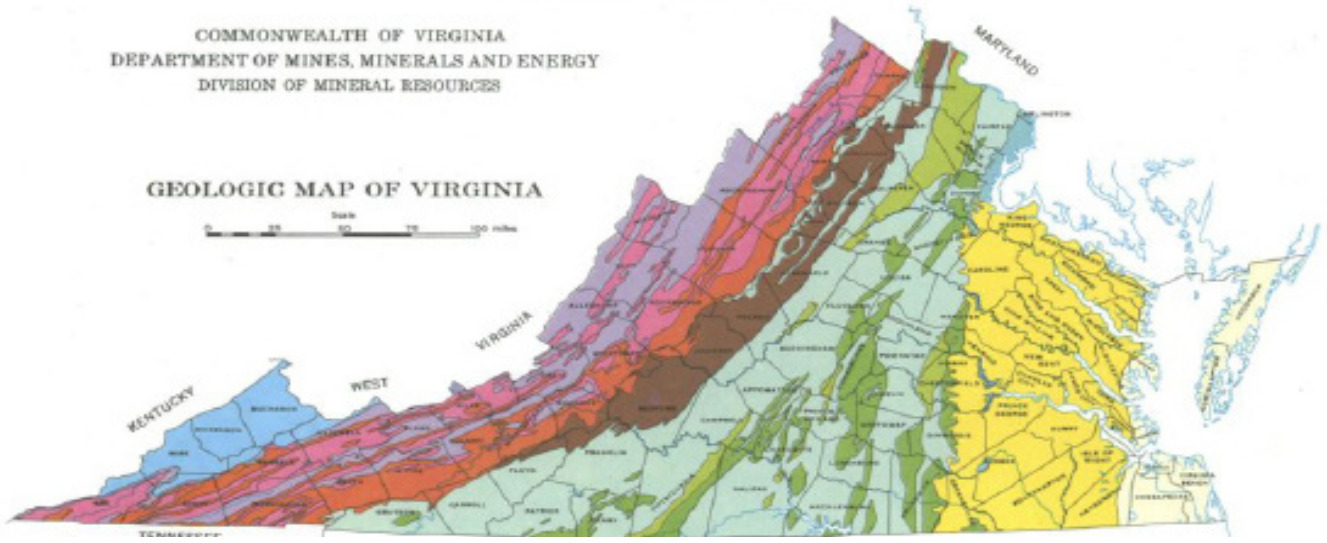
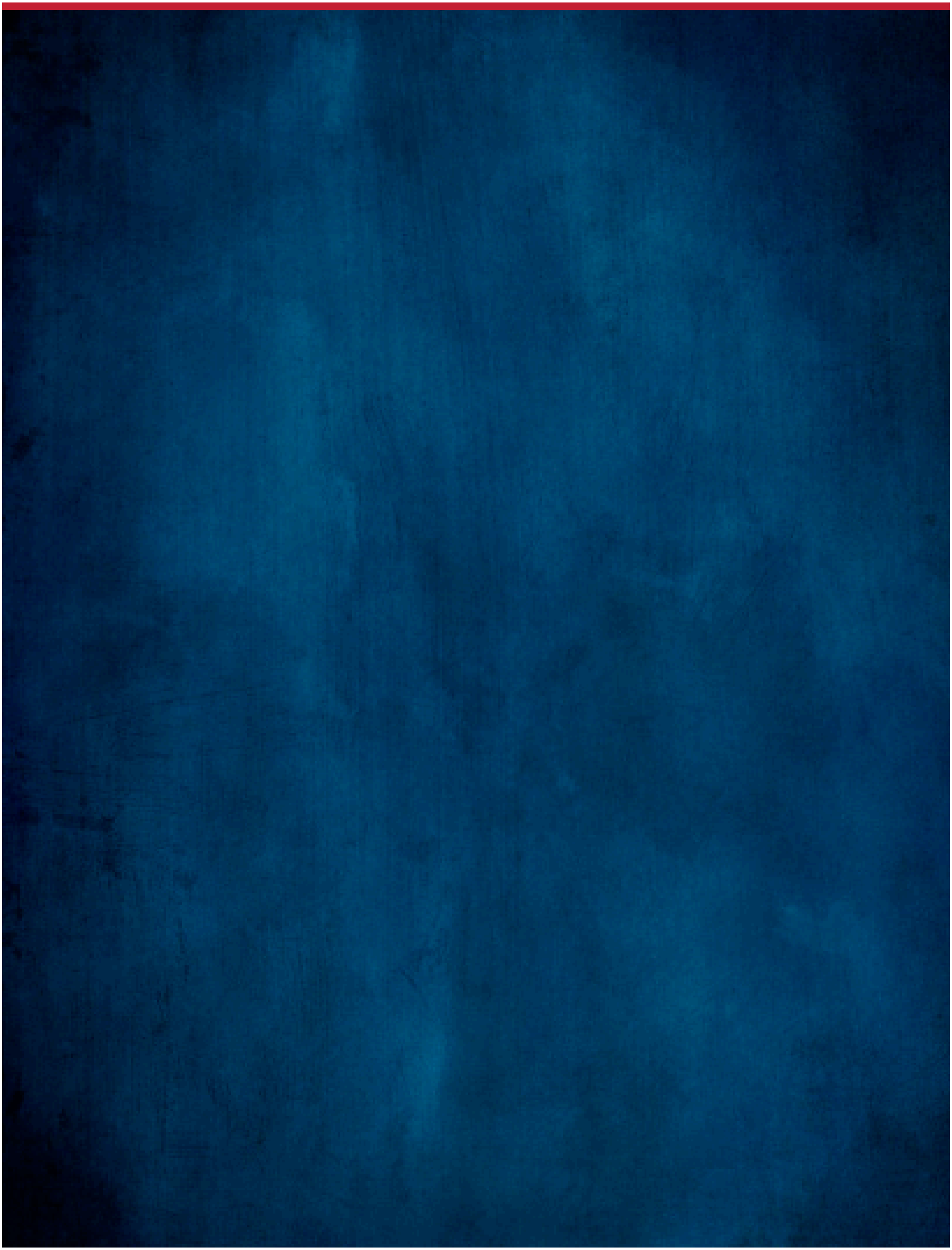
museum in a box



VIRGINIA ROCKS AND MINERALS



MUSEUM IN A BOX CONTENTS

Virginia Rocks and Minerals

About Us
Virginia Science Standards of Learning

SECTION 1: RESEARCH
This educational plan covers the following sections:
1- Basic Vocabulary
2- Properties of Rocks + Minerals
3- Earth + Plate Tectonics
4- Classification of Rocks
5- Virginia's Geological Provinces
6- Virginia Resources.

