high, broad plateau that once existed there. Weathering and erosion have removed much of the original material of the plateau, creating broad mountain valleys, and leaving the more resistant underlying rock.

The rocks that would one day become Mount Jefferson were originally formed from depositions in a trough or basin on the floor of an ancient sea, 600 million to 800 million years ago. Some sand and clay materials were washed into the basin from the surrounding land areas, eventually forming the sedimentary rocks gneiss and schist. Other materials were deposited as volcanic debris from now extinct volcanoes. The black rock amphibolite, seen in the park today, is an example of an igneous, volcanic rock that has been changed into a metamorphic rock by heat and pressure.

It is difficult to explain Mount Jefferson's height. Amphibolite is normally not very resistant to erosion and is usually found at lower



elevations. The gneiss and schists found in the valley below Mount Jefferson, normally have a higher quartz content and are more resistant to erosion. It has been suggested that the gneiss and schists in this area are more thinly layered than in the rest of the southern Blue Ridge Highlands, thereby making them mechanically weaker and causing them to erode more easily. The topography at Mount Jefferson is controlled by joint and fracture patterns in the area.

The Park's Natural Resources:

Plant Communities:

Mount Jefferson State Park has a wide variety of trees, shrubs and flowers. Sugar maple, red maple, black locust, ash, hickory, birch, white oak and red oak form the canopy in most of the park's forests. The understory, flowering shrubs of purple rhododendron, mountain laurel and wild azalea, is a visual treasure to be enjoyed during the summer months. Native wildflowers such as trillium, jack-in-the-pulpit and Dutchman's breeches add variety to your visit.

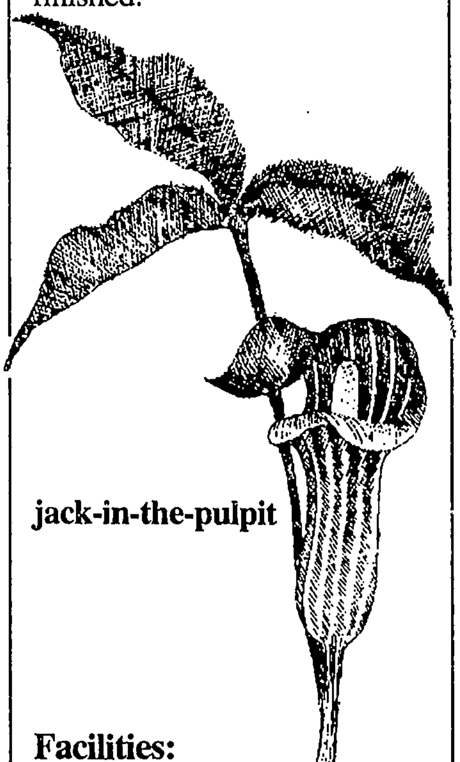
Wildlife:

Wildlife you might encounter on the mountain include chipmunks, groundhogs, red and gray squirrels, ruffed grouse and numerous song birds.

Hiking Trails:

The park's two hiking trails are accessed from the picnic area. They begin as one trail, but divide into two at the ridge line after passing the restrooms. The left fork, the Summit Trail, is a 50-yard trail to a North Carolina Forest Service fire tower on top of Mount Jefferson.

The right fork is the Rhododendron Trail, a self-guided nature trail. It is a one mile loop which leads to Luther's Rock overlook, meanders through rhododendron thickets and then returns to the picnic area. Trail booklets are available at the summit area parking lot. School groups can borrow trail booklets at the park office. Please return them to the office when you are finished.



jack-in-the-pulpit

Facilities:

Restrooms: Restrooms are located above the picnic area. They are open from May 15 to November 1.

Picnic Area: Thirty-two tables and nine grills are located in a wooded area above the parking lot. No reservations are required as the area is used on a first-come basis.

Overlooks: There are two overlooks located along the road leading up to the summit of Mount Jefferson.

NOTE: The road to the top of Mount Jefferson is very steep and many vehicles overheat as a result. Please take appropriate measures to ensure that you have a safe and productive trip.

Scheduling a Trip:

1. To make a reservation, contact the park at least two weeks in advance.

2. Complete the Scheduling Worksheet, located on page 8.1, and return it to the park as soon as possible.

Before the Trip:

1. Complete the pre-visit activity in this Environmental Education Learning Experience.

2. The group leader 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, to identify themes and to work out any potential problems.

3. The group leader should discuss park rules and behavior expectations with adult leaders and participants. Safety should be stressed.

4. *The group leader is responsible for obtaining a parental consent form for each participant.* Be sure that health conditions and medical needs are noted. A sample consent form is located on page 8.2.

5. Research Activity Permits may be required for activities in which samples are to be taken from the park. Contact the park to determine if research activity permits are needed.

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

While at the Park:

As you enjoy the natural setting of the park while hiking or picnicking, remember that the park is for your enjoyment, so please follow all safety tips and obey all park rules and regulations.

1. Complete the on-site activity in this Environmental Education Learning Experience.

2. When hiking and studying at Mount Jefferson State Park, please be safety conscious. Some sections of the park's trails are strenuous. It is recommended that proper footwear be worn and that water be carried. Also, hazards such as bees and extreme weather conditions may exist. These hazards can cause problems if you are not prepared. Students with any medical conditions should be monitored closely by the adult leaders.

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

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

5. All plants and animals are protected within the park. Injuring or removing plants or animals are prohibited in all North Carolina State Parks. Removal of rocks is also prohibited. This allows others in the future to be able to enjoy our natural resources.

6. Picnic only in the designated picnic area. Help keep the park clean and natural by not littering and by picking up any trash left behind by others.

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

Following the Trip:

1. Complete the post-visit activity in this Environmental Education Learning Experience.

2. Build upon the field experience 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. Please complete the program evaluation sheet on page 8.3 and send it to the park.

Park Information:

Address:

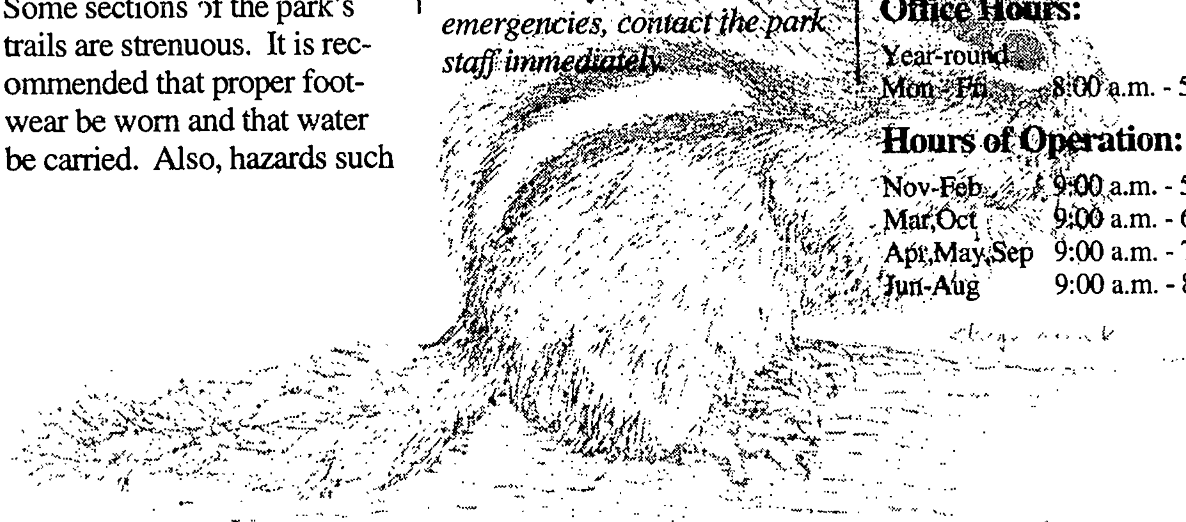
Mount Jefferson State Park
P. O. Box 48
Jefferson, NC 28640
Tel: (910)-246-9653
Fax: (910)-982-3943

Office Hours:

Year-round
Mon - Fri 8:00 a.m. - 5:00 p.m.

Hours of Operation:

Nov-Feb	9:00 a.m. - 5:00 p.m.
Mar,Oct	9:00 a.m. - 6:00 p.m.
Apr,May,Sep	9:00 a.m. - 7:00 p.m.
Jun-Aug	9:00 a.m. - 8:00 p.m.



Introduction to the Activity Packet for Mount Jefferson State Park

The Environmental Education Learning Experience (EELE), *Metamorphic Mountain,* is designed to introduce the student to the geology of the Blue Ridge Mountains through hands-on environmental education activities for the classroom and the outdoor setting of Mount Jefferson State Park. It is targeted for the 5th through 7th grades and meets established curriculum objectives of the North Carolina Department of Public Instruction. Three types of activities are included:

1) pre-visit activity
2) on-site activity
3) post-visit activity

The on-site activity will be conducted at the park, while pre-visit and post-visit activities are designed for the classroom. The pre-visit activity should be introduced prior to the park visit so that students will have the necessary background and vocabulary for the on-site activities.

The pre-visit activity will introduce the students to the different rock types: sedimentary, igneous and metamorphic. The students will learn how rocks are formed, how to recognize them and how they erode.

The on-site activity will familiarize the students with the actual rock types of Mount Jefferson State Park, their characteristics and where they are found in the park.

The post-visit activity is designed for review and will broaden the students' understanding of geology through an activity dealing with how we use rocks and minerals.

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, *Metamorphic Mountain,* will expose students to the following major concepts:

- **Geology**
- **Rock types and their uses**
- **Rock cycle**
- **Geologic time**
- **Weathering and erosion**

The first occurrence of a vocabulary word used in these activities is indicated in **bold type**. Their definitions are listed in the back of the activity packet. A list of the reference materials used in developing the activities follows the vocabulary list.

