Geology Box
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NC Standards
SVM Geology Box

Science Essential Standards

1st Grade
1.E.2.1 Summarize the physical properties of Earth materials, including rocks, minerals, soils and water that make them useful in different ways.

2nd Grade
2.P.2.1 Give examples of matter that change from a solid to a liquid and from a liquid to a solid by heating and cooling.

3rd Grade
3.E.2.2 Compare Earth's land features (including volcanoes, mountains, valleys, canyons, caverns, and islands) by using models, pictures, diagrams, and maps.

4th Grade
4.P.2.1 Compare the physical properties of samples of matter (strength, hardness, flexibility, ability to conduct heat, ability to conduct electricity, ability to be attracted by magnets, reactions to water and fire).
4.P.2.2 Explain how minerals are identified using tests for the physical properties of hardness, color, luster, cleavage and streak.
4.P.2.3 Classify rocks as metamorphic, sedimentary or igneous based on their composition, how they are formed and the processes that create them.

5th Grade
5.P.2.3 Summarize properties of original materials, and the new material(s) formed, to demonstrate that a change has occurred.
5.P.3.1 Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures. (conduction, convection or radiation)
5.P.3.2 Explain how heating and cooling affect some materials and how this relates to their purpose and practical applications.

6th Grade
6.E.2.3 Explain how the formation of soil is related to the parent rock type and the environment in which it develops.

8th Grade
8.E.2.1 Infer the age of Earth and relative age of rocks and fossils from index fossils and ordering of rock layers (relative dating and radioactive dating).
8.E.2.2 Explain the use of fossils, ice cores, composition of sedimentary rocks, faults, and igneous rock formations found in rock layers as evidence of the history of the Earth and its changing life forms.

High School

Earth/Environmental

EEn.2.1.1 Explain how the rock cycle, plate tectonics, volcanoes, and earthquakes impact the lithosphere.
EEn.2.1.2 Predict the locations of volcanoes, earthquakes, and faults based on information contained in a variety of maps.
EEn.2.1.3 Explain how natural actions such as weathering, erosion (wind, water and gravity), and soil formation affect Earth’s surface.
EEn.2.2.1 Explain the consequences of human activities on the lithosphere (such as mining, deforestation, agriculture, overgrazing, urbanization, and land use) past and present.
EEn.2.8.3 Explain the effects of uncontrolled population growth on the Earth’s resources.

SVM Geology Box Minerals

1. Beryl
    - *Silicate Mineral*
2. Biotite Mica
    - *Silicate Mineral*
3. Calcite
    - *Carbonate Mineral*
4. Chalcopyrite
    - *Sulfide Mineral*
5. Corundum
    - *Oxide Mineral*
6. Fluorite
    - *Halide Mineral*
7. Halite
    - *Halide Mineral*
8. Kyanite
    - *Aluminum Silicate Mineral*
9. Muscovite Mica
    - *Silicate Mineral*
10. Olivine
    - *Iron Silicate Mineral*
11. Pyrite Crystals
    - *Iron Sulfide Mineral*
12. Pyrophyllite
    - *Aluminum Silicate Mineral*
13. Quartz
    - *Silicate Mineral*
14. Staurolite
    - *Silicate Mineral*
15. Tourmaline
    - *Boron Silicate Mineral*

Geology Box Mineral Histories

Beryl. Very hard mineral (beryllium aluminum silicate) found in granitic rocks and pegmatites. Discovered in Macon County in 1871, aquamarine (blue beryl) and golden beryl were mined in Mitchell County in the early 1900s; by the end of the century, Macon County's Littlefield Mine and Yancey County's Ray Mine continued to produce modest amounts for amateur collectors.

Calcite. A Carbonate mineral. It is the most common form of natural calcium carbonate. It is abundant in North Carolina and is mined in quarries across the state.

Chalcopyrite. A copper iron sulfide mineral. It is found in the Appalachian mountain region. Chalcopyrite has been mined at the Ore Knob mine in Ashe County, NC, which was originally opened in 1855 as a copper mine.

Corundum. A form of aluminum oxide, second only to the diamond in hardness, found in Madison County in 1846. Mining began in 1871 in Macon County, where corundum soon found greater application as an abrasive than a gemstone. By 1895 nearly all of the corundum produced and used in the United States came from the counties west of the Blue Ridge, though the use of artificial abrasives after 1900 brought an end to the industry.

Fluorite. Also called Fluorspar, it is the mineral form of calcium fluorite. It is a widely occurring mineral that can be found across the globe. In North Carolina, Fluorite can be found in several areas of the state, although it is most common in WNC.

Halite. Commonly known as Rock Salt, Halite is the mineral form of sodium chlorite.

Kyanite. Aluminum silicate, often in flattened blue crystals, found in metamorphic rock and some pegmatites. It was commercially produced in the Spruce Pine district southeast of Burnsville from 1934 to 1944 for use as a refractory. Kyanite has continued to interest mineral collectors, and occasionally gem-grade material is found.

Mica. Group of aluminum silicates occurring in the Blue Ridge Mountains and western piedmont, notable for its perfect cleavage into thin, elastic sheets. Used early on as a form of window glass (called isinglass), mica was first mined in Mitchell County in 1858 and in Jackson County in 1867. North Carolina produces two-thirds of the nation's scrap mica, which found numerous industrial uses in the late nineteenth and early twentieth centuries.