SECTION 2: ACTIVITIES

1. Identifying Rocks and Minerals
2. Volcanic "Rock"
3. Yummy Sedimentary and Metamorphic Rocks
4. Mining Minerals
5. Mining Simulation

SECTION 3: SPECIMENS INCLUDED IN PHYSICAL BOX

ABOUT US

University of Richmond Museums comprises the Joel and Lila Harnett Museum of Art, the Joel and Lila Harnett Print Study Center, and the Lora Robins Gallery of Design from Nature. The museums are home to diverse and fascinating collections and exhibitions of art, artifacts, and natural history specimens.

Admission is always free and all are welcome. The museums regularly present exhibitions, lectures, openings, gallery talks, workshops, concerts, symposia, and other programs. Guided tours can be arranged to accommodate school groups or special interest groups. Visit *museums.richmond.edu* or call 804-289-8276 for information about hours, programs and exhibitions.



Museum in a Box

The Museum in a Box program brings University Museums' collections to a wide variety of locations including K-12 classrooms, community centers, and places of worship. Each box includes lesson plans based on the Virginia Standards of Learning, relevant activities, and touchable. Boxes are available for two-week periods, free of charge.

Subjects include:

- Virginia Rocks and Geology
- Mollusks and Coral Reefs
- *Growing Up in Civil Rights Richmond*
- Prints and Printmaking
- Mineralogy

For more information about guided tours and Museum in a Box, contact Martha Wright, Assistant Curator of Academic and Public Engagement, University Museums, *mwright3@richmond.edu* or 804-287-1258.

VIRGINIA STANDARDS OF LEARNING, SCIENCE

5th grade:

5.1 The student will plan and conduct investigations in which: 1) rocks, minerals, and organisms are identified using a classification key;

5.7 The student will investigate and understand how the Earth's surface is constantly changing. Key concepts include

a) identification of rock types;

b) The rock cycle and how transformations between rocks occur;

c) Earth history and fossil evidence;

d) Weathering, erosion, and deposition

6th Grade:

6.2 The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts include: c) nonrenewable energy sources

9th Grade: Earth Science

ES.4 The student will investigate and understand how to identify major rock-forming and ore minerals based on physical and chemical properties. Key concepts include:

a) hardness, color and streak, luster, cleavage, fracture, and unique properties; and

b) uses of minerals.

ES.5 The student will investigate and understand the rock cycle as it relates to the origin and transformation of rock types and how to identify common rock types based on mineral composition and textures. Key concepts include:

a) igneous rocks;

b) sedimentary rocks; and

c) metamorphic rocks.

ES.6 The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include: c) resources found in Virginia;

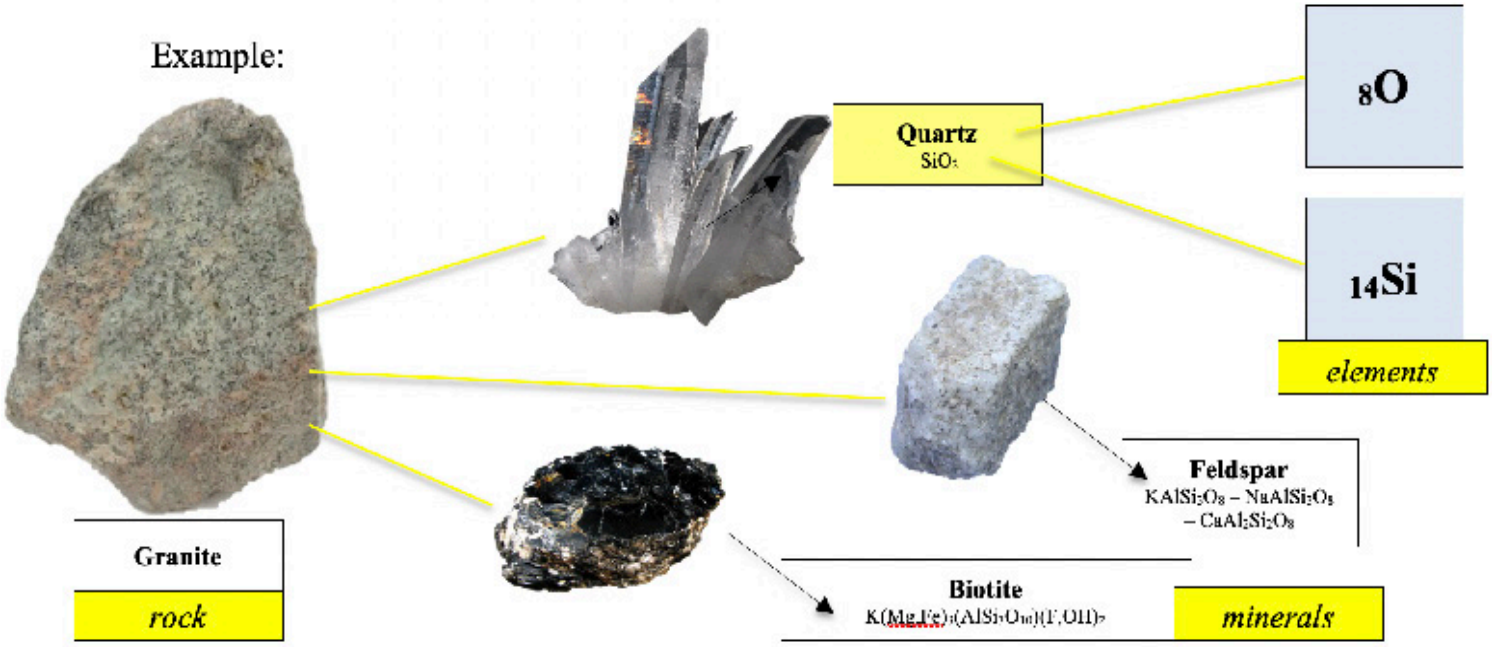
1
Basic Vocabulary

WHAT IS THE DIFFERENCE BETWEEN ROCKS AND

Geology - This term comes from two Greek words: gē – the Earth, and –logia – the study of a subject. Geology is an Earth Science that studies the structure, properties and history of the Earth; various processes that transform the Earth (which take place inside of the Earth as well as on its surface), also fall into this field of research.

Mineral – a naturally occurring solid formed by geological processes. Minerals have a specific chemical structure and can be represented by a chemical formula. They can be made up of one or more chemical elements. For example, diamond is made up of just carbon, but kyanite is made up of aluminum, silicon and oxygen.

Rock – a naturally occurring solid made up of minerals or mineral-like matter. For example, granite is a rock and is composed of quartz, feldspar, and biotite



It is really important that you remember the following:
All rocks are made of two or more minerals, but minerals are not made of rocks!

Think of a rock as a cake. To bake a good cake you need flour, sugar, eggs...

University of Richmond Museums

2
Properties of Rocks and Minerals

HOW DO WE IDENTIFY ROCKS AND MINERALS?