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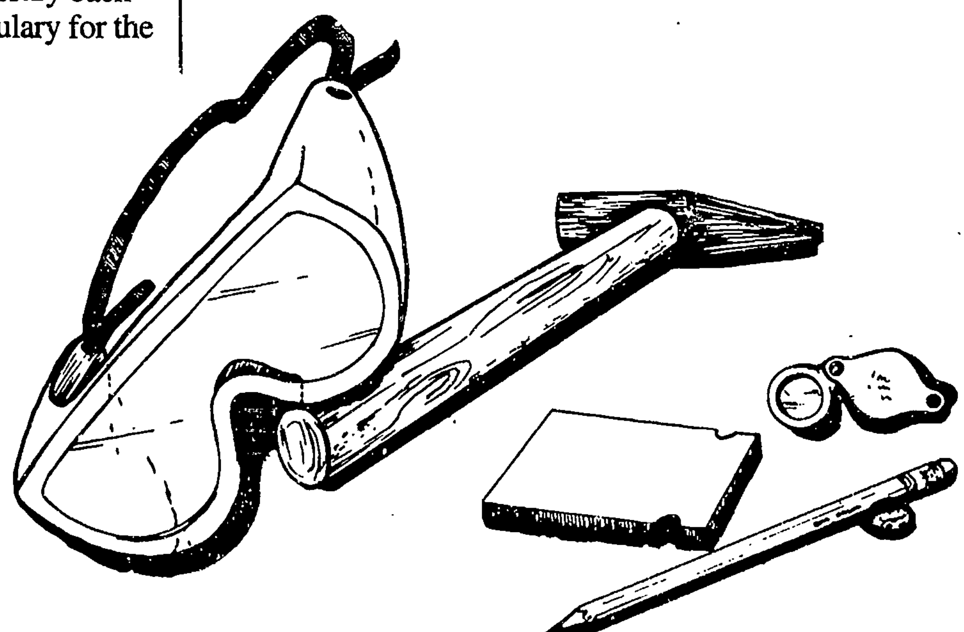

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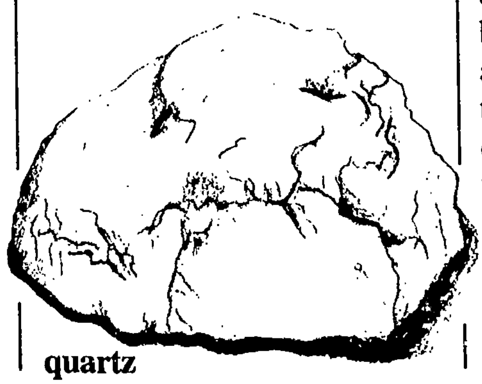
Introduction to the Geology of Mount Jefferson State Park

Geology– it is something most of us seldom think about, yet it effects all of our lives... where and how we live, the resources available to us and the landscape that surrounds us. The powerful geologic process that formed our continent –whether as sudden and catastrophic as a volcanic eruption or as slow as a stream cutting its path to the sea– eroded and sculpted the landscape, created varied **minerals** and **rocks**, concentrated minerals into ore deposits that could one day be mined, and laid down the soil which would become forests and farmlands. The eventual result is the beautiful state we enjoy today.

Geology influences the world and our lives in many different ways. For example, the hardness and structure of the rocks profoundly influence the landscape of North Carolina. When rocks weather, they produce soil and, thus, significantly influence the type of vegetation we see. Mineral deposits provide us with raw materials needed to construct cities, supply our heat and energy needs, and fabricate the commodities of our modern civilization. The Blue Ridge region is well known for its deposits of feldspar, mica and **quartz**–essential materials used in the ceramics, paint, plastics and electronics industries. Significant deposits of copper were once mined in the Blue Ridge; in fact a major deposit, now depleted, is nearby at Ore Knob, less than eight miles east of Mount Jefferson.

The rocks now found at Mount Jefferson State Park were originally igneous or sedimentary. However, when the rocks were buried in the **Earth's crust** intense heat and deforming pressure converted all the older strata to **metamorphic rocks**. We can easily see that the rocks are tilted, folded and fractured; all these, along with unmistakable signs of metamorphism, are evidence that the area has had a long, complicated geologic history.

The oldest rocks of the Blue Ridge, some of which are exposed in a 10-mile wide belt passing several miles northwest of Mount Jefferson, make up the region's geological basement, the foundation upon which all the region's geologic structure is built. Locally, these very ancient rocks were mostly derived from molten rock materials, called **magma**, that gradually hardened or crystallized far down in the earth's crust. With the passage of time, these deep-seated, generally granitic rocks underwent deformation and metamorphism and were altered to various types of granitic gneiss. Geologists who study these rocks have concluded that throughout much of eastern North America very similar deformation and metamorphism occurred at this same time, approximately one billion to one and one-quarter billion years ago.



quartz

An integral part of the deformation process must have involved widespread uplift of the land. Of course, whenever uplift occurs, the elevated region becomes exposed to the forces of **erosion**. If uplift proceeds faster than the eroding, wearing-down process, then a highland or plateau or even a mountain landscape may evolve. In our area, however, subsequent geologic events have virtually obliterated evidence needed to determine how high the land became during this extremely archaic time. It seems likely though that a major mountain chain developed. As the uplifting forces gradually died away, erosion continued and, ultimately, the land's elevation and features must have been greatly worn down.

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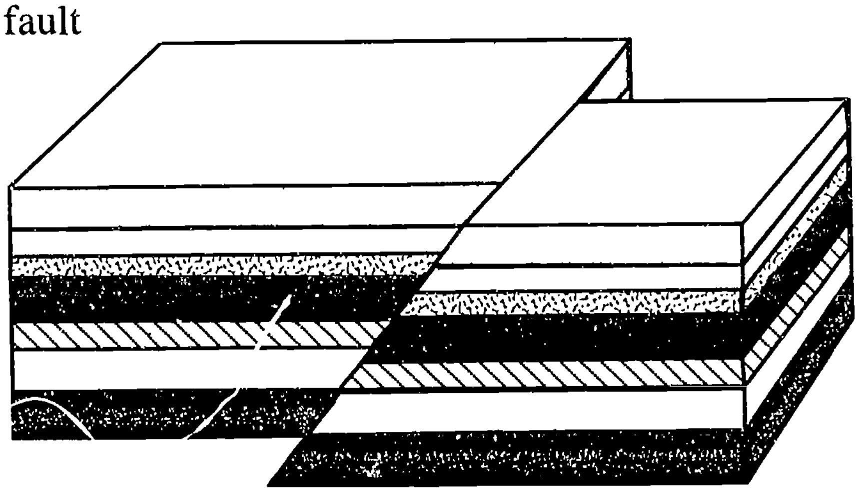
The next chapter in the story of the Mount Jefferson State Park region is recorded in rocks that formed in an ocean environment many, many miles to the east. At first, vast outpourings of fiery hot **lava** dominated the scene in this vicinity. Most of the material was probably very similar to the flows and shallow intrusions of very fluid lava people can see today in and around the Hawaiian Islands. As each great sheet of lava cooled it solidified into a dark-colored, rock called basalt. Between some of the lava eruptions, thin layers of sand and mud were deposited. Eventually, as the eruptions became less frequent, the sandy and muddy deposits began to dominate in this part of the ocean basin. All this activity is estimated by some geologists to have occurred between 550 to 600 million years ago.

On the scale of geologic time, the earth's crust is seldom quiet for long. About 475 million years ago it appears the rocky materials filling this distant ocean basin began to get squeezed together. The basin's great thickness of accumulated lava flows and **sediments** started crumpling up, or **folding**, and also began moving westward by sliding along great underground thrust faults. As the layers were squeezed, crumpled and moved, the original minerals in the rocks recrystallized into new and different minerals and shapes. The old lava flows, or basalts, were altered to rocks containing abundant, dark-colored hornblende and variable proportions of light-colored feldspar, along with some other lesser minerals. In the sediments, the original clay making up the muddy component recrystallized mostly to biotite and muscovite-mica; the original quartz and feldspar grains of sand and silt became reorganized and recrystallized into larger, intergrown and interlocking crystals. Thus were formed the metamorphic rocks that underlie Mount Jefferson State Park–*amphibolite,* which dominates, is mostly made up of hornblende (one specific mineral in a large group of minerals collectively called amphiboles) and feldspar; *schist,* which contains abundant biotite and muscovite: and *metagraywacke* (sometimes referred to as metamorphosed "dirty **sandstone**"), which contains abundant quartz and feldspar, with lesser biotite and mica. This episode of folding, **faulting** and metamorphism, very vigorous at first but then gradually dying out, also resulted in uplift and subsequent erosion and sculpting of the land. But again, critical evidence that would enable us to estimate the height of the mountains that undoubtedly developed has been greatly obscured by subsequent geologic events. Finally, about 375 million years ago, roughly 100 million years after the start of this major deformation, uplift and metamorphic episode, the earth in the region returned to relative tranquility.

The earth is a dynamic, ever-changing body, however, and another great mountain-building movement, named the Alleghanian Orogeny, began to deform eastern North America and this area's rocks again. Evidently, this event was one consequence of the collision-like interaction of the continental plates of North America and Africa. As before, great masses of the earth's rocky crust were carried west or northwestward along another series of major thrust faults. In the Mount Jefferson State Park

fault



region, it appears that many of the pegmatite and quartz veins that formed in cracks or fractures developed during this episode. The sum of the previous westward movement and the most recent one is certainly many miles; some geologists estimate the total lateral displacement may well exceed 200 miles!

From the mineral **composition** of the rocks now exposed in and around Mount Jefferson State Park, geologists conclude that the rocks were once probably buried some 10 miles or so beneath the surface of the earth. Because these rocks are now at the earth's surface, that means the total uplift must have been on the order of 50,000 to 55,000 feet! However, because erosion was occurring at the same time the rocks were being pushed up, we can surely presume that the mountains were never as high as 50,000 feet. Clearly, their actual height long ago is difficult to estimate, but it seems reasonable to infer that the peaks may have been on the order of 15,000 to 20,000 feet. What remains today, some 250 million years later, we can think of as the erosion-scarred, nearly worn-down roots of former mountain ranges. More **resistant rocks** underlie the hills and peaks we see now; less resistant rocks underlie the valleys and lowlands.

So, as we look carefully at the earth we can see that it changes constantly. New rocks form, they are heated and cooled, folded and faulted, perhaps even metamorphosed, and may undergo the processes of deep burial and then uplift and exposure at the earth's surface. Once exposed at the surface, they weather and erode and produce sediment that washes into nearby streams and rivers and moves to the ocean. These processes and their results continue today and are visible all around us. As you walk the trails at Mount Jefferson, it is interesting to think about the many changes these rocks and the landscape have undergone to reach their present form.

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 Activity

#1 Rainbow Rock (page 3.1.1)

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

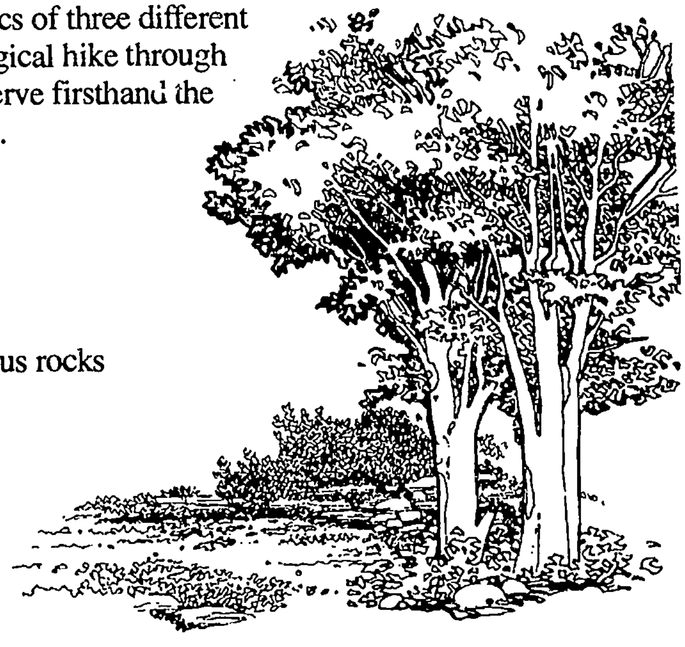
Major Concepts:
- Rock cycle
- Mechanical weathering
- Sedimentary rock formation
- Metamorphic rock formation
- Igneous rock formation

Objectives:
- List the three main rock classifications.
- Describe how the three rock classifications are formed.
- Explain the rock cycle.
- Name the predominant metamorphic rock, and its minerals, found at Mount Jefferson State Park.