Olivine. Pale green igneous rock with a sandy texture. Found in the mountains, deposits of olivine rock were known as early as 1875 as "crysolytic sandstone" and later as "olivine" or "dunite." Beginning in the 1930s olivine has been used as a basic refractory in the steel industry and as a molding sand in foundry work. North Carolina is the nation's major olivine producer, with mines in Jackson, Mitchell, and Yancey Counties.

Pyrite Crystals. The most common of the sulfide minerals, pyrite is known as "fool's gold." Large amounts of pyrite are found at the Standard Mineral Company Mine in Moore County. The Standard Mineral Company is interested in pyrophyllite, not pyrite, so mine allows organizations such as the Mountain Area Gem and Mineral Association to mine pyrite.

Pyrophyllite. Soft white silicate associated with the metavolcanic sedimentary rock of the Carolina slate belt. Used in ceramics, insecticides, and other products, pyrophyllite was first identified in 1856 in Moore County. In 1921 a processing plant was built near Robbins on what proved to be the largest deposit in the state and the only underground workings. North Carolina is the nation's largest domestic producer, with mines in Moore and Orange Counties.

Quartz. One of the most widespread minerals, found in all classes of rock. Quartz (silicon dioxide) comes in many varieties, such as milky quartz. Rock crystal, a glass-clear variety, is sought by collectors in the western counties; one Ashe County piece (now in New York's Metropolitan Museum of Art) was displayed at the 1900 Paris Exposition. Avery, Mitchell, Yancey, and Cleveland Counties produce quartz sand for industrial use.

Staurolite. Staurolite has been mined in a variety of counties in WNC as well as the Piedmont area of the state. It is a nesosilicate mineral and is best known for its unique cross shape.

Tourmaline. A crystalline boron silicate mineral. Tourmaline is considered a semi-precious stone and it comes in a variety of colors. Tourmaline has been mined in Hiddenite, Alexander County, North Carolina. Hiddenite is also the location of a major Emerald mine in the state.

Information from: https://www.ncpedia.org/mining-part-2-important-minerals

Mineral Identification

What is a mineral?

A mineral is a naturally occurring chemical compound. In addition to **occurring naturally** it must also be **inorganic** (not composed of plant or animal matter), **solid**, it must have a **definite chemical composition**, and it must have an **ordered internal structure**. To be considered a mineral, the chemical compound MUST meet these five characteristics.

What are mineral properties?

There are thousands of different minerals. To determine the mineral you might have, you can examine it for several different characteristics or properties.

- <u>Color:</u> Sometimes minerals are described by color. Often minerals come in a variety of colors, so it is difficult to determine the type of mineral by color alone.
- <u>Streak:</u> Streak is the color of a mineral when it is in powdered form.
- <u>Luster:</u> Different minerals will reflect light differently. Some will be glassy, metallic, nonmetallic, brilliant, or dull. This is the mineral's luster.
- <u>Hardness:</u> Hardness refers to how easily the surface of a mineral can be scratched. The *Moh's Hardness Scale* is used to determine the hardness of minerals, and ranges from 1 to 10, with Talc being a 1 and Diamond being a 10.
- <u>Cleavage:</u> Cleavage refers to how a mineral breaks. Some break into sheets while others break into cubes.
- <u>Magnetism:</u> Some minerals have the ability to attract or repel other magnetic minerals.
- <u>Crystalline Structure:</u> Mineral crystals have different shapes and sizes. The crystal structure of a mineral is determined by the ordered arrangement of atoms, ions, or molecules.

This link is a helpful resource when identifying minerals!

➢ http://www.mineralogy4kids.org/mineral-identification

Be a Geologist

Activity Guide for Teachers

Grades:

1 - 5

Materials:

- Geology Box Mineral/Rock Samples
- Geology Box Mineral Flashcards
- "Be a Geologist" worksheet

Located in the SVM Geology Box are 15 different mineral flashcards and various rock/mineral samples. These samples are from the Western North Carolina area.

Students can work individually or in pairs. They will each select one of the mineral flashcards. After choosing a flashcard, students will read about their mineral and use the image and given information to match the flashcard to the physical samples.

Students will each be given a worksheet titled "Be a Geologist." After examining their sample, they will record information about the sample, such as the name of the minerals it contains and where it came from, if provided. There is also space provided for students to draw and image of their sample and record words that describe their sample. Following their observations, students will write a few sentences about it.

This activity serves as a great introduction to rock and mineral identification, which students will explore in more detail in later grades.

Name: ______________________________

Be A Geologist

Name of your sample: ______________________

Where did it come from? ____________________

Draw your sample in the space below:

Check the words that describe your sample:

Rough	Smooth	Round	Flat	Light Colored	Dark Colored	Shiny	Dull

Using the information you have observed about your rock or mineral, write a couple of sentences about it in the space below.

____

____

____

____

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Crystal Candy Activity

When a mineral is left to grow in a free space without interference from other minerals, it will grow crystals. Minerals crystallize in various types of liquid solutions, such as cooling magma or evaporating sea water. Minerals develop a distinct crystal form when growing, with flat planes known as crystal faces. The geometric pattern of these faces reflect the internal atomic arrangement of the crystal structure. This Crystal Candy activity can be used to help students understand how crystals form and grow.