All rocks and minerals you have looked at are solids. However, they differ in many aspects. For example, coal and talc crumble easily, while unakite is very hard and heavy. It is important to pay attention to all these different qualities, because they are useful in identifying samples. Rocks and minerals all have distinct sets of physical and chemical qualities, and the criteria you have looked at are some of the most common characteristics used when describing rocks and minerals.

Activity #1 is detailed below to supplement this lesson.

Useful terms when identifying rocks and minerals:

Cleavage describes the way a specimen breaks. Cleavage is when a mineral breaks with smooth, flat surfaces - for example, Mica. Cleavage is used most often to identify minerals, and not frequently for rocks.

Fracture is another the way the specimen can break. Fracture is when a mineral does not break along the "cleavage plane", i.e. does not give out the smooth, flat surfaces. For example, Talc. Fracture is used most often to identify minerals, and not frequently for rocks.

Tenacity is toughness or resistance to being destroyed. It tells us how easily a rock will break, split, crumble or change shape. This is frequently only used to identify rocks, and seldom to identify minerals.

Streak is discovered when dragging a specimen across an unglazed tile. The color left behind is the streak. Some specimens has different colors than their streak. For example, Hematite, has a dark brown/black color, but a red streak.

Color and Luster are three other terms used to identify both rocks and minerals. Color refers to the hue of the specimen, luster refers to the sheen or lack thereof.

Hardness is discovered through scratch testing (see next pages)

We will now take a closer look at one of the qualities of rocks and minerals you have investigated – their hardness. Please take out the colorful triangles from envelope #2 and hang them in descending order. By doing so, you create the Mohs scale of mineral hardness.

Mohs scale of mineral hardness is a quantitative scale (i.e. a scale that uses numbers as the criterion to rank order), which describes the ability of a harder material to scratch a softer material.



Friedrich Mohs, a German geologist, created the scale in 1812.

The hardness of rocks is linked with their mineral composition. For example, granite is mainly made up of quartz (a 7 on Mohs scale) and feldspar (a 6 on Mohs scale), which explains its approximate hardness of 6.5.

Also, you should remember that every rock and mineral can scratch itself!

It is important to pay attention to hardness of rocks and minerals, because this can help us identify a sample and learn about how we use rocks and minerals as resources (more in section 5).

MOHS HARDNESS SCALE

INCREASING HARDNESS


1 TALC


2 GYPSUM

← FINGERNAIL


3 CALCITE

← COPPER COIN


4 FLUORITE


5 APATITE

← KNIFE / GLASS


6 FELDSPAR

← STEEL


7 QUARTZ


8 TOPAZ


9 CORUNDUM


10 DIAMOND

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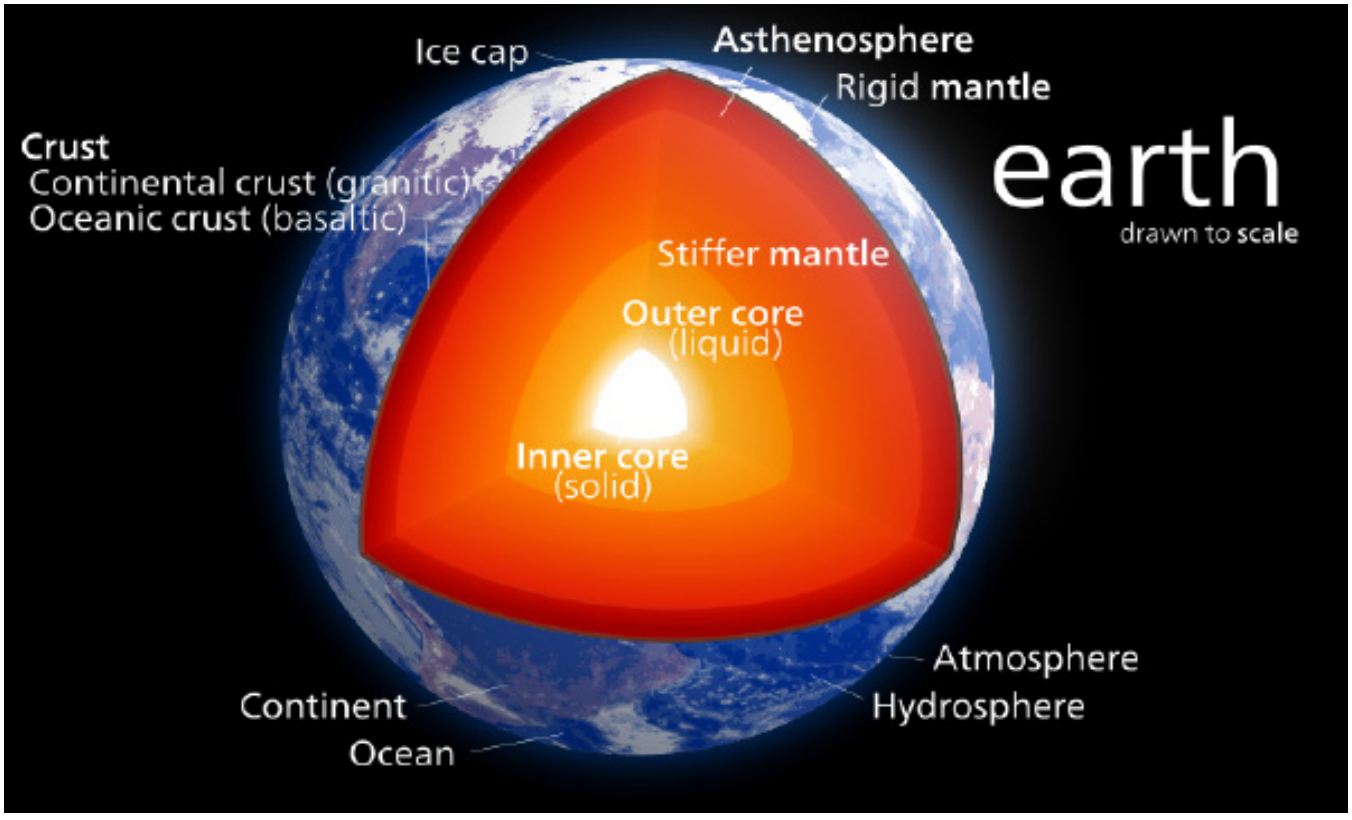
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3
Earth and Plate Techtonics

HOW DO ROCKS AND MINERALS FORM?

In order to understand how rocks are formed and classified, it is important that you understand how the Earth is formed as a planet. Please use the provided visual to explore the sections of the Earth.

- The crust makes up less than 1% of the Earth's mass (0.4%) There are 8 elements that make up 99% of the Earth's crust including oxygen, magnesium, aluminum, silicon, calcium, sodium, potassium, and iron.
- The mantle is the solid casing of the Earth, making up about 70% of the Earth's mass (68.1%). It is compiled of silicon, oxygen, aluminum and iron.
- The core is mainly made of iron and nickel and makes up about 30% of the Earth's mass (31.5%). The outer core is 1370 miles thick and is liquid and the Inner core is 790 miles and is solid. The outer core would take almost a whole day (23 hours) to drive from one side to the other!