II. On-Site Activity

#1 Geo-Trek (page 4.1.1)

This activity is designed to familiarize the student with the specific rock types of the southern Blue Ridge highlands, their characteristics and where they are found in the park. In Part I, students will learn the names and characteristics of three different rocks found in the park. In Part II, on a geological hike through Mount Jefferson State Park, students will observe firsthand the effects of geologic processes on the landscape.



Major Concepts:

Part I. Rock ID
- Rock formation
- Rock characteristics
- Sedimentary, metamorphic and igneous rocks

Part B. Talking Rocks
- Weathering
- Erosion
- Rock cycle

Objectives:

Part I

- Identify three major rock and five major minerals found at the park by listing their distinguishing characteristics.
- List five characteristics that geologists use to help identify rocks and minerals.

Part II

- Describe three factors that cause rocks to weather.
- Describe how metamorphic rock is formed and name one common to this area.
- Describe how sedimentary rocks are formed and how they are layered.
- Explain why rocks found in this area are no longer in a horizontal plane.

III. Post-Visit Activity

#1 Geo-Scavenge (page 5.1.1)

This activity is designed to reinforce and review previous lessons, and to broaden the student's understanding of geology.

Major Concepts:

- Uses of rocks and minerals

Objectives:

- Differentiate between 10 objects, and 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 — Rainbow Rock

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

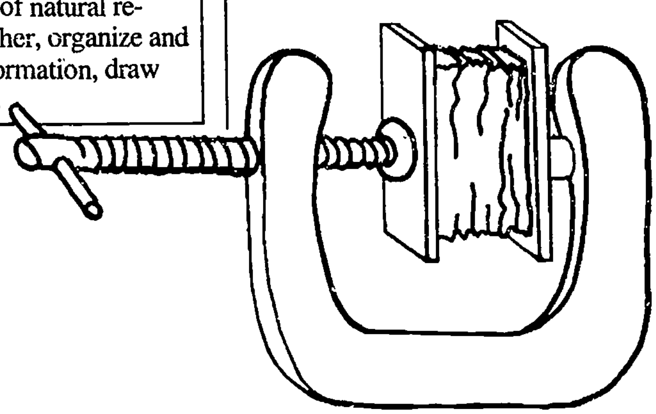
Group Size:
30 students or less, class size

Estimated Time: 2 to 4 hours

Appropriate Season: Any

Materials:
Provided by the educator:
Per student: safety goggles, large pocket pencil sharpener, four wax crayons of the same color, (either red, green, blue, or yellow), envelope, wax paper, "Rock Cycle" worksheet, "Rainbow Rock" worksheet
Per group: hot plate, two oven mittens, petri dish, aluminum foil, three disposable aluminum foil pie pans, trivet, newspaper (enough to cover lab surfaces–have lots of newspaper handy)
Per class: samples of real sedimentary, metamorphic and igneous rocks (contact the park if you need to borrow a rock set), crushed ice, water
Provided by the park:
Per group: one 8 inch C-clamp, two boards

Special Considerations:
Take proper safety precautions. The hot plate and hot crayon wax can cause burns. C-clamps 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 classifications.
- Describe how the three rock classifications are formed.
- Explain the rock cycle.
- Name the predominant metamorphic rock, and its minerals, found at Mount Jefferson State Park.

Educator's Information:

Students often 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 separated into five parts.

Instructions:

Set the stage by asking students to describe local rocks and 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 highways 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 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

Each student should complete a "Rainbow Rock" worksheet 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 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 of weathering. As a result, a 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.)

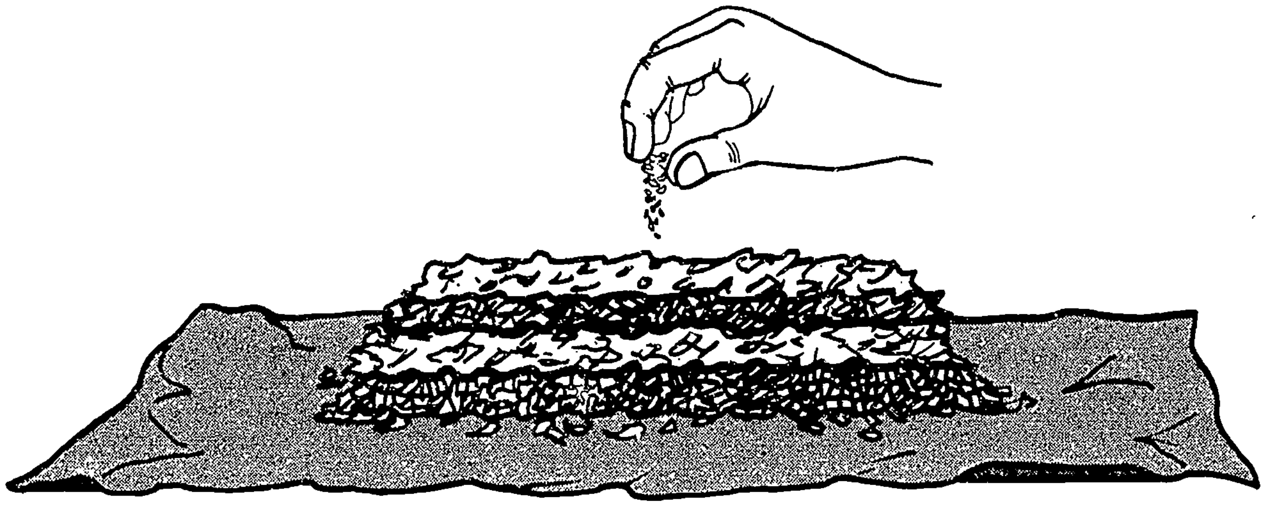
"Why do similarly sized fragments seem to be found together?" (Answer: Because similar weathering processes will usually take place in one particular area. Smaller, lighter rock fragments will be carried farther away, in a winnowing effect.)

When the "weathering" is complete, the students should wrap their fragments in their wax paper and place each wax paper packet in an envelope, unless you plan to do part B immediately. Label each envelope as to its contents, "red," "yellow," etc., 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 (31 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

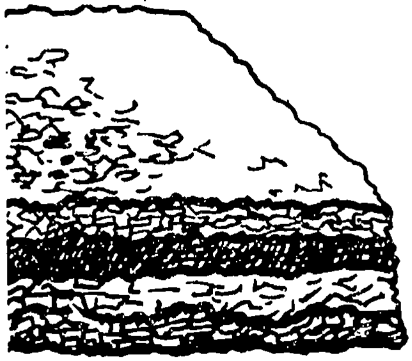


of another (see illustration).

Students should record their observations of their "weathered" fragments on their "Rainbow Rock" 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 when the activity is resumed.

Part C: Sediments/ Sedimentary Rock Simulation

Instruct the groups to place their folded foil package between two pieces of plywood. Apply very light pressure with the C-clamp to compress the plywood pieces and the "rock"



fragments that are between them. Once the "rock sandwich" has been lightly compressed, remove it from the C-clamps. 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 spaces between the crayon fragments are now smaller.)

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.

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 Appalachian 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.

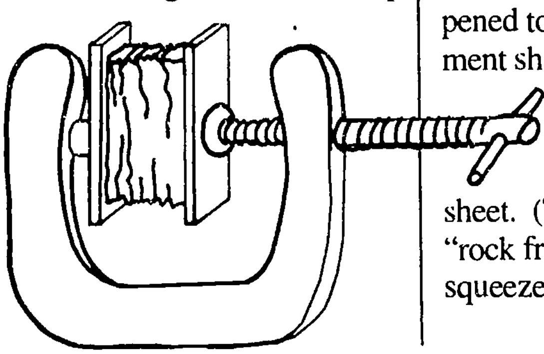
There is not much sedimentary rock left in its original layered form at Mount Jefferson when compared to the amount of metamorphic rock. This is due to the age of the rocks and the changes the rocks underwent as the fragments were buried, heated, folded and pressed together. As "Rainbow Rock" demonstrates,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

Examine a sedimentary rock with fossils imbedded 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 and igneous rock, any fossils that might have been present are usually destroyed. Since almost all the rocks at Mount Jefferson State Park are metamorphic, no fossils have been found here.

If you are breaking the activity into sections, stop here and label each package for proper distribution later.

Part D: Metamorphic Rock Simulation

Each group should place their foil package with the "sedimentary rock" between the two plywood boards and the C-clamps again. Tell the students to tighten the C-clamp 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 we do not have the equipment to measure this change. 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 overriding rock load and continental plate movement.



Have the students release the compression on the C-clamp, 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.)

Examine a real metamorphic rock and compare it to the metamorphic "crayon rock." Also compare the real metamorphic rock to the real sedimentary rock. Have the students examine the texture, the edges and overall appearance of these rocks. 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. The larger piece of "metamorphic rock" will go in an envelope labeled "metamorphic." (You can reuse the envelopes used earlier to hold the crayon fragments.) If you are breaking the activity into sections, stop here and label each group's pie pan for proper distribution later.

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 remaining two pie pans with aluminum foil and do the following:

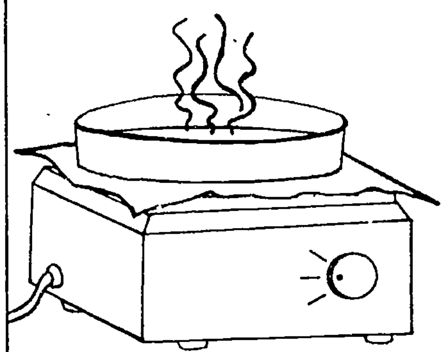
Groups 1 and 2 should each fill one of their pie pans with crushed ice.

20 A

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

Group 4 should place the "weathered fragments" and the smaller pieces of "sedimentary and metamorphic rocks" they saved earlier into one of their foil-lined pie pans. (Groups 1, 2, and 3 will save their fragments and "rock" pieces for comparison with "igneous rocks" they will make during this part of the activity.)

For the igneous rock simulation, all groups should place the "weathered sediments" they set aside in envelopes, plus the larger piece of "metamorphic rock," into one of their foil-lined pie pans. ***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 "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 "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 which has been placed in their second 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" from sections B and C. 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 metamorphic rocks" will at least 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 rock" from the pie pans. Students should make comparisons between the igneous rock in each group's pie pans, then draw and write their

observations on their worksheet. For instance, comparisons should be made between the crystal sizes and shapes formed by each of the group's cooled magma. Comparisons should also be made between these "igneous rocks" and the "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 sedimentary or 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."