Grades:

4 - 8

Materials:

- 2:1 Sugar & water solution (two parts sugar, one part water)
- Jar
- String
- Pencil/Popsicle Stick
- Weight
- Waxed paper

Directions:

1. Heat the water until it is boiling and completely dissolve the sugar in the water. Stir continuously until the solution becomes clear. Pour the water into a jar.
2. Tie something to the end of the string to weigh it down. Tie the other end to a pencil or popsicle stick. The string should be two-thirds the length of the jar.
3. Dip the string in the sugar solution, remove it, lay it straight on a piece of waxed paper, and leave it to dry for a few days.
4. Gently suspend the prepared string in the solution and let sit at room temperature, undisturbed, for a week. You can check each day to see how much your crystals have grown.
5. At the end of the week, the crystals on your string should be clearly defined, with sharp right angles and smooth faces of various sizes. These are called *monoclinic* crystals. Their shape is determined by the way the individual sugar molecules fit together. Staurolite is the only mineral in the box that is also has a monoclinic crystal structure.

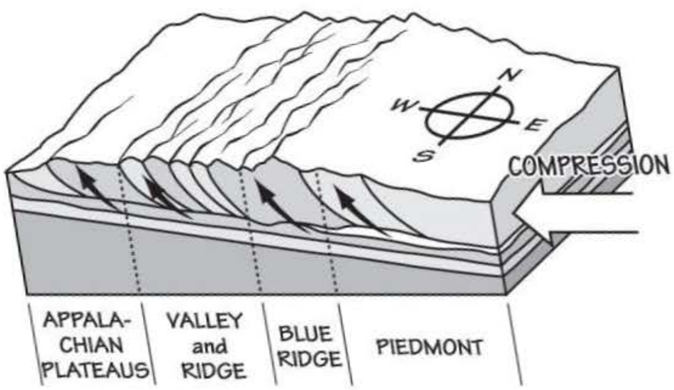
Helpful Links:

- ➢ http://www.exploratorium.edu/cooking/candy/recipe-rockcandy.html
- ➢ http://www.mineralogy4kids.org/all-about-crystals

The Rocks Beneath Our Feet

We have decided to write a three part "Quick Science in the News" series on Buncombe County's geology and how it connects and ultimately affects our lives here in Asheville. The first installment will focus on the development of our geology and the events that unfolded to create our landscape.

Western North Carolina is known for its scenic landscapes and its beautiful terrane. Drive along the Parkway and you may notice the extensive folds that form the Blue Ridge Mountains responsible for the wonderful views on our horizon. Rock hounds and geologists alike know the treasures these mountains hold and the incredible story they tell.



Buncombe County sits in the center of a fold and thrust belt known as the "Blue Ridge Thrust Complex". This merely means the group of rocks in our area represent the result of millions of years of compression and collision between continental plates. A fold and thrust belt is a term used to describe a series of foothills and mountains that develop from extensive folding as rocks compress and subsequently thrust on top of each other as compression persists. The Blue Ridge Thrust Complex records a complex history of mountain building throughout hundreds of millions of years.

The story begins 1 billion years ago. The eastern margin of current day North America was located where the Blue Ridge Mountains are today. To the East was a vast ocean with microcontinents and island arcs making their way towards North America. The oldest rocks found in the Blue Ridge Trust Complex were formed during this first phase of continent building of current day North America. These rocks were originally sedimentary rocks of sandstone, shale, and limestone deposited in the warm shallow ocean east of proto-North America.

Around 1 billion years ago proto-North America collided with another continent forming the first super continent Rodinia. The sandstone, shale, and limestone that once lay on the eastern margin of proto-North America were folded and thrusted upward onto the continent as the collision took place resulting in the formation of the ancestral Grenville Mountains and metamorphosed the rock. The sandstone became quartzite, schist, and gneiss; the shale became schist and gneiss; and the limestone became marble. During this mountain building event igneous rock intruded into the sedimentary rock as subduction took place. Blobs of igneous rock slowly made their way into the thickened continental crust as the Grenville mountain building event continued, resulting in a complex array of metamorphic and igneous rock.

Eventually the collision slowed to a halt and millions of years of tectonic dormancy allowed weathering and erosion to wear down the Grenville Mountains. Layers of sedimentary rock formed, covering much of the metamorphic and igneous rock from this early mountain building event. The pressure and heat associated with the extensive burial further metamorphosed the underlying rock.

Because of the complex history of mountain building, continent collision, and rifting the geology of Buncombe County is complicated with different stages of severe metamorphism. Overlying the basement rocks of the Grenville Mountains is a rock group called the Ashe Metamorphic Suite. These rocks show evidence of undergoing up to four separate metamorphic events in at least three separate mountain building events. The bulk of which occurred during the Cherokee Orogeny, a mountain building event which saw the collision of a land mass (current day Carolinas) into proto-North America some 450 million years ago.

These mountain building events drastically changed the landscape and the geology of the entire eastern margin of North America. Mountain building caused thickening of the continental crust, metamorphism, and the development of basins where sediments shed from these mountains collected.

Since the final rifting apart of Pangaea some 175 million years ago, the eastern margin of North America has remained tectonically dormant, allowing the younger rocks to weather and erode exposing the older rocks below. In and around Asheville, rocks have been weathered and eroded away exposing geology from the Ashe Metamorphic Suite as well as rocks from the supposed Grenville Orogeny. Because these rocks have seen intense waves of metamorphic activity they present quite the array of interesting minerals and textures. In Part II of *The Rocks Beneath Our Feet* we will discuss the wide array of minerals found in this region and how they form.