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Hokie Stone is limestone infused with magnesium calcium under pressure and temperature. Hokie Stone is exclusively quarried for use by Virginia Tech projects. The stone is the primary finishing and façade material on many Virginia Tech campus buildings.

Plate Tectonics:

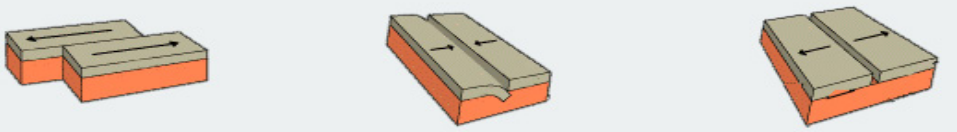
Convergent plates occur when two plates push into one another, deforming the region. When this happens, either the two plates collide with each other, or one plate subducts under the other, which stays on top. The subducted plate melts oftentimes creating additional magma for hotspots.

Divergent plates occur when two plates moving away from one another. New bedrock forms in the open space between the plates making this boundary one of construction.

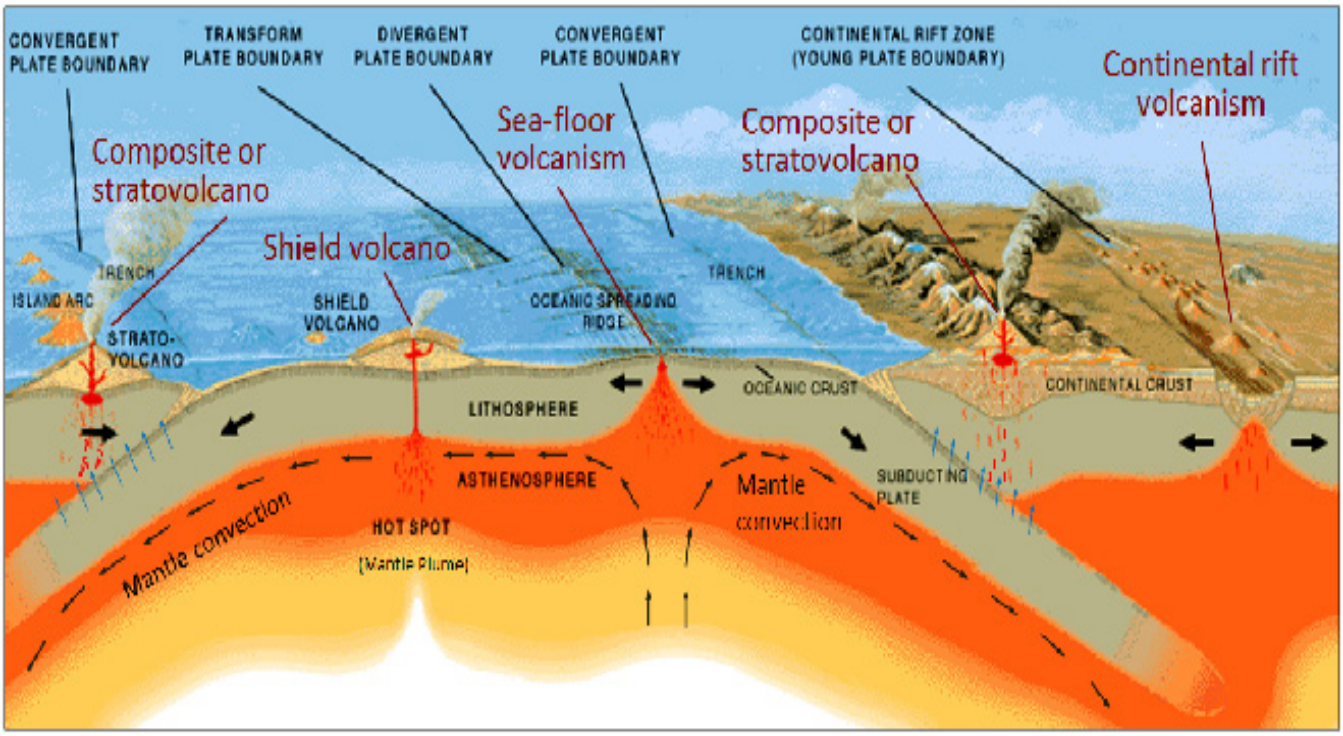
Transform faults occur when two plates neither create nor destroy but horizontally move and scrape against one another. This is often the source of earthquakes

When discussing supercontinents and the history of the earth, visuals can be super helpful. If you are able to watch a video in class, go onto YouTube and search for a video titled “Continental Drift: 3.3 Billion Years.” This does a great job of showing how land masses popped up and with plate tectonics and continental drift, the continents became what, and where, they are today. The video even includes the rising and dropping water levels as the earth endured global cooling and freezing throughout its billions of years. Near the end of the video you can see the water sitting vertically across the great states, reminding us of the sea life that used to live in the Great Interior Seaway (which extended from the Gulf of Mexico to Canada). Many fossils exist in land-locked states like

PLATE TECTONIC TYPES



TRANSFORM CONVERGENT DIVERGENT



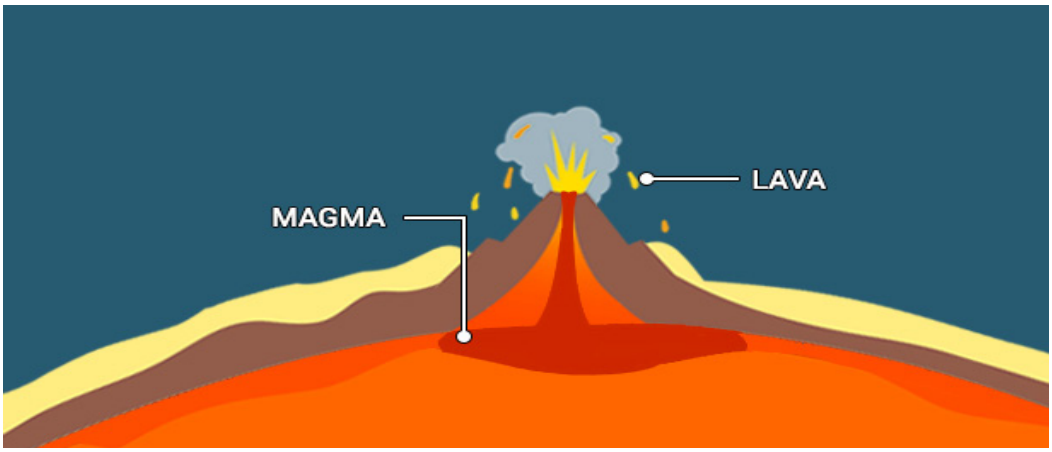
4
Classification of Rocks

HOW ARE ROCKS CLASSIFIED?