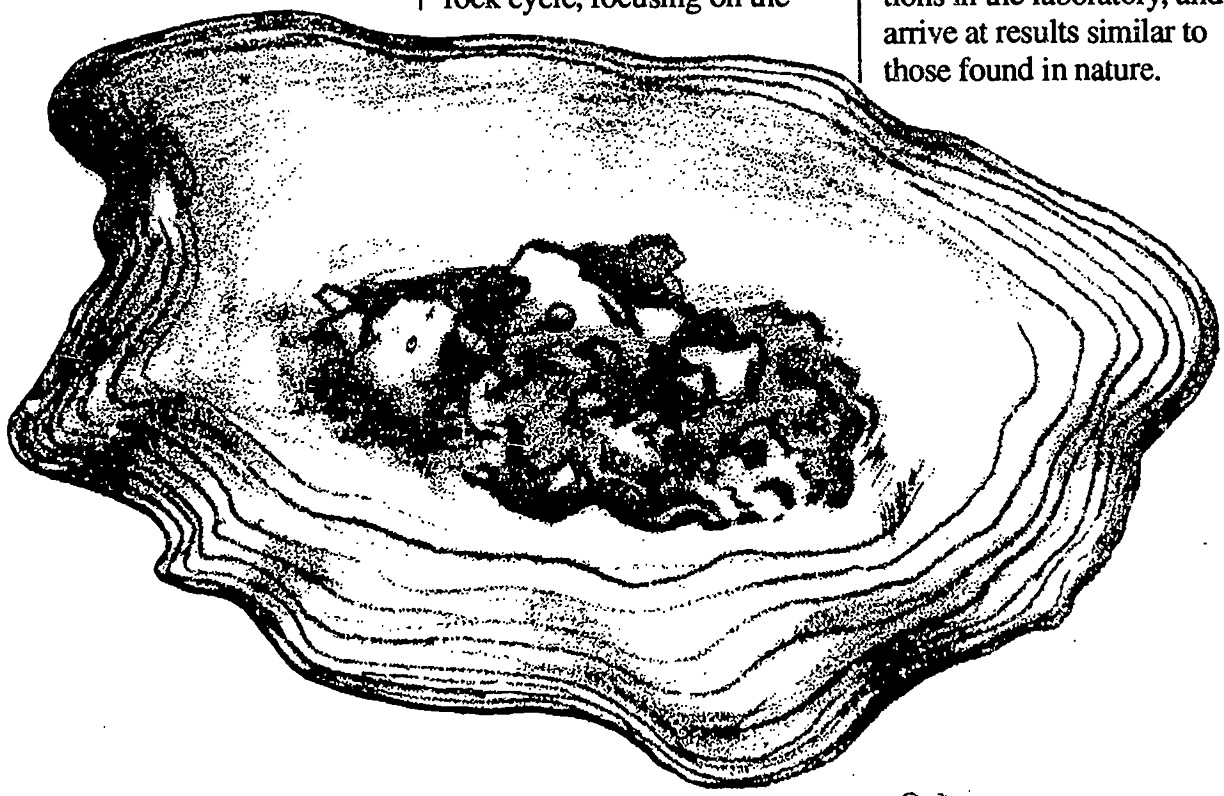
Using Group 4's pie pan, discuss the effect of the "lava" flowing directly onto the sedimentary and metamorphic "rock" and "sediments."

If possible, show the students various examples of real **volcanic rocks** and compare the real rocks with their igneous "crayon rocks." Remind the students that most of the rock visible at Mount Jefferson State Park were first volcanic, eroded to sediments then compressed into sedimentary and finally, with the collision of North America and Africa, were pressed into metamorphic rock. These rocks have formed deep within the Earth. The processes of weathering and erosion have exposed them to our view and shaped the landscape into what we see today.

While the students are looking at the three types of rocks, lead a discussion on the rock cycle, focusing on the processes they observed in action to transform 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 not all conditions for rock formations can 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.



Student's Information

Rocks forming the **Earth's crust** are classified according to their origin. There are three basic rock classifications. Of these three, two (**igneous** and **metamorphic**) are formed by geologic 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 considered the **rock cycle**. (The rock cycle is discussed below.)

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 presses the deposition into rock, or the sedimentary particles are cemented together. Examples are limestone, **sandstone** and shale.

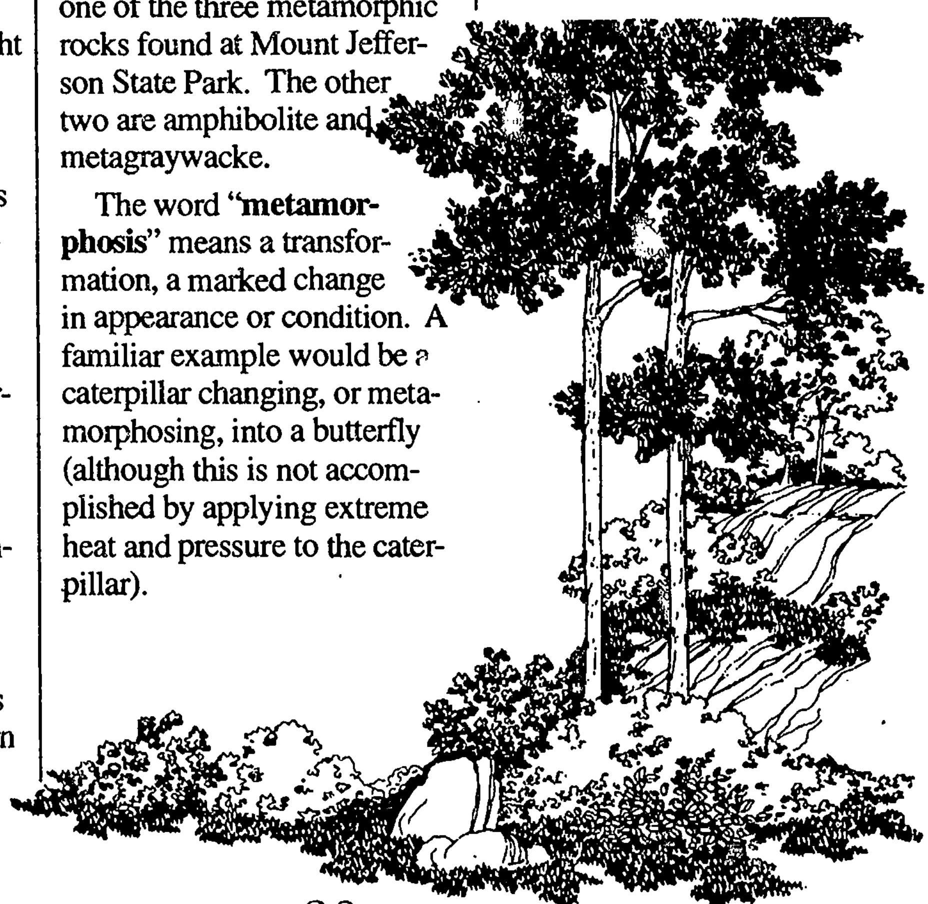
Sedimentary rocks are important when discussing the rock cycle and are also important in the understanding of how metamorphic rock is formed. The metamorphic rock of the Blue Ridge Mountains was formed when sedimentary rock layers were subjected to extremely high temperatures and tremendous pressure. The chemical action of solutions and gases during the last 540 million years of the Earth's dynamic activity played a part as well.

There is no sedimentary rock at Mount Jefferson. There is sedimentary rock in the eastern part of the state. A good example of sedimentary rock can be seen at Cliffs of the Neuse State Park in Seven Springs, North Carolina.

2. **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 Schist, which is made from mudstone. Schist is a major rock type found throughout the Blue Ridge Mountains and is one of the three metamorphic rocks found at Mount Jefferson State Park. The other two are amphibolite and metagraywacke.

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

3. **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. There are no intrusi e igneous rocks at Mount Jefferson. A good example of intrusive igneous rock can be seen at Stone Mountain State Park, located in Wilkes County at Traphill, North Carolina.



The Rock Cycle

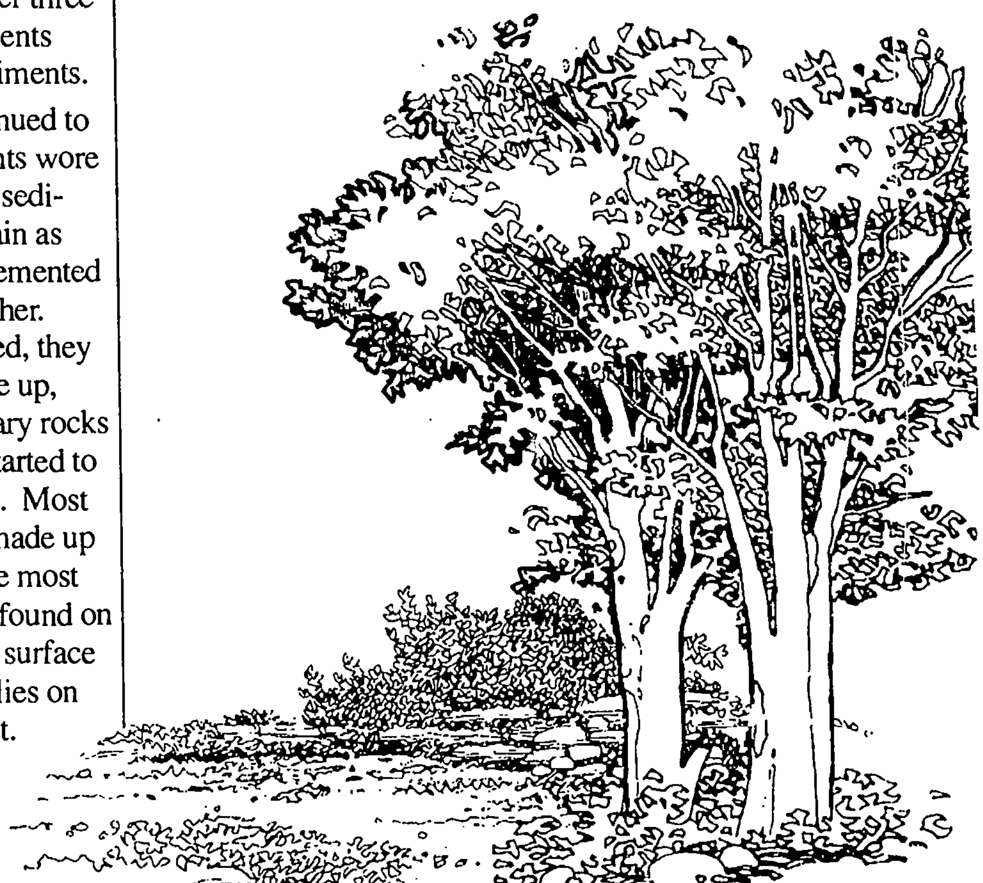
Geologists believe that at one time the Earth was a ball of molten magma and gases. As the Earth cooled, the outermost layer of magma solidified into a crust of igneous rock. Today, the Earth's crust is 30 miles thick in some places, yet in others it is so thin that lava can spew up through cracks.

Even as the first rocks cooled, **weathering** began breaking them down into sediments which were **eroded** away by wind and water. Those first sediments were deposited at the edges of the continents in the first oceans. The eroded rock particles traveled more quickly than they do today, as there were no plants to stabilize these first soils. For over three billion years, the continents were bare rock and sediments.

The sediments continued to build up as the continents wore down. The underlying sediments became rock again as the pressure and heat cemented the particles back together. As the continents eroded, they became lighter and rose up, exposing the sedimentary rocks to the air, where they started to erode away once again. Most of the Earth's crust is made up of igneous rock, but 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 but drift about on top of the molten **mantle** which is beneath the crust. The North American continental plate is moving westward, causing the crust at the leading edge of the Pacific plate to slide underneath the continental plate. This pushes the crust down far enough that it melts, turning into magma. (The collision of the Pacific and continental plates is what pushed up the Rocky Mountains.) This type of collision causes sedimentary and igneous rocks caught in it to be under tremendous heat and pressure, enough so that a third class of rock is formed: metamorphic. Eventually the metamorphic rock will reach the Earth's surface where it will be subjected to weathering.