(Written by Cory Van Auken)

Further Reading on the Geology of Buncombe County:

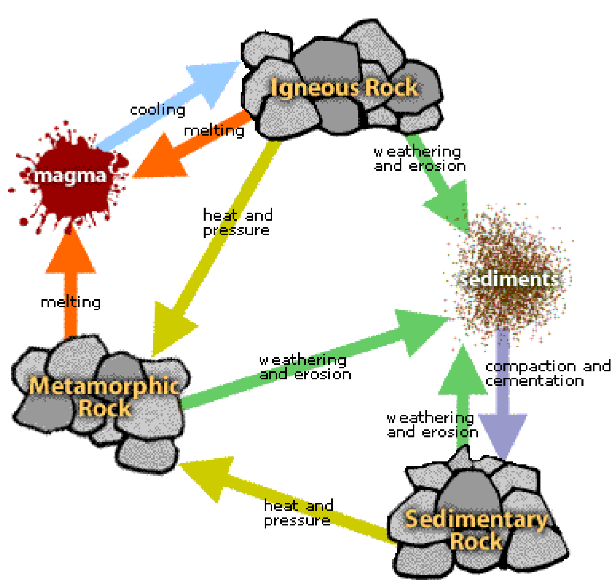
http://geology.teacherfriendlyguide.org/index.php/rocks-se/region-1-blue-ridge

http://coweeta.uga.edu/publications/889.pdf

http://earth.geology.yale.edu/~ajs/1984/04%20and%2005.1984.04.Abbott.pdf

Rock Types of WNC

Rock Type	Definition	WNC Examples
Igneous	Igneous rocks are those that solidify from a molten or partially molten state.	Dunite (Yancey Co.), Granite (Surry Co.), Pegmatitic Granodiorite (Mitchell Co.)
Metamorphic	Metamorphic rocks are any rock type that has been altered by heat, pressure, and/or the chemical action of fluids and gases. Metamorphic rocks are classified by their structure and their dominant minerals.	Amphibolite (Mitchell Co.), Garnetiferous Gneiss (Macon Co.), Granulitic Gneiss (Buncombe Co.), Migmatitic Gneiss (Transylvania Co., Buncombe Co., Alexander Co.), Mylonitic Gneiss (Henderson Co.), Marble (Swain Co.), Metasiltstone (Watauga Co.), Pyrophyllite Phyllite (Moore Co.), Quartzite (Watauga Co.),
Sedimentary	Erosion and deposition play a key part in the formation of sedimentary rocks. Wind, water, ice, and chemicals break down existing rock into sediment that is then transported and deposited by wind, water, and glacier	Dolomite (McDowell Co.), Quartz Sandstone (Haywood Co.)



Discussion Questions

- Why are Metamorphic rocks common in the Western North Carolina region?
- In what other areas of the state might Igneous or Sedimentary rocks be more common?
- Why are there many different variations of the rock gneiss?

Additional Activity

➢ Choose one of the rocks listed. Research information on the rock. What minerals is it composed of? Can you tell what type of rock it might have been previously in the rock cycle? Is there a specific mine or quarry where this rock can be found in NC?

Edible Rock Cycle Activity

This activity can be used to illustrate the different steps of the rock cycle. Using candy, you can demonstrate to your class how rocks change and how they are shaped and formed while moving through the rock cycle.

Grades:

ALL (younger grades may need additional assistance)

Materials:

- Starbursts (or AirHeads)
- Ziplock baggies
- Scissors (make sure they are thoroughly washed!)
- PAM

• Wax Paper • Microwave • Microwave Safe Plate	OR	• Crock Pot • Tin Foil • Water

Directions:

1. Each student should have 4-5 different colored Starbursts (unwrapped).
2. To create weathered "sediment," use the scissors to cut the Starbursts into smaller pieces. Add the pieces to a Ziplock baggie and seal.
3. With the Starburst pieces in the baggie, students can squish the different sediments together, mixing the colors. This demonstrates compaction and cementation of sediments to become **sedimentary** rocks.
4. Students should then remove their sedimentary Starburst rock from the bag and shape it with their hands, stretching and folding it. By applying heat and pressure, their sedimentary rock has now become a **metamorphic** rock.
5. The next step can be completed one of two ways:
   - Place a sheet of wax paper (and spray with PAM, if desired) on a microwave safe plate. Microwave each Starburst rock for about 5 seconds.

     OR
   - Heat water in a Crock-Pot. Form tin foil boats and spray with PAM. Add the Starburst rock to the tin foil boat and place into the Crock-Pot until melted.

The heat of the microwave or the water from the Crock-Pot represents magma, which melts an existing rock. Once cooled, it is an **igneous** rock.

Tips and Tricks!

- Once you complete the final step, you can repeat the entire activity with your students to demonstrate that rocks are always moving through the rock cycle.
- When melting the Starburst rocks in “magma,” add popsicle sticks to make the rocks easier and less messy for students to eat.
- When creating sedimentary rocks, add other candy, such as Nerds, for additional sediment.

THE QUARRY STORY

By Vulcan Materials Company

The Story of How a Quarry Works
Unless you've visited or toured a quarry, chances are you don't know much about what goes on inside one. In the simplest terms, a rock quarry is a place where little rocks are made from big rocks. Although the basic process is the same, each quarry is different and some of the things in Quarry Story may not apply to all operations. Geography, geology and the type of stone mined, how close a quarry is to neighbors, the size of the operation and the main transportation method used to get the stone products to customers all have an impact on how each quarry is designed and operated.

At Vulcan Materials Company, our primary business is quarry mining. We take big rocks out of quarries and make smaller rocks and sand by crushing them. We sell the crushed rock and sand to builders and contractors who use them to build roads, highways, bridges, houses, shopping malls, schools, churches and other buildings and structures.

Words that are highlighted in the Quarry Story are defined at the end.