The whole Earth is made of rocks and minerals. The crust, which is the layer we live upon, is also made up of rocks and minerals. Much of the crust is covered by water, sand, soil and ice. If you dig deep enough, you will always hit rock. Inside the Earth there is a liquid core of molten rock and on the outside there is a hard crust. The mixture of molten and semi-molten rock is called magma.

Magma is the molten rock material under the Earth's crust, from which igneous rock is formed.

Lava is the molten rock material expelled by a volcano in an eruption. When it reaches the surface and comes out of a volcano, magma becomes lava.



Below the Earth's crust, rocks are constantly being formed, destroyed and formed again. This process is known as the rock cycle. Please use the visual provided to show the three rock types and their cycle.

Over time, rocks undergo many changes. Igneous rock can breakdown and become sedimentary rock, and both can change into metamorphic rock. Sedimentary rock can change into metamorphic rock or melt and then become igneous rock. Metamorphic rock can melt into igneous rock, breakdown into sedimentary rock, or be changed into another form of metamorphic rock. The

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IGNEOUS ROCKS

Igneous rock is a rock that is formed through the cooling and solidification of magma or lava.

New igneous rocks are created when volcanoes erupt and magma, the molten liquid rock comes up to the surface of Earth, turns into lava, cools and solidifies (known as extrusive igneous rock). Some igneous rocks are also created below Earth's surface, through cooling and solidification of magma, and then are later exposed at the surface (known as intrusive igneous rocks).

In order to learn more about formation of igneous rocks, conduct a volcano experiment and create your very own model of an igneous rock! Go to Activity #3 to find the directions.

We have following igneous rocks in our box:
- anorthosite
- granite
- feldspar (Amazonite is green feldspar)



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METAMORPHIC ROCKS

Metamorphic rock is a rock formed from an igneous rock, a sedimentary rock or another metamorphic rock through exposure to heat and pressure.

As the tectonic plates move, rocks are exposed to compression, stress and shearing forces which can deform them. Consequently, they are compacted, and this is why metamorphic rocks are always more dense then the original unprocessed material. Metamorphic rocks are also less vulnerable to erosional breakdown. Think about the characteristics of the rocks you have evaluated in the first exercise during this session. A tough tenacity of a rock could suggest it is a metamorphic rock! As the Earth's plates move over geologic time, one plate containing a particular type of rock may become subducted under another plate. Just the weight of the top plate can cause the subducted rock to undergo metamorphism! In some cases, heat from the Earth's interior can melt the rock slightly. Then, the rock is metamorphosed through temperature.

We have following metamorphic rocks in our box:
-talc
-marble
-schist



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SEDIMENTARY ROCKS

Sedimentary rocks cover 75% of the earth's surface. Most of the rocks found on the Earth's surface are sedimentary even though sedimentary rocks only make up less than 5% of all the rocks that make up Earth.
Sedimentary rock is a rock formed through compaction and cementation of sediment, i.e. naturally occurring material created in the course of weathering and erosion.

When mountains are first formed, they are tall and jagged like the Rocky Mountains on the West Coast of North America. However, over millions of years the mountains undergo weathering and erosion which lowers their height. Big mountains crumble due to different factors, including precipitation, temperature, running water and wind.

- *Weathering is the process where rock is dissolved, worn away or broken down into smaller and smaller pieces. There are mechanical, chemical and organic weathering processes.*

- *Erosion happens when rocks and sediments are picked up and moved to another place by ice, water, wind or gravity.*



Material that is created as a result of these processes is called sediment. Sediment can be transported by a variety of ways, for example through wind and water. Sediment that is created as a result of erosion flows down streams and rivers that have their sources in the mountains. When the water slows

Sedimentary rocks can often tells us a lot about the fauna and flora, i.e. plants and animals of the remote past in the area where they were found. Metamorphic and igneous rocks heat to such an extremely high temperature that the fossils would melt with the rock. A fossil is naturally preserved remains or traces of a once living organism from the remote past (generally one that lived prior to the last glacial period 10,000 years ago)



Fossils occur because the remains of plants and animals are covered rapidly by sediment, such as layers of mud, silt, or sand. Fossils are found most commonly in areas where swamps, lakes, seas and oceans occured– in other words, in places where water was present. In these areas, plant and animal remains are more likely to be buried in a layer of sediment. These anaerobic (without oxygen) environments allow the organic material to become preserved.

Sometimes large amounts of organic material are deposited in anaerobic environments. The plants slowly increase the amount of carbon and release their other gases such as oxygen and nitrogen. The first layer of plants transforming into a carbon rock is Peat. With heat and pressure, the Peat turns into Lignite, and then over time (with more heat and pressure), the lignite turns into Coal. This process is called Coalification. Coal is used as a very important fossil fuel in Virginia (more in setion 5).

We have following sedimentary rocks in our box:
-coal
-shale
-dolomite
-sandstone (all types)
-chesapecten jeffersonius + petrified wood



5

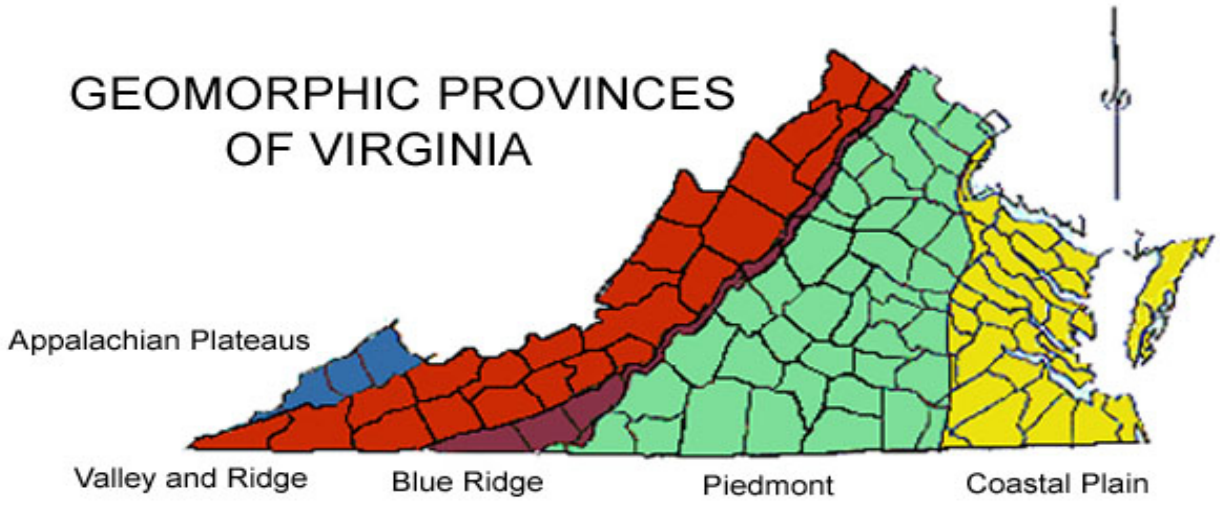
Virginia's Geological Provinces

Now let's put what you have just learned about rocks into a discussion about the state of Virginia. Please take a look at the provided visuals of the five geologic provinces of Virginia.