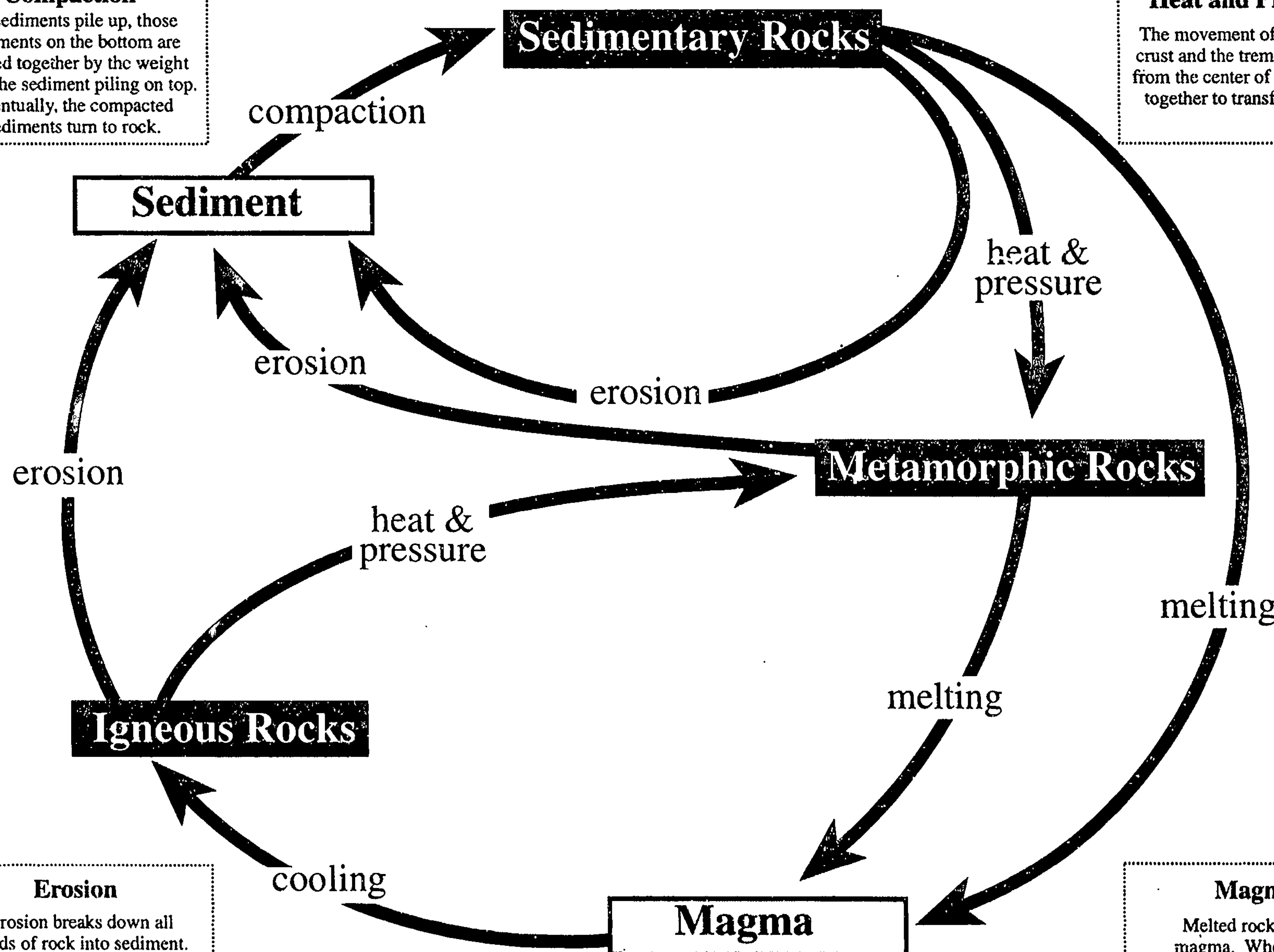
The continuing cycle of rocks melting down and then cooling into rocks again, or breaking down and then being pressed into rocks again has happened many times. It is hard to imagine, but all the rocks you see around you were once sediments at the bottom of the sea, and one day the particles in these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

"Rainbow Rock" Worksheet

1. Describe and draw the "weathered sediments" that 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 are 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 are formed. How have they changed with the addition of heavy pressure?

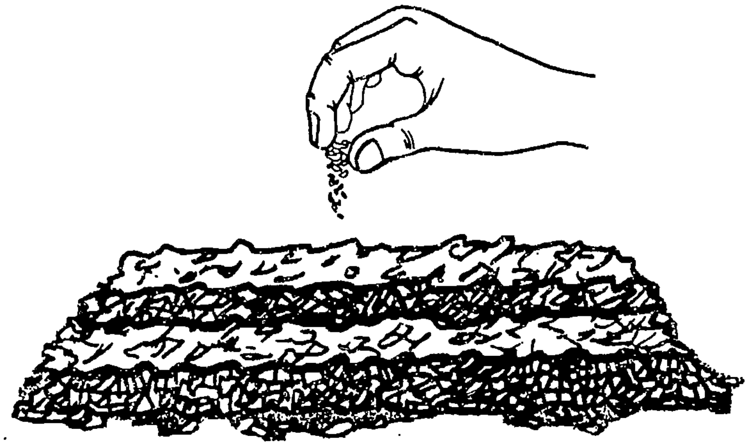
4. Do a colored drawing of each of the four "igneous rocks" created. Compare and contrast the formation of the extrusive with the intrusive igneous rocks.

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.

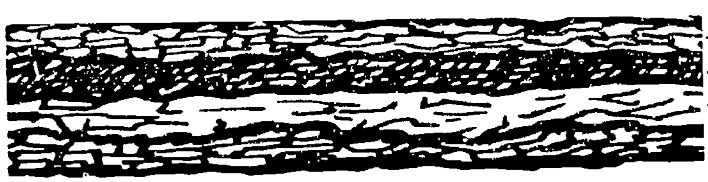
"Rainbow Rock" Answer Sheet

1. Describe and draw the "weathered sediments" that 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 are 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 are formed. How have they changed with the addition of heavy pressure?



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

Curriculum Objectives:
Grade 5
- Communication Skills: listening, reading, vocabulary and, viewing comprehension
- Guidance: competency and skill for interacting with others
- Healthful Living: recreational safety
- 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
- Guidance: competency and skill for interacting with others
- Healthful Living: recreational safety
- Science: Earth science environment
- Social Studies: organize and analyze information, draw conclusions, locate and gather needed information

Grade 7
- Communication Skills: listening, reading, vocabulary and, viewing comprehension
- Guidance: being responsible in a group
- Science: soils, scope of Earth science, Earth forms and natural phenomena
- Social Studies: organize and analyze information, draw conclusions, locate and gather needed information

Location:
Part I:
Summit picnic area
Part II:
Starting point for the hike will be the second overlook parking area. The hike will end at the outlook tower located at Mount Jefferson's summit.

Group Size:
30 or less; for Part I, divided into seven groups of about four students each

Estimated Time:
Part I: 50 minutes
Part II: 1 to 2 hours

Appropriate Season:
Spring and summer months are recommended, weather permitting

Materials:
Part I:
Provided by the park: 1 large rock identification work sheet
Per group: pencil, index card, rock hammer, safety goggles, streak plate, penny, steel file, hand lens, Field Guide to Rocks and Minerals, rock and mineral set to include the following rocks: schist, amphibolite, metagraywacke; and the following minerals: feldspar, hornblende, muscovite, biotite, quartz
Provided by the educator:
Per student: "Rock and Mineral Identification" Fact Sheet

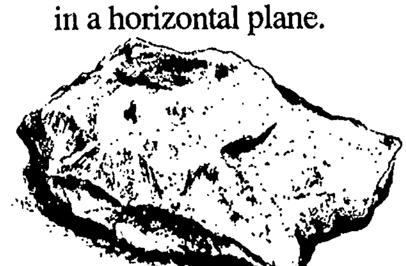
Part II:
Provided by the students: pencil and paper for drawing geological features

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

Part II
- Weathering
- Erosion
- Rock cycle

Objectives:
Part I
- Identify three major rocks and five major minerals found at Mount Jefferson State Park by listing their distinguishing characteristics.
- List five characteristics that geologists use to help identify rocks and minerals.

Part II
- Describe three factors that cause rocks to weather.
- Describe how metamorphic rock is formed and name one common to this area.
- Describe how sedimentary rocks are formed and how they are layered.
- Explain why rocks found in this area are no longer in a horizontal plane.



metagraywacke

Educator's Information:

This activity is divided into two parts:

In Part I, "Rock ID," the students will identify five different types of **minerals** and three different types of **rocks**. Each one is a common mineral or rock found at Mount Jefferson State Park and some can probably be found around the students' homes and school.

Students will be required to fill-in a rock and mineral identification worksheet in which, for a mineral, they will determine color, streak color, luster, cleavage, hardness and name. For the rock identification, the students will determine color, major and minor minerals, texture, foliation, what it was formed from and name.

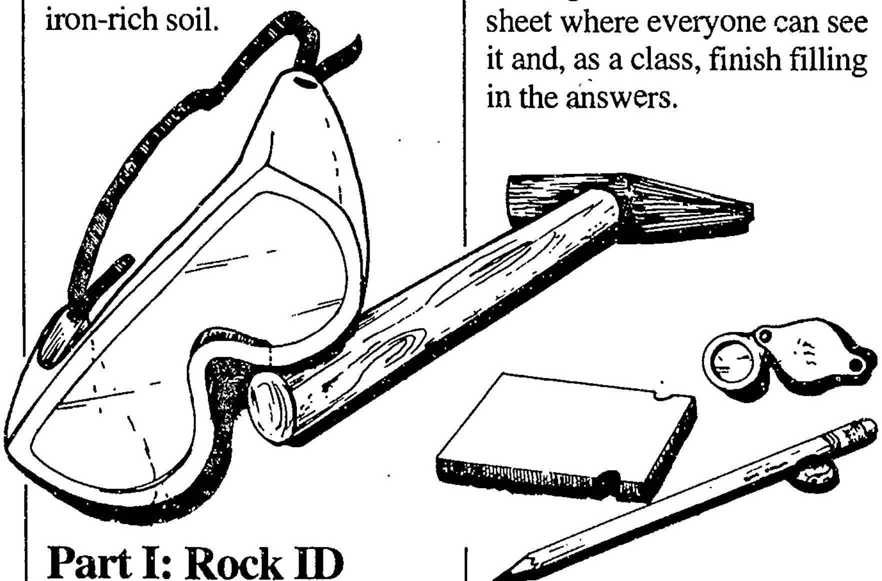
In Part II, "Talking Rocks," the students will hike through the park and observe the effects of geologic processes on the landscape.

NOTE: Before arriving at the park for the on-site activities, teachers and students should read through this "Rock ID" activity and the "Introduction to the Geology of Mount Jefferson State Park," found in the Introductions.

Suggested Extensions:

1. Have the students bring rocks to class and try to identify them using the "Rock and Mineral Identification" fact sheet and worksheet.

2. If time allows, take the group on the Rhododendron Trail to examine amphibolite and metagraywacke outcrops more closely. A self-guided trail brochure is available to help you identify the mountain vegetation growing in this iron-rich soil.



Part I: Rock ID

Instructions:

1. Divide the students into seven groups, one group placed at each station. Have the students put on their goggles for this activity.