Finding, Preparing and Designing a Site
Before we can start operating a quarry many preparations must be made. First, our **geologists** must find a place where there is a large supply of rocks beneath the earth's surface. We mine **igneous**, **metamorphic**, and **sedimentary** rocks to be used for construction. A **quarry** is frequently located near a community where our products are needed because if it isn't, it will cost our customers too much to haul the **crushed stone**, which is very heavy, over long distances.

Obtaining Permits
After we find a good place to put a quarry, our geologists survey the land, and we develop a design that will make our quarry safe and efficient. Then, we have to get a variety of operating **permits** from local, state and federal governments. For instance, to obtain the environmental permits, it is necessary to provide a plan that shows we can and will obey all environmental rules of the state and federal governments. Once we obtain the proper permits, equipment is purchased, roads are built to the facility and we begin building the **processing plant**.

Being A Good Neighbor
It is very important to us that we operate as a good neighbor in the communities where we build quarries. For example, at many sites we create **buffer zones** around the quarry so noise is kept to a minimum. We landscape the entrance to the quarry so that it blends with the surrounding area. We install special water systems so we can recycle the water we use in processing, and we put in many other features to protect the health and safety of our employees and our neighbors.

Being Good Environmental Stewards
Great care is also taken to protect the environment and the animals that live on our quarry lands. A quarry site might be as big as 600 or more acres, but, only a small part of that land is actually used for the quarry and processing plant. We often establish wildlife habitats in the **buffer zones** to attract and protect animals that might live around our quarries. At some locations we have also built parks, nature trails and ball fields in buffer zones. Our quarries are full of so many interesting things that they are often seen as

huge outdoor classrooms where students can come to see what we do and learn about earth science and nature. Once we decide where to put a quarry, we prepare the site for quarrying.

Preparing the Site
In order to get to the rock beneath the surface of the earth, we have to clear the land we are going to mine. Once we have the land prepared we are ready to begin mining rock. At many sites, the material that is removed is used to begin construction of **berms** and other buffer areas, or donated for landscaping or construction projects in the community.

Getting Rocks out of the Earth
Drilling and **blasting** is a very important part of how we get rocks out of the earth. We design this process around how much rock we want to break apart, the type of rock we are working with and the size pieces we want to break off. We hire experts to help with drilling and blasting because they know exactly how to work with **explosives** to make sure this part of the process is handled safely, efficiently and as quietly as possible.

First, holes are drilled in the earth and explosives are placed inside. The explosives are detonated to provide the smallest release of energy for the most efficient blast. The entire blasting process occurs in just a few seconds. Larger quarries may blast once a day and smaller quarries may blast once or twice a week. Blasting is monitored with a special machine to record sound and **vibrations** so that the community around our quarry remains protected and safe.

The blasts that occur when the explosives are set off free the stone from the **quarry wall**. The big pieces are removed by **pit loaders** and dumped into large **haul trucks**.

Loading Rocks and Hauling Rocks from the Pit
The area that begins to form out of the earth when we blast away big pieces of rock becomes the quarry or pit. We use very large haul trucks to load and move the rocks out of the pit and to the processing plant where they are crushed and divided into different sizes. Trucks move back and forth between the pit and the processing plant.

Now that we have the rocks out of the ground and moved over to the processing plant, we begin turning big rocks into little rocks.

Breaking Rocks
When trucks deliver the big pieces of rock to the **processing plant**, the rocks are put into a **primary crusher** that will break them into smaller pieces. The primary crusher can crush between 300 and 2,000 tons per hour. Depending on what size we want to make the rocks, they may be put through different kinds and smaller sizes of crushers one or two more times. As the rocks pass through the crushers, they are moved around the processing plant on **conveyor belts**.

Separating Rocks into Different Sizes
After crushing, comes **screening**. As the rocks are broken down to smaller sizes, we use screens to separate them into piles that are the same size. Some screens are larger and they allow the bigger rocks to pass through. The smaller screens let only the small rocks through. Rocks may be crushed and screened many times before they are put in a stockpile with other rocks the same size.

Moving Rocks Around the Processing Plant
For rocks to get from one place to another at our plant, they travel on long, continuously moving **conveyor belts**. The conveyors help move rocks in an economical way, saving money and time.

Taking Care of Our Employees and Our Neighbors
During the entire quarrying process, we make sure that we protect the health and safety of our employees and neighbors. Mining rocks and moving rocks around a processing plant can create fine particles of dust. We control dust by using water sprays on the rocks as they are processed, and by using spraying equipment to wet quarry roads.

To protect the environment, we use water that we recycle in our own **closed loop water system** that collects rainwater and water that we use during processing. Water is stored in a **recycling pond** where the **sediment** is allowed to accumulate. If we have to **discharge** water from a recycling pond, we test the water to make sure that it is safe and that it meets environmental **water quality regulations**.

Storing Rocks
Stockpiles are huge piles of rock, sand, gravel and other materials, and we do mean huge. Some of our stockpiles are as much as 30 feet high and 800 feet around. They are so big that we have to keep them outside. Because they are exposed to the weather, they have to be carefully maintained so heavy rain doesn't wash them away. We also have to be careful not to let other materials get mixed in with them. We use bulldozers and front end loaders to keep the stockpiles in place. When customers come to our facility for a load of crushed stone, they go to the stockpile. We use a **shipping loader** to fill their trucks with the rocks and other **aggregates** from the stockpile.