There is a Geologic Time Chart of Virginia (created by William and Mary College) included in this manual. You will find that directly behind the pictures of the packed box layout. This may come in handy when detailing the history of each region.

The Commonwealth of Virginia is divided into counties, independent cities, school divisions etc. But these divisions are only administrative! From a geological point of view (do you remember what "geology" means?) the Commonwealth is divided into five provinces:

Coastal Plain
Piedmont
Blue Ridge
Valley and Ridge
Appalachian Plateau



Adapted from Geology of Virginia, by R. V. Dietrich
Cartography by Sue Byrom

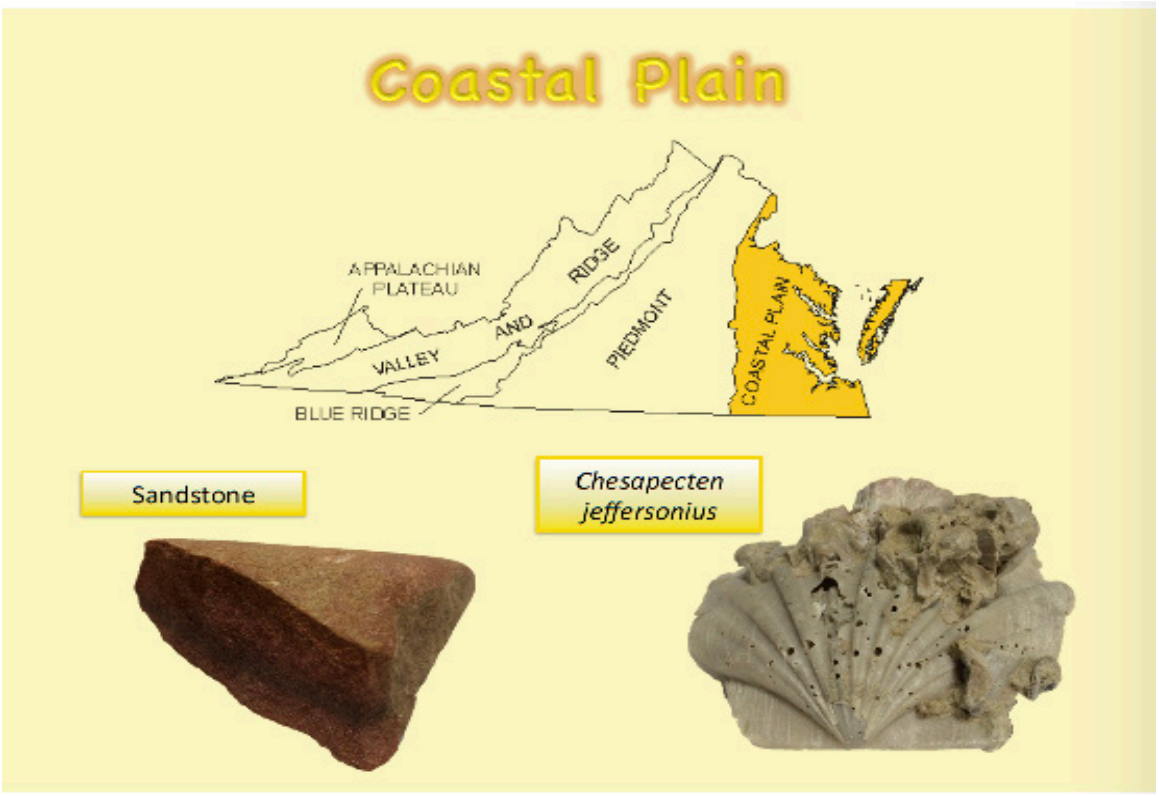
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COASTAL PLAIN

The Coastal Plain province is a generally flat landscape, with low elevation, dissected by rivers and streams. The province begins at the Atlantic coast, and extends west towards the Fall Line. The Fall Line, which extends the entire way up Virginia, marks the area where streams or rivers have rapids or short falls, as they flow eastward from the relatively harder rocks of the Piedmont onto softer sediments heading towards the coast. Sixty-five million years ago, the Fall Line marked the sea coastline, which means that Richmond was once beachfront property.

The Coastal Plain province is the youngest part of the Commonwealth, where rocks near the surface range from just 1 million years old to around 65 million years old. The most common type of rock in the region is sedimentary rock. Remember the geology of the Coastal Plain is strongly connected with water, and so is the occurrence of sedimentary rocks! This part of the Commonwealth has been covered by the ocean several times, and you can find many fossils throughout the province, such as our state fossil, the scallop Chesapectin jeffersonius.

We have the following Coastal Plain specimens in our box:
Red Sandstone
Sandstone



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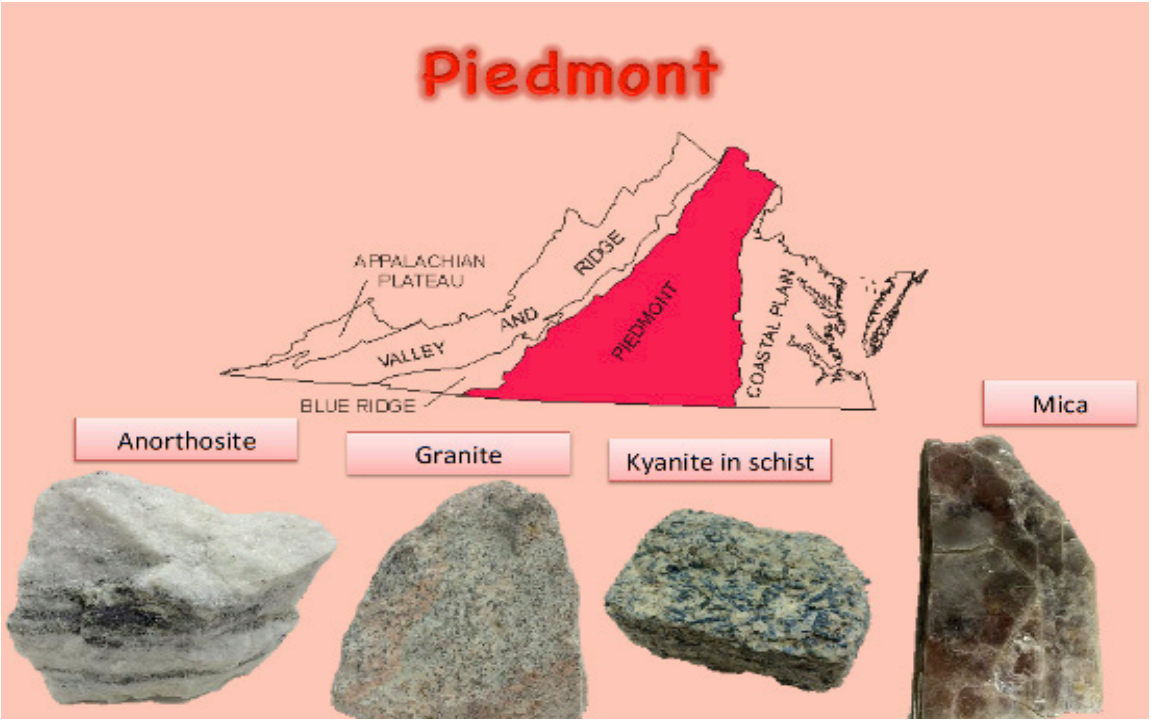
PIEDMONT