2. Using the mineral **quartz** (M1), lead the groups through the tests on the "Rock and Mineral Identification" worksheet. Make sure each group understands how to do each test and describe their results before moving on to the next test. When all the groups have finished a test, write the answers on the large identification worksheet. To help in this process, encourage the students to use the "Rock and Mineral Identification" fact sheet and "Rock and Mineral Classification" fact sheet.

3. Have the students repeat the identification steps for each of the other four minerals and three rocks at their station.

4. After each group has completed their worksheet, place the large identification worksheet where everyone can see it and, as a class, finish filling in the answers.

5. Have the groups discuss how they came to their conclusions. Also, lead them in a discussion on how geologists key out minerals and rocks.

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 who is breaking the rocks or other students. It is important for all students to wear safety goggles during this activity.

Rocks

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. Ninety-five percent 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 **sediments**, are deposited on land or in the water. With enough pressure from the weight of the sediments and water above, the lower sediment particles get pressed into sedimentary rock. For example, if large amounts of volcanic ash built up on the bottom of a lake or ocean, the ash would eventually be 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. However, these sedimentary rocks are only 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 rock both physically and chemically. The tremendous amount of pressure brought about with the collision of continental tectonic plates is one of the major forces that creates metamorphic rock. This type of metamorphic process changes shale to schist (sometimes referred to as mica schist or muscovite/biotite schist), limestone to marble, and sandstone to quartzite.

Geologists have identified about 2,000 rocks, each with their own characteristics. To identify rocks, geologists look at fresh color, texture, foliation, composition and many other characteristics.

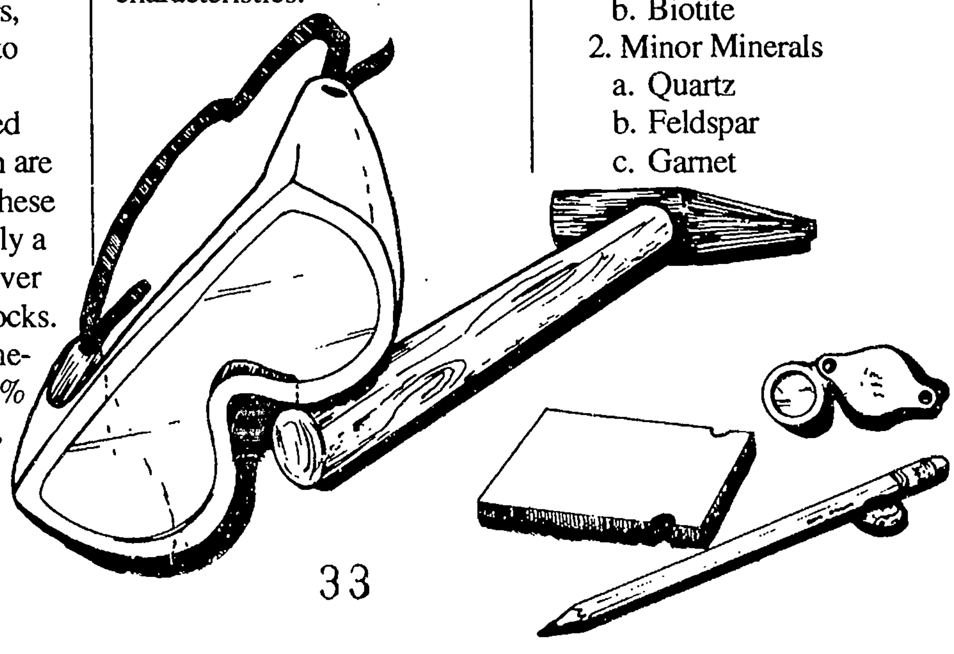
Metamorphic Rock Types at Mount Jefferson State Park

All the major rock types at Mount Jefferson State Park are metamorphic. These rocks and their component minerals are:

I. Amphibolite:
1. Major Minerals
   a. Hornblende
   b. Feldspar
2. Minor Minerals
   a. Epidote
   b. Biotite
   c. Garnet

II. Metagraywacke:
1. Major Minerals
   a. Quartz
   b. Feldspar
2. Minor Minerals
   a. Biotite
   b. Muscovite
   c. Garnet

III. Schist:
(Mica-schist, Muscovite/biotite schist)
1. Major Minerals
   a. Muscovite
   b. Biotite
2. Minor Minerals
   a. Quartz
   b. Feldspar
   c. Garnet



Minerals

A rock is made up of one or more minerals, so one characteristic geologists look for is the type of minerals found in a rock, and the ratio of minerals to one another. 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**, for example, is a combination of two elements, silicon and oxygen, and has a chemical formula of SiO_2. Quartz is a common mineral in the park and in North Carolina. Gold is a mineral of just one element with the chemical formula (and symbol) of Au. Gold has been found in several locations in Avery, Watauga and Ashe counties, as well as in the Ore Knob Mine, but not in quantities sufficient for mining.

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

The relationship between a rock and its minerals can be compared to a fruitcake's relationship to its ingredients. If the rock were the fruitcake, the minerals would be the raisins, nuts, cherries, candied fruit, sugar, flour, eggs, 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%
		TOTAL 98.8%

Rock and Mineral Identification Fact Sheet

Rocks are identified by their component minerals.

Minerals:

Quartz:

Entire books have been written about this mineral. It is a common mineral, found in many different types of rocks. In its pure form, quartz will be clear, but it usually contains impurities which give it a variety of colors, including white, red, pink, smoky black, black, yellow, green and gray. Its chemical formula is SiO_2, silicon dioxide.

Quartz is classified as hard (listed at 6.5) because a file will barely scratch it, if at all. Its luster is greasy to glassy. Quartz does not have layers and is therefore not a sedimentary rock, although it is found in sedimentary rocks, as well as igneous and metamorphic rocks. Quartz has no cleavage and produces a colorless to whitish streak when rubbed on a scratch plate.

Quartz often acts like a "rock glue." When rocks crack and the crack goes deep enough into the Earth, often silicon dioxide will fill the crack and "glue" the rocks back together. Quartz can develop into beautiful hexagonal crystals if the quartz does not completely fill the crack or cavity.

There are two interesting things about this rock glue called quartz. First, the glue is usually harder than the rock it glues back together. This results in quartz being found on top of the soil after the rocks it has glued together have weathered to soil. Second, when the silicon dioxide is traveling from deep in the Earth, other minerals will sometimes come along with it, creating a quartz based rock. One of those minerals is gold. Tons of gold have been found in the southern piedmont of North Carolina, primarily in association with quartz.

Quartz is very weather resistant and is usually elevated slightly above other rocks and minerals when located within the park. Quartz veins can be seen in the amphibolite outcrop located at the second overlook on Mount Jefferson.

Early European settlers in this area used quartz-based rock to build walls and fences. Some of these structures still exist and can be seen from the park's second overlook.

Feldspar:

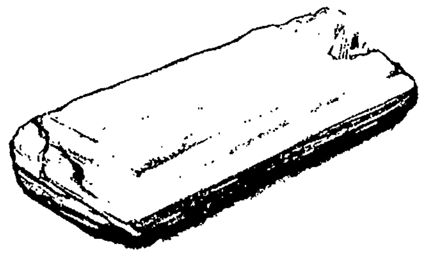
Feldspars form the most abundant group of minerals. If the group was considered a single mineral it would be the most common mineral by far; five times as common as quartz. Feldspars are found in nearly all igneous rocks and rocks formed from them. Feldspars show two good cleavage faces, which are at right angles or nearly so. They have a hardness of 6 or better. This mineral group will usually have a smooth, glassy or pearly luster. Feldspars leave a white streak when rubbed on a scratch plate. They are among the minerals found in the amphibolite found on Mount Jefferson. When closely examined, amphibolite has small white specks embedded in it; these specks are small feldspar flakes.

Feldspars are mined almost entirely from bodies of pegmatite, a special kind of rock containing large crystals of feldspar, as well as quartz. A large feldspar mining operation is located at Spruce Pine, in Mitchell County.

Hornblende:
(See Amphibolite)

Hornblende is a lustrous green, brown or black mineral. It is a silicate and contains aluminum and other elements. Hornblende can occur in crystals or in other forms, such as fibers and granules. Hornblende has a glassy luster, a hardness of 5-6 and it usually has cleavage varying in two directions. It usually occurs in metamorphosed igneous rock, such as amphibolite.

Its name is of Germanic origin. *Horn* refers to its dark color, which reminded people of an animal's horn, and *blende* in German refers to being false. This is because the rock looks like it could be melted down into a metal, which it can not. Hornblende can be found in and around amphibolite outcrops located on Mount Jefferson.



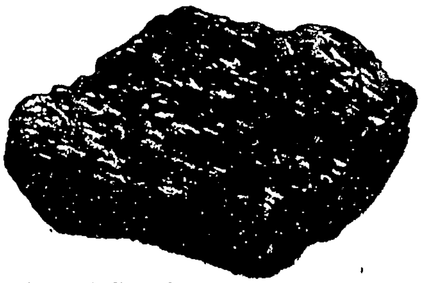
Muscovite:

Muscovite is a type of mica which contains aluminum, oxygen, potassium, silicon and water. It is a light colored mica that is colorless and has a luster that varies from glassy to pearly. It has a hardness of 2 to 2-1/2 and its cleavage is strong in one direction. Most muscovite is very clear and leaves a colorless streak when rubbed on a scratch plate. It is so named because in Russia, the poorer Muscovites used it instead of glass. Muscovite is formed from highly metamorphosed, shaley sediments. All micas will cleave in one direction into very thin sheets. One sheet can be as thin as 1/10,000 of an inch. Muscovite can be seen throughout the park.

Biotite:

Biotite is one of the dark-colored micas, consisting of aluminum, hydrogen, iron magnesium, oxygen, potassium and silicon. It has a hardness of 2-1/2 to 3 and a pearly luster. Biotite cleaves strongly in one direction and leaves a colorless streak when rubbed on a scratch plate. It is abundant in some granites and is also common in schists and gneiss. Biotite may occur with muscovite in metamorphic rocks. Thin sheets often show light spots and rings. Biotite and muscovite can be seen together throughout the park.

Rocks:



Amphibolite:

Amphibolite is a metamorphic rock consisting mainly of an amphibole mineral (hornblende) and feldspar (plagioclase). It is difficult to split into thin layers, meaning it has poor foliation. The amphibolites were originally mafic (dark) volcanic rocks either from lava flows or materials ejected by a volcano and deposited in layers. Its fresh color is black. It is listed as medium-grained in texture.

Metagraywacke:

Metagraywacke is a metamorphic rock which formed from gray, coarse-grained sandstone. It consists of poorly sorted, angular to subangular grains of quartz with variable amounts of feldspar, muscovite and biotite. This rock can be non-foliated to very coarsely foliated. It represents metamorphism of a muddy or dirty sandstone, a sedimentary rock made up of abundant quartz particles and variable amounts of feldspar and clay particles.

Schist:

Schist is a finely foliated metamorphic rock that can be readily split into thin flakes or slabs. Schist is a less abundant rock type that is found interlayered primarily with metagraywackes. It originated as a sedimentary rock, most likely a shale layer composed of clay. Its fresh color is medium to dark gray. It is formed from shale and is made up of the minerals muscovite, biotite, quartz and garnet. The texture of this rock is fine to medium-grained. It is well-foliated, which means it splits easily.