Weighing Rocks and Trucks
Our rocks are sold by the ton. Before we can bill a customer for the materials they buy from us, we have to know the weight of each load. When trucks come to our facility, they are weighed before loading. Once they are loaded they are weighed again. Then, we subtract the weight of the empty truck from the weight of the full truck and we know how much the load weighs. This is the way we calculate how much the company has to pay for the load. Weighing is also important because it helps make sure that the trucks leaving our quarry are not too heavy for the roads they will travel on. Each state has laws that say how much weight a truck can legally carry. If a truck weighs too much, some of the material is taken off of it and then it is weighed again before it leaves the quarry.

Delivering Rocks to Where they are Needed
Most of the time customers come to our facilities and we load the materials they need onto their trucks for transport to where they need to use them. Sometimes though, the materials have to be moved over greater distances. If materials need to be moved a long way, we might use boats, trains or barges to move them.

As you can see, making little rocks out of big rocks isn’t as easy as it sounds. At Vulcan Materials Company, we work very hard to be our nation’s best and most environmentally friendly producer of construction materials. We are committed to doing things right, every day, through every step in the process of making rocks. We take important steps to make sure that our employees and neighbors are safe and the environment is protected. We hope you enjoyed learning about how a quarry operates. If you have any questions, please contact us at learning@vmcmail.com.

Vocabulary Words

- **Aggregates –** Rocks, sand, gravel and other materials that are used in construction.
- **Berm –** An earthen barrier, covered with native plants, that provides a physical and visual screen between public property and a quarry site. Berms also limit access to the site and help keep noise levels down in the community.
- **Blasting –** The process of using explosives to break large pieces of rock out of the earth.
- **Buffer zone –** An area surrounding a quarry that helps provide a visual and sound barrier between the quarry and the surrounding community. These buffers consist of naturally occurring plants and trees, planned habitats and other areas developed by Vulcan. Buffer zones often include berms.
- **Closed loop water system –** A system of capturing and recycling the water we use in the processing plant.
- **Conveyor belt –** An endless, moving, flexible belt that takes rocks from one place to another around the processing plant.
- **Crushers –** The machines used to break big rocks down into smaller rocks. Rocks go through several different size crushers during the processing operation.
- **Crushed stone –** Rock that is crushed to a specific size in a quarry processing plant.
- **Discharge –** Water meeting environmental standards that is allowed to leave a settling pond and go into a stream or river. Discharges usually occur only during times of extremely heavy rainfall. Water quality regulations and a quarry's environmental permits cover water discharges.
- **Drilling –** The process of putting holes in the ground where explosives will be placed for blasting.
- **Dust suppression –** The process of reducing the amount of dust that goes into the air.
- **Explosives –** The material that is detonated during the blasting process to break big pieces of rock out of the earth. The explosive used in the stone industry is not dynamite, but a mixture of ammonium nitrate and diesel fuel called ANFO.
- **Geologist –** Someone who studies nature and the earth. Vulcan uses geologists to help decide where we should put quarries and to determine what kind of rocks are located at each site.
- **Haul trucks –** Trucks that haul loads of rocks from the pit to the primary crusher at the processing plant.
- **Igneous rocks –** A type of rock that forms from hot magma or lava that comes from deep within the earth. As it slowly cools it becomes rock such as granite, basalt, or gabbro.
- **Metamorphic rocks -** A type of rock that develops from the alteration of sedimentary, igneous, or other metamorphic rocks due to extreme heat and/or pressure. Some examples of metamorphic rocks are granite gneiss (formed from granite), marble (formed from limestone), and quartzite (formed from sandstone).
- **Mining –** the process of digging rocks out of the earth.
- **Permitting –** The process of getting approval from local and state government agencies to operate a quarry.
- **Pit –** Another name for a quarry. A place where rocks are dug or mined out of the earth.
- **Pit loader –** An excavation tool that helps move the rocks from the earth into haul trucks.
- **Primary crusher –** The first crusher that big rocks are crushed by. The primary crusher makes the rocks small enough to go through the secondary and tertiary crushers.
- **Processing plant –** Where rocks from the quarry are taken to be processed into different sizes. The processing plant begins at the primary crusher.
- **Quarry –** A place where rocks are dug or mined out of the earth.
- **Quarry wall –** The boundary of the quarry, as viewed from inside the pit. Also, the part of a quarry where blasting takes place.
- **Recycling pond –** A place where water is stored and recycled for use in quarry operations.

- **Screening –** Different size screens are used to separate rocks into piles of the same size. Rocks are passed through several different size screens during processing.
- **Sediment –** Sand and other matter that is in the water that we recycle. Sediment is heavier than water and settles to the bottom of a recycling pond.
- **Sedimentary rocks –** A type of rock that develops from the consolidation of sediments that have been deposited by one of three methods of weathering. They are as follows: mechanical, chemical, or organically extracted. Some rocks formed from these processes are sandstones and shales (mechanical), limestone and dolomite (chemical), and marl (organic).
- **Shipping loader –** Shipping loaders are used to put rocks into a customer's truck.
- **Stockpile –** Large piles of rocks and sand where dump trucks go to pick up loads of the construction materials.
- **Vibrations –** Movement caused by blasting.
- **Water quality regulations –** Federal, state and local laws that must be met if water is allowed to flow from a quarry site into a stream or river.

Google MyMaps Quarry Exploration

9-12

Have students read **"The Quarry Story"** and discuss the various forms of environmental precautions and types of equipment used in these types of operations. Either on their own or with a partner, students will then use Google MyMaps application to locate, mark, and explore at least three of the following quarries in WNC. Students should save their maps to turn in.

Students should look closely and using what they learned while reading **"The Quarry Story"** label at least two of the defined vocabulary words from the story at each mine. If they have time, while waiting on others to complete the activity, they should explore the company websites, and note anything that stands out to them.