The Piedmont is the largest geological province in the Commonwealth, covering the area between the Fall Line and Blue Ridge. The province is characterized by a gently rolling topography, which becomes steeper heading towards the Blue Ridge. Thick vegetation, soil, and a clayey, decomposed rock material called saprolite cover much of the area. In Piedmont, saprolite can be as thick as 30 meters (about 100 feet)! The bedrock in the Piedmont, which is usually not exposed at the surface, is composed of a variety of igneous and metamorphic rocks. These rocks are seen primarily in road cuts, mines, or where streams and rivers cut away banks.

Many of the deeper rocks of the Piedmont formed elsewhere, and were slowly moved into their current location by tectonic forces over long periods of time. Other rocks, such as granite, formed from magma underground. Rocks from the Piedmont are very old - granite is 330 million years old, and anorthosite (from Hanover county) is a little over a billion years old.

Sedimentary rocks can also be found throughout the province. During the early part of the time period called the Mesozoic, small coal measures formed after rivers and streams carrying sand, silt, and mud flowed into the lowland basins and buried swamps and marshes. This is why we have samples of bituminous coal (from Chesterfield county) in the box!

We have the following Piedmont specimens in our box:
-Granite -Marble -Sandstone -Brown Mica -Amazonite



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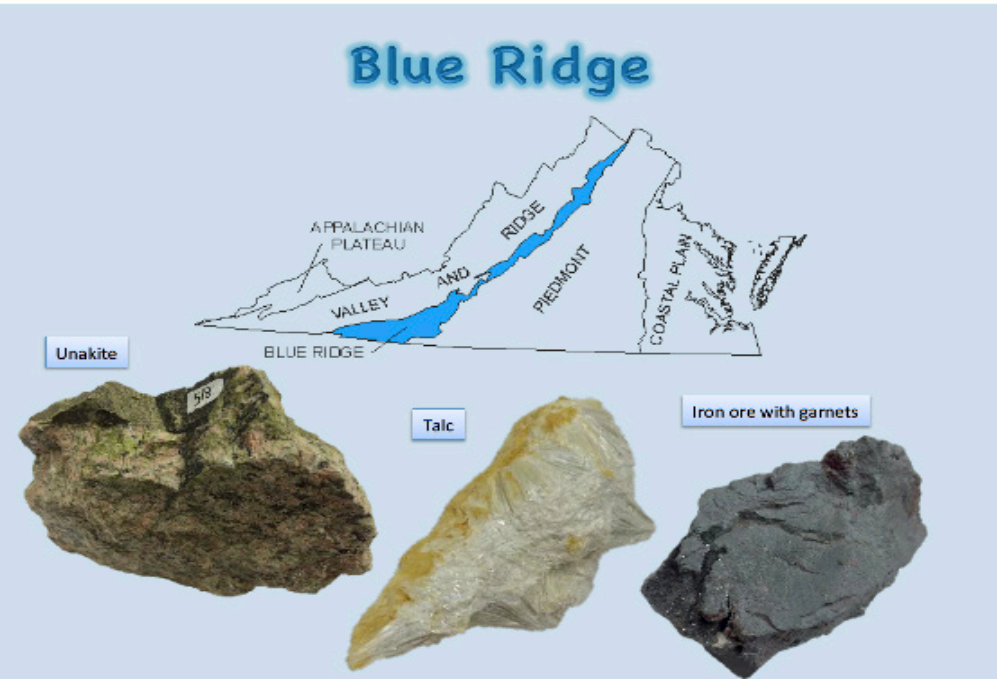
BLUE RIDGE

The Blue Ridge province is a rugged region, with steep slopes and narrow ridges. The lowest elevation is at about 1,500 feet above sea level. The oldest rocks in Virginia can be found in the Blue Ridge. The rocks in the mountains vary from Cambrian-age sediments, and Precambrian igneous and metamorphic rocks. At 5787 feet, Mt. Rogers is the highest mountain in Virginia. However, once the Blue Ridge Mountains were as tall as the Himalayas! Millions of years of erosion have cut them down, and exposed the igneous rocks at the base. The rock bed was formed through volcanic eruptions and rising magma from divergent plates during rifting of the ancient super continent Rodinea (over 800 million years ago).

Unakite, a metamorphosed form of granite, can be found in the Blue Ridge. It is often used as gem rock because of its vivid colors of reddish-brown feldspar and green epidote. Another more common Blue Ridge rock called Greenstone is basalt that has been transformed by heat and pressure when it was buried deep in the Earth's crust.

This is a great opportunity to You Tube the continents drifting and converging from Rodinia to Pangea (described below), to the current layout of our geography today.
Video visuals helps us understand how different the world looked, and how fossils of the same species were found an ocean apart. Search for: Scotese Animation: Breakup of Rodinia and Formation of the Pacific Ocean and/or Earth's History in the last 600 million years.

We have the following Blue Ridge specimens in our box:
-Kyanite -Talc -Anorthosite