Rock and Mineral Classification Fact Sheet

Color - Color is the identifiable color of the rock or mineral when it is freshly broken. To determine the rock or mineral's overall color, use the rock hammer to break it so you can see the color inside. This is important, as the outside color may have been altered due to weathering factors. (Quartz may be colorless; white, if it has water vapor trapped inside; pink; smoky; black; yellow; or purple if it has impurities within it, depending on the impurities.)

Luster - Luster is the way a mineral reflects light. Classify the luster as pearly, glassy, dull or metallic. (Quartz has a glassy luster.)

Hardness - Hardness is based on what material is able to scratch a rock or mineral's surface. 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. Try to scratch the rock or mineral with these objects to help establish the rock or mineral's hardness. Use the hand lens to see if any of these things made a scratch on the rock or mineral's surface. (Quartz can be scratched by a file, so it is hard: 5.5 - 6.5.)

Hardness:

1 - 2.5	(very soft)	fingernail
2.5 - 5.0	(soft)	penny
5 - 6.5	(hard)	steel file
6.5 -10.0	(very hard)	porcelain

Cleavage - Cleavage is the tendency of a mineral to break or split along a defined plane surface. Observe whether the mineral has cleavage or not, and describe it. (Quartz does not have cleavage tendencies.)

Streak - Streak is the color a mineral leaves behind when it is scratched across a streak plate or unglazed porcelain. Write down the streak's color. (Quartz leaves a white streak.)

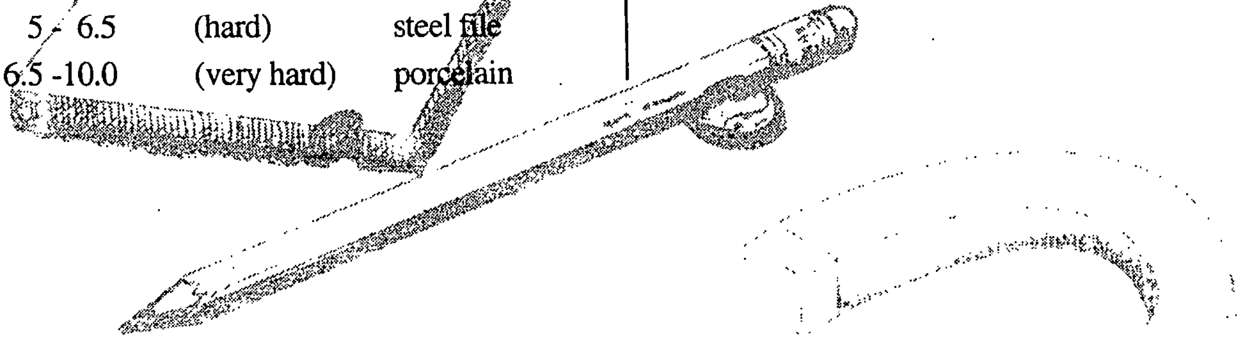
Texture - Texture is the size and shape of the mineral crystals present in the rock and their spatial relationships with each other.

Foliation - A rock either has layers or it doesn't. The development of wavy or contorted layers under intense metamorphism is called foliation.

Major/Minor Minerals - The minerals that combine to make up a rock.

Formed From - Every rock is formed from a previous stage in the rock cycle. Name the rock and rock type (sedimentary, metamorphic, igneous) this rock was formed from.

Name - A rock or mineral is identified using all these characteristics. Identify and name the rock or mineral with the help of the "Rock and Mineral Identification" fact sheet.



Rock and Mineral Identification Worksheet

Minerals						
Mineral Sample	Color	Luster	Hardness	Cleavage	Streak	Name
1						
2						
3						
4						
5						

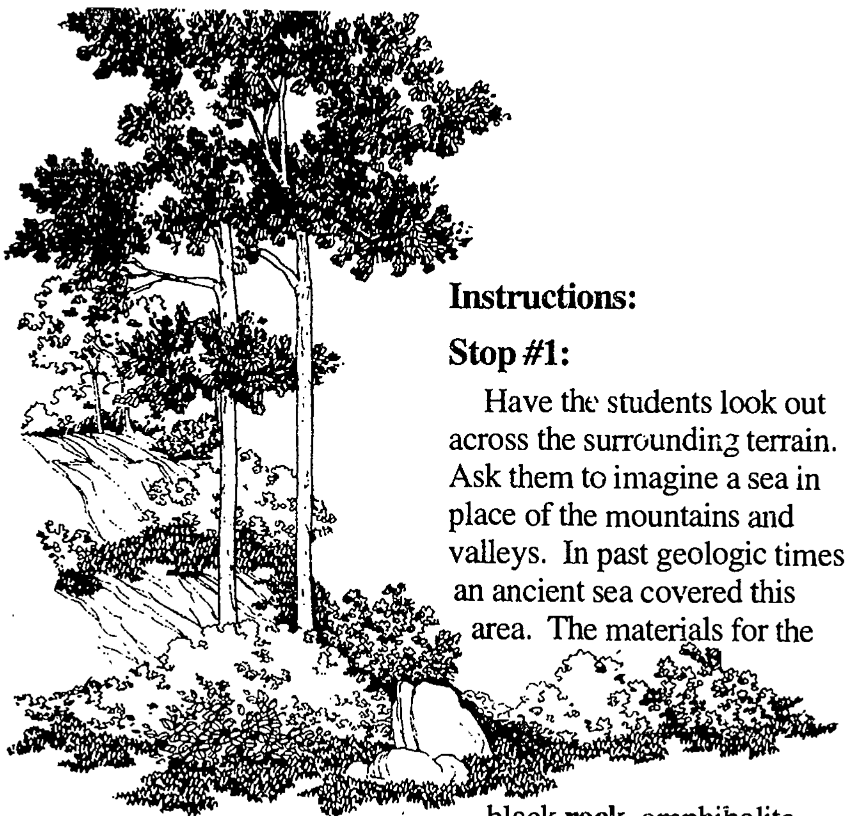
Rocks						
Rock Sample	Color	Texture	Foliation	Major/Minor Minerals	Formed From	Name
1						
2						
3						

Rock and Mineral Identification Worksheet

Minerals						
Mineral Sample	**Color**	**Luster**	**Hardness**	**Cleavage**	**Streak**	**Name**
1	colorless to colored varieties	glassy to greasy	7	none	white	quartz
2	white, pink or gray	glassy	6+	two directions nearly always at right angles	white	feldspar
3	black to greenish	glassy	5 - 6	two varying directions	colorless	hornblende
4	colorless	glassy to pearly	2 - 2 1/2	strong in one direction	colorless	muscovite
5	black	pearly	2 1/2 - 3	strong in one direction	colorless	biotite

Rock						
Rock Sample	**Color**	**Texture**	**Foliation**	**Major/Minor Minerals**	**Formed From**	**Name**
1	black	medium	poor	hornblende, feldspar	mafic volcanic (igneous)	amphibolite
2	silvery gray	fine to medium	finely foliated	muscovite, biotite, quartz, garnet	shale (sedimentary)	schist
3	medium to dark gray	medium to coarse-grained	non-foliated to coarse	muscovite, feldspar, quartz , biotite	dirty sandstone (sedimentary)	metagraywacke

Part II: Talking Rocks



Instructions:

Stop #1:

Have the students look out across the surrounding terrain. Ask them to imagine a sea in place of the mountains and valleys. In past geologic times an ancient sea covered this area. The materials for the black **rock**, amphibolite, were deposited in a basin on the floor of the ancient sea some 600 to 800 million years ago. Some of the materials in the basin were washed in from surrounding land areas, but other materials were deposited as volcanic debris from now extinct **volcanoes**.

At this stop there is a large **outcrop** of black rock. This black rock, amphibolite, is the most common rock found in the park. Amphibolite is made up of an **aggregate** or combination of **minerals**. Hornblende and feldspar are the two primary minerals that make up the amphibolitic on Mount Jefferson. Epidote, a yellowish-green, pistachio-green, or blackish-green mineral and biotite, a black-colored mica, are also present in the amphibolite. Amphibolite is an example of a **metamorphic rock**.

The amphibolite here at the second overlook was at one time actually molten, **igneous rock** from volcanoes. After the eruptions, the volcanoes eroded away, their debris and **sediments** washing into the sea for thousands of years. The weight of the layers began to place great heat and pressure on the lower layers, producing **sedimentary rock**. This sedimentary rock was put under such intense heat and pressure from the collision of the North American and African continental plates that the sedimentary rocks were metamorphosed, eventually changing to the black amphibolite found in the park today. The newly formed metamorphic rocks were put under continuing pressure from the collisions when the rocks were still very hot and pliable, resulting in the amphibolite being **folded** and curved. When the rocks cooled, they retained their folded and bent shapes.

Have the students note the physical characteristics of the soil around the amphibolite outcrop. This soil is being produced by the rock's **weathering**. Some characteristics the students should notice include fine particles, reddish-orange particles, small greenish particles and small shiny

Special Considerations:

This is a one mile hike of moderate difficulty. Sturdy footwear is recommended.

Mount Jefferson State Park contains many high rock outcrops. Students will visit some of these outcrops during the geology hike. Teachers, please make sure the students understand that horseplay will not be tolerated and that serious injury or death could result from a fall.

Part of this hike will be along the park road. Please be alert for vehicular traffic along this road.

flakes. Have the students try to find examples of hornblende, epidote, feldspar, **quartz**, garnet, biotite, muscovite and vermiculite. Have them refer to their "Rock and Mineral Identification" fact sheet to help identify the minerals.

What do these soil characteristics tell us?

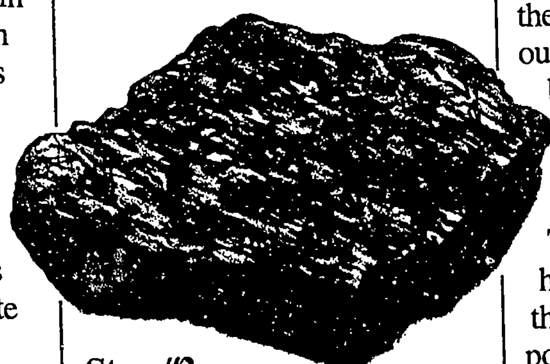
1. Fine particles settled here because there is no steep slope at the base of the outcrop. Water running downhill from the top of the mountain during storms or snow melts slowed here, allowing the fine particles to settle.

2. Reddish-orange colored particles are nothing more than weathered pieces of amphibolite. Amphibolite commonly breaks down to clay-rich, reddish-orange soil.

3. The small greenish particles are small pieces of the mineral epidote which is sometimes present in amphibolite.

4. The small, shiny flakes are mica. These particles would indicate the breakdown of another primary rock type of the park, schist, commonly called mica schist because of the high proportion of mica in the rock. Black mica flakes are called biotite. White-clear mica flakes are called muscovite. Gold-colored flakes are called vermiculite. Vermiculite is chemically weathered biotite, and is commonly mistaken for flakes of gold.

Before going on to the next stop, have the students notice veins of white quartz running through the amphibolite. Quartz is much more **resistant** to weathering than amphibolite, which is why the white quartz veins are usually 1-2 inches above the less resistant amphibolite layers. This process of weathering is called differential weathering. Differential weathering has occurred where some minerals are visibly weathering faster than other minerals.