- BV Hedrick Gravel & Sand
403 Gravel Plant Road
Lilesville, NC 28091
- South McDowell Quarry
1182 Old Glenwood Road
Marion, NC 28752
- Lake Norman Quarry
6941 Quarry Lane
Stanley, NC 28164
- Green River Quarry
3675 Spartanburg Hwy
Flat Rock, NC 28731
- North Buncombe Quarry
100 Goldview Road
Asheville, NC 28804
- Aquadale Quarry
12423 Old Aquadale Road
Norwood, NC 28128
- Norman Sand
407 Yarborough Road
Candor, NC 27229
- Grove Stone & Sand
842 Old US Highway 70
Black Mountain, NC 28711
- Vulcan Materials Company
2284 Clear Creek Rd,
Hendersonville, NC 28792
- Vulcan Materials Company
Hwy 19 & 23 South
Enka, NC 28728
- Vulcan Materials Company
396 Granite Ln
Bakersville, NC 28705
- Vulcan Materials Company
3517 Old Hendersonville Hwy
Pisgah Forest, NC 28768
- Vulcan Materials Company
5145 Linville Falls Hwy,
Newland, NC 28657
- Vulcan Materials Company
Causby Quarry Road
Morganton, NC 28655

Students can also visit the rock garden at the Museum, which has samples of rock from three of these local quarries. UNC-Asheville has an even larger rock garden, which is open to the public.

Gem Mining in Western North Carolina

8-12

After watching a short video about gemstone mining in North Carolina, **(Emerald Mining in Hiddenite, NC, 10:31)** Students should read **Roby Buchanan's interview with DuPuy and Hotchkiss** then answer some questions about their lives, line of work, and its impact on the environment.

EEn.2.2.1 Explain the consequences of human activities on the lithosphere (such as mining, deforestation, agriculture, overgrazing, urbanization, and land use) past and present.

1. Where is Hawk, North Carolina? Hiddenite?
2. Why was Mr. Buchanan able to find a ready supply of cheap gemstones there?
3. The what two minerals gave Jamie Hill the idea that emeralds would be plentiful in his location?
4. What does a lapidary do?
5. Why are emeralds so expensive?
6. Why did Mr. Buchanan enter the profession?
7. What's the biggest difference between how Jamie and Roby access their raw goods?
8. Do you think their method of obtaining and cutting stones was sustainable? Why or why not?
9. Why do you think people may be drawn to this kind of work?
10. Did you know before today that mining was so important to North Carolina's economy?

Member file

INTERVIEW WITH ROBY BUCHANAN
HAWK, N.C.

Jan. 13, 1965.

LAPIDARY

b-Buchanan
d-DuPuy
h-Hotchkiss

d-Roby, how long have you been up here?
b-I've always been here. I was born right here.
d-Would you mind telling me how long ago?
b-62 years ago.
d-I hope I'm as spry at 62 as you are.
b-You probably will be a lot sprier.
d-How did you get interested in this rock business, anyway?
b-That's kind of a long story.
d-Did any of your folks dabble with it?
b-Not in the gems. But they did in the mine.
d-In a general sort of speaking, what is mined around here?
b-Mica, mostly. That was what my father mined, was mica. He never did do much at feldspar.
d- In the mica, you would occasionally run into gems?
b-Yes.
d-What were some of the first stones that you found?
b-Oligoclase. It's a variety of feldspar. It's a transparent, clear stone. We cut it. The average man would think it was glass, maybe.
d-When I first came up here, you had your shop run by water power. Was that your first, the beginnings of your business?
b-I've been cutting about forty years. It did begin on the grist mill down there; that was originally a grist mill.
d-How did you learn how to cut stones?
b-I had to figure that out by myself. At that time there wasn't anything wrote at all about it.
d-You did it the hard way.
b-The hard way. I had to make my copper disks for cutting then. Now you can buy 'em a lot cheaper than you can do 'em yourself.
d-As I remember it, when we first visited you, you unrolled a piece of toilet paper from your pocket and unrolled one of the prettiest rubies I ever laid my eyes on.
b-Well, it couldbe. I carried 'em in my pocket back then. They wasn't many. Storage wasn't a problem.
d- This other mineral that you mentioned as one of the first that you found, from then on how did it go from there? Now a ruby you wouldn't find under the same circumstances?
b-No, not exactly. Mostly would be beryl, aquamarine; not too many rubies, we never did have too many rubies. ~~////~~ They're not found right in this area here. They find a few over in Macon County but not many over there that you can call gem quality.

d-What about amethysts?
b-Amethysts we found, not here, but down east of here. Smoky topaz.
d-Because of the interest in gem hunting, has the supply of findable gems been reduced by people coming in?
b-I'd say it has.
d-They're found hit or miss, hither and yon, as you stumble on them?
b-That's exactly right. Most of the mines it was a by-product from the mica mines when they was in operation. Now they're hard to get from any source.
d-Because of that, you have to depend somewhat on stones from other places?
b-Exactly. I've imported quite a few ~~//////~~ rough stones.

Quartz in Spruce Pine

Grades:

9-12

Description:

Spruce Pine is a small town in Mitchell County, located about an hour north of the Swannanoa Valley. Like many small towns in the mountains of western North Carolina, Spruce Pine was a popular gem mining town. Sapphires and emeralds may seem like treasures, but the real wealth comes in the form of the mineral quartz.