Stop #2:

This stop is just up the road from the second overlook parking area, approximately 50 yards on the left. This stop is located at the base of a large outcrop of amphibolite. Have the students describe the size of the rocks here and compare them to the size of the rocks at the last stop.

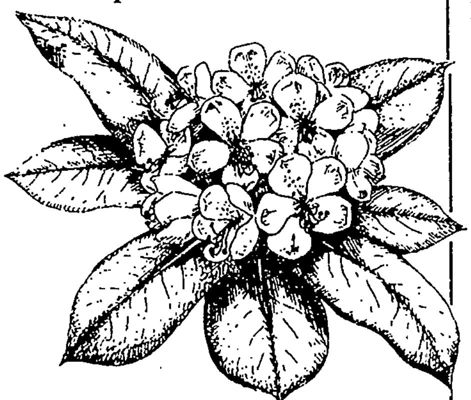
This outcrop of amphibolite is somewhat larger and more exposed than the section of outcrop just examined at the second overlook. Notice the many cracks and fractures all over this outcrop. These cracks and fractures are called joints. These joints allow more of the amphibolite outcrop to be exposed to erosive forces, thus causing much more breakdown of the amphibolite. When water seeps into these joints and freezes, it causes the rock to break apart in a process called ice wedging. When the pieces of rock break away from the main outcrop, gravity takes over, causing the rock to tumble and fall, crashing and bumping into other rocks along the way. This process is known as **mechanical weathering**.

Examine the ditch line at the base of the amphibolite outcrop. Small rocks at the base of the outcrop were deposited there as the result of the breakdown of the rocks forming the outcrop. These rocks were deposited here as the result of gravity; they were not water transported as were the small particles of rock located at the first stop.

Students might also notice pyrite, known as fool's gold, and garnets embedded in this outcrop of amphibolite.

Stop #3:

Located at the south end of the summit area parking lot, this rock outcrop contains some metagraywacke, but the primary rock type here is schist (mica schist). Schists are relatively soft and have many thin, flaky layers. Schists are considered metamorphic rock and are not usually seen as an outcrop in the park. Most often they are buried beneath valley floors. Here, the schist has been exposed by the erosive forces of weather and the road construction project to develop this parking lot. Schists probably surrounded the metagraywacke and amphibolite bodies which form Mount Jefferson before millions of years of **erosion** wore away the softer schists, exposing the metagraywacke and amphibolite we see in the park today. Note the single black vein of amphibolite to the left of the schist outcrop.



Stop #4:

Walk up the service road, through the picnic area to the next stop. It is located at the Rhododendron Trail head. Just to the left of the trail head sign is what appears to be a cave. This is not a true cave, but is known as a fissure cave caused by a crack in the amphibolite. Notice the small trees growing out of the cracks and fractures on this outcrop. This is another form of mechanical weathering.

Stop #5:

This stop is located at Mount Jefferson's summit. A rock outcrop is located beside the lookout tower.

This outcrop is an example of metamorphosed **sandstone** know as metagraywacke. Metagraywacke was once sedimentary rock before it was changed by intense heat and pressure. Ask students what this process is called (answer: metamorphism).

Metagraywacke is sometimes called "dirty sandstone" because of the abundance of clay in the original sediment. The main minerals found in metagraywacke include quartz, (which makes it more resistant than amphibolite), feldspar and mica flakes. The mica flakes are primarily biotite and muscovite. Since metagraywacke is the primary rock found at Mount Jefferson' summit, it is a good possibility that this quartz-rich rock is the reason why this area of the mountain has eroded more slowly than others. The elevation of this area is 4,683 feet. The rock outcrop where the elevation sign is posted is an excellent example of differential weathering.

This is the end of the hike.

Summation:

Mount Jeffeson's height and soils are a result of the rocks that formed this region–amphibolite, schist and metagraywacke. The mountain was shaped by the north and south forks of the New River. As you look out over the mountains and valleys that surround Mount Jefferson today, try to imagine the valleys filled in, so you would be standing on a rolling plain several million years ago. With the passing of time, the rivers and streams have cut out the valleys, washing the material north into the Ohio River valley and later on down the Mississippi River. Sediments from the Appalachian Mountains filled in the shallow sea that once stretched into the middle of what we now call the North American continent.

The park was formed in 1958, as a result of local citizens petitioning the state legislature to make the mountains a state park. North Carolina State Parks are sanctuaries for wildlife. On Mount Jefferson, everything is protected by law. You cannot disturb the plants or animals. Even the rocks you see have to be left in the park. The role of state parks is to preserve and to protect the beauty, the rocks and significant features you see around you, as well as to educate our citizens about the significance of these resources, so people will use the park, and all the world's resources, wisely.

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, and 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 divided into two parts. In the first part, the students will try to identify whether items you provide in the classroom (see material list) are derived from rock, mineral, fossil fuel or organic matter. In the second part, they will take the "Geo-Scavenger Hunt" list home and identify the things on the list, as well as other things 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.

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 nd 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.

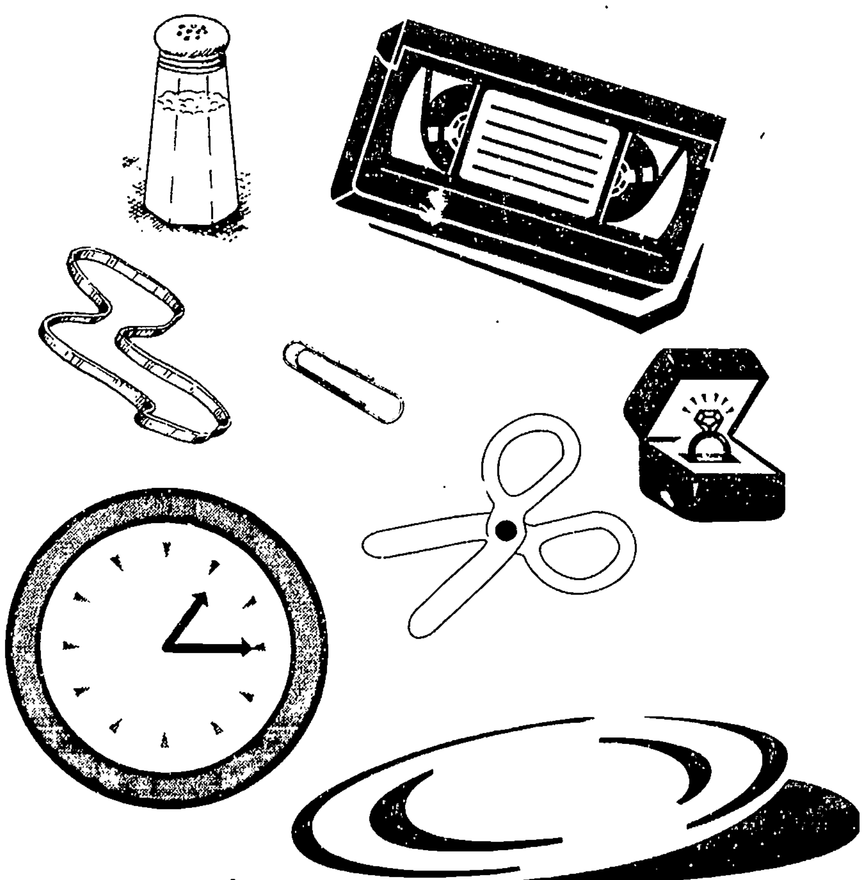
3. Uncover the items for the students to look at and have students decide, as a class, how to classify each item: rock, mineral, fossil fuel or organic. If the students are having trouble deciding, walk the students through some of the following examples:

- 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.



Earth's Energy Storehouse

Mount Jefferson State Park is part of the Blue Ridge Mountain belt of rocks, which is an area rich in **rock** and **mineral** deposits. The deposits along this belt have been mined for feldspar, mica and gold. North Carolina is one of the nations's leaders in the annual production of these valuable minerals.

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 **organic** matter, or living things. 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 three-fourths of its existence.

We could not exist without other living things. We eat and wear them, and build and repair our houses with 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.

Geo-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:				

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Geo-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	X	X	
door mat			X	X
clock	X	X	X	X
scissors	X			
wool blanket				X
unglazed pottery	X			
diamond ring	X	X		
chalk	X			
oil paint	X		X	
diaper			X	X
baby powder		X		
table salt		X		
rubber band				
newspaper				X
birdbath	X		X	
spark plug	X	X		
chewing gum				X
other:				

VOCABULARY

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

Chemical weathering - Process that changes the minerals in rocks, resulting in a weakening of the rocks.

Composition - A putting together of parts or elements to form a whole; a combining.

Core - The innermost or most important part of anything; heart; center; essence.

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 rocks - Rocks formed on the Earth's surface by the cooling of molten magma material originating from within the Earth's crust.

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

Faulting - In geology, a fracture on the Earth in which layers of rock slide up or down along the break.

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

Igneous rock - Rock formed by the cooling of molten rock on or under the surface of the Earth. The crust of the Earth is approximately 95% igneous rock.

Inorganic - Involving neither organic life nor the products of organic life, not composed of organic matter; especially mineral.

Intrusive igneous rock - The type of igneous rock that forms when magna cools inside the Earth, usually course-grained mineral crystals. An example is quartz.

Lava - 1. Molten rock that issues from a volcano or a fissure in the Earth's surface. 2. The rock formed by the cooling and solidifying of this substance.

Magma - 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 - Type of weathering which breaks rocks apart without changing their mineral composition.

Metamorphic rock - Rocks that have been altered chemically and/or physically by great heat and pressure. Amphibolite is an example.

Minerals - Chemicals found in the Earth's crust. They are inorganic and occur naturally. Each type has its same chemical make-up wherever found, as well as its characteristic crystal shape, color, specific gravity and hardness. Quartz is a common mineral found in the park.

Monadnock - A hill of more resistant rock, left as a residue of erosion, that stands above the surrounding area.

Outcrop - An exposure of rock or sediment at the Earth's surface as in road cuts, rock exposures on hillsides and stream bed exposures.

Quartz - A hard, crystalline mineral of silicon dioxide, SiO_2. Quartz is among the hardest and most resistant of all minerals - so it is often left behind where wind and rain have worn away surrounding rock.

Rock - Substances made up of one or more minerals. Rocks are an important part of the Earth's crust, mantle and core. They come in three forms: igneous, sedimentary and metamorphic.

Rock cycle - The set of processes that describe how rocks change from one type to another.

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

Sandstone - Sedimentary rock composed primarily of quartz sand grains, deposited over millions of years, that are cemented more or less firmly together.

Sediment - Material that settles to the bottom; dregs; lees.

Sedimentary rock - Rock made by the compaction and/or cementing of sediments. Example: sandstone, shale.

Vent - The exit hole for the lava flow from a volcano.

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

Volcano - 1. A vent in the Earth's crust through which molten lava and gases are ejected. 2. A mountain formed by the materials so ejected.

Weathering - Any of the chemical or mechanical processes by which rocks exposed to the weather 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 and water. (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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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: Mount Jefferson State Park
P.O. Box 48
Jefferson, NC 28640

Fax: (910) 982-3943

PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure - an environmental education experience at **Mount Jefferson State Park**. 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 ______________

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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.

Mount Jefferson State Park
P.O. Box 48
Jefferson, NC 28640
Fax: (919) 982-3943