Have students read the following BBC article titled, "Silicon Valley's Secret Recipe"

➢ http://news.bbc.co.uk/2/hi/technology/8178580.stm

Lead students in a discussion about the article by asking them to answer the following questions:

- Why are the quartz minerals of Spruce Pine important for the technology industry?
- The article was published in 2009, how do you think the mining industry in Spruce Pine has grown and changed in the decade since? What do you think the future of the mining industry in Spruce Pine will look like?
- The article mentions one of the mining corporations in Spruce Pine, Unimin. Another large mining corporation in Spruce Pine is the QUARTZ Corp. How do you think the locals of the area feel about large foreign mining corporations in the area?
    - Unimin is owned by SCR-Sibelco, a Belgian Company. The QUARTZ Corp is a joint venture between two European countries: Imerys (French) and Norsk Mineral AS (Norwegian).
    - Students can watch the QUARTZ Corp's promotional video for further discussion material.
        - ➢ https://www.youtube.com/watch?v=A_b7FCyD_5Y

Supplemental Reading: "The Mineral City: Exploring the Spruce Pine Mining District"

➢ https://www.ourstate.com/mineral-city/

Mineral

Biotite Mica

Silicate Mineral

Found in Igneous & Metamorphic Rocks

Color – black, brown, greenish black

Mohs Hardness Scale – 2.5-3.0

Fun Fact – breaks into sheets

Uses – paints, cosmetics, rubber, plastics, construction products

Mineral

Beryl

Silicate Mineral

Found in Igneous & Metamorphic Rocks

Color – dark green, aqua, pink, yellow, clear

Mohs Hardness Scale – 7.5-8.0

Fun Fact – can be found as gemstones emerald & aquamarine

Uses – gemstones in jewelry, ore of beryllium

<u>Mineral</u>

Muscovite Mica

Silicate Mineral

Found in Igneous & Metamorphic Rocks

Color – gray, silver, clear

Mohs Hardness Scale – 2.5-3.0

Fun Fact – breaks into sheets

Uses – paints, cosmetics, rubber, plastics, construction products

<u>Mineral</u>

Pyrite Crystals

Iron Sulfide Mineral

Found in Igneous & Metamorphic Rocks

Color – gold

Mohs Hardness Scale – 6.0-6.5

Fun Fact – called ‘fool’s gold”

Uses –jewelry, construction projects

Mineral

Quartz

Silicate Mineral

Found in Igneous, Sedimentary, Metamorphic Rocks

Color – white, pink, purple, yellow, green

Mohs Hardness Scale – 7.0

Fun Fact – can be found as gemstones amethyst, rose quartz, jasper, citrine

Uses – gemstones in jewelry, glass making, sand, drilling for oil & gas, paints, cosmetics

Mineral

Kyanite

Aluminum Silicate Mineral

Found in Igneous & Metamorphic Rocks

Color – blue, green

Mohs Hardness Scale – 6.5-7.0

Fun Fact – resists high heat

Uses – gemstones in jewelry, ceramics, automotive industry

Mineral

Olivine

Iron Silicate Mineral

Found in Igneous & Metamorphic Rocks

Color – dark green, yellow green

Mohs Hardness Scale – 6.5-7.0

Fun Fact – found in meteorites located in the asteroid belt between Mars & Jupiter

Uses – gemstones in jewelry, steel making

Mineral

Tourmaline

Boron Silicate Mineral

Found in Igneous & Metamorphic Rocks

Color – black, dark green, blue, purple, yellow

Mohs Hardness Scale – 7.0-7.5

Fun Fact – can be magnetic

Uses – gemstones in jewelry, fertilizers, flat hair irons, hairdryers

Mineral

Halite

Halide Mineral

Found in Sedimentary Rocks

Color – white, clear, pink, black, brown

Mohs Hardness Scale –2.5

Fun Fact – known as rock salt

Uses – seasoning for food, winter road treatment, cosmetics, medicines

<u>**Mineral**</u>

Calcite

Carbonate Mineral

Found in Igneous, Sedimentary, Metamorphic Rocks

Color – white, clear

Mohs Hardness Scale –3.0

Fun Fact – used in antacid tablets (TUMS)

Uses – soil fertilizers, construction projects, paints, medicines

Mineral

Corundum

Oxide Mineral

Found in Igneous & Metamorphic Rocks

Color – white, purple, red, blue

Mohs Hardness Scale –9.0

Fun Fact –can be found as gemstones ruby, sapphire

Uses –gemstones in jewelry, sand paper

<u>Mineral</u>

Fluorite

Halide Mineral

Found in Igneous, Sedimentary, Metamorphic Rocks

Color – white, purple, blue, yellow

Mohs Hardness Scale –4.0

Fun Fact –can glow in the dark and are cube shaped

Uses –chemicals, ceramics, telescopes, digital cameras

<u>Mineral</u>

Pyrophyllite

Aluminum Silicate Mineral

Found in Igneous & Metamorphic Rocks

Color – white

Mohs Hardness Scale –2.0

Fun Fact –found only in 3 states (NC, GA, CA)

Uses –construction projects, ceramics, insect repellants

Mineral

Staurolite

Silicate Mineral

Found in Metamorphic Rocks

Color – brown, brown black, black

Mohs Hardness Scale –7.0-7.5

Fun Fact –crystals are always 6 sided

Uses –used to date the age of rocks around it

<u>**Mineral**</u>

Chalcopyrite

Sulfide Mineral

Found in Igneous & Metamorphic Rocks

Color – brassy yellow

Mohs Hardness Scale –4.0

Fun Fact –looks like pyrite but not cube shaped

Uses –used in jewelry