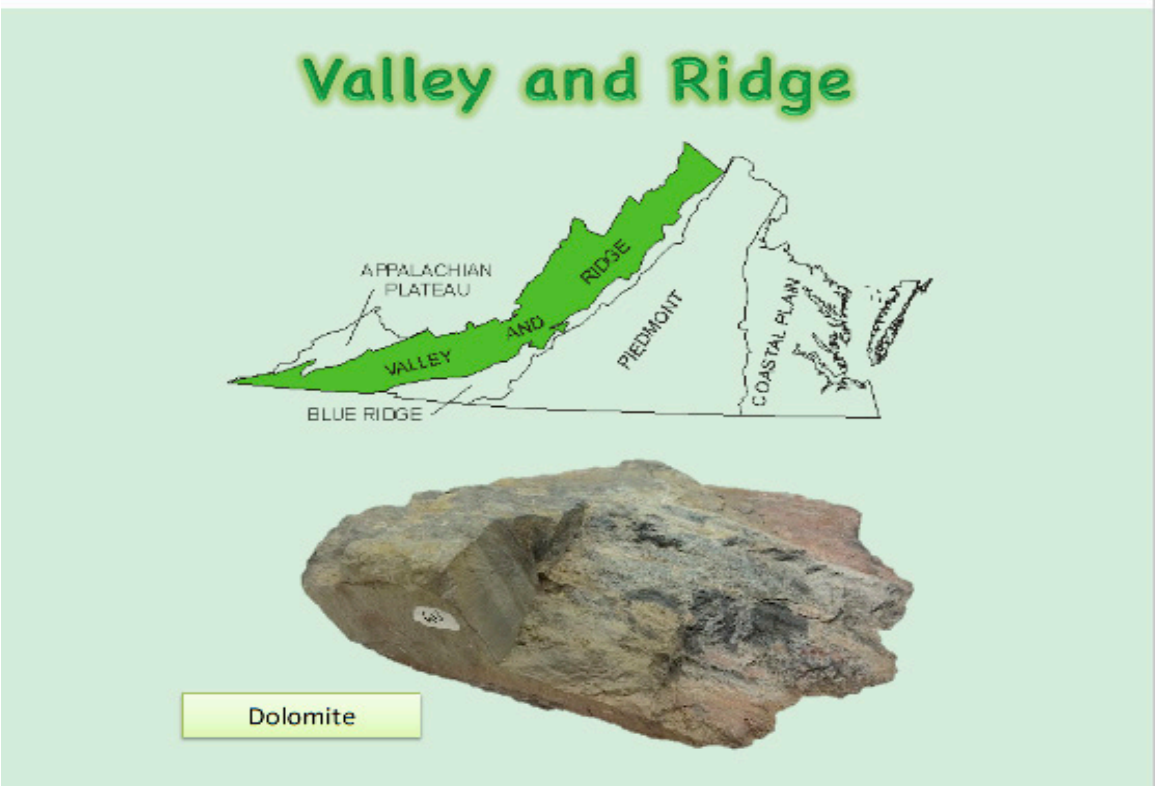
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VALLEY AND RIDGE

Long linear ridges separated by valleys characterize the Valley and Ridge province, which lies east of the Appalachian Plateau and west of the Blue Ridge. This area is home to some of the more striking features in Virginia, such as the Natural Bridge, the Natural Chimneys, and Burkes Garden.

Most of the visible rocks of this province are older sedimentary rocks: shales, sandstones, limestones and dolomites that have been faulted, tilted, and folded due to tectonic forces. The characteristic ridges and valleys are a result of erosion: The valleys in this province are underlain primarily by limestone and dolomite rocks which tend to erode easier than more resistant sandstones and conglomerates that support the ridges. The abundant caves and sinkholes in the Valley and Ridge are also the result of carbonate rocks that are easily dissolved. These sedimentary rocks lie on a basement of pre-Cambrian crystalline rocks.

We have following Valley and Ridge specimens in our box:
-Limonite
-Shale
-Dolomite

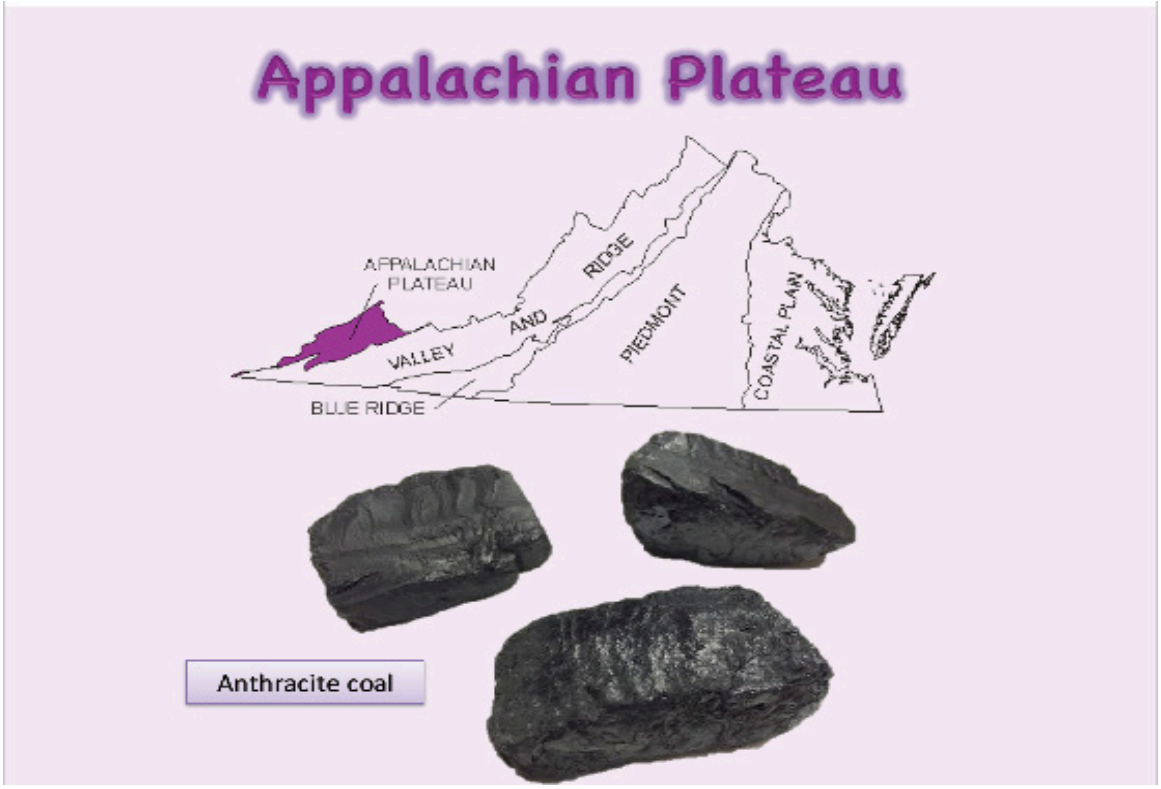


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APPALACHIAN PLATEAU

This is the smallest geological province of the Commonwealth covering mostly just three counties in the Southwestern corner of the state. The boundary between Valley and Ridge and Appalachian Plateau is a transition from tight, accordion-like folds of the Valley and Ridge to low-amplitude folds and flat-lying rocks in the Plateau. Millions of years of erosion have created rugged topography in the region. The Plateau historically was a swampy environment, which emerged after receding of the ocean (around 300 million years ago). A great example of what it looked like long ago would be the Great Dismal Swamp in the Coastal Plain. Appalachian Plateau rocks include sandstone and shale, but this region is best known for producing coal, which is a vital resource to Virginia.

We have following Appalachian Plateau specimens in our box:
-Anthracite Coal
-Petrified Wood



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6
Virginia Resources

WHAT RESOURCES CAN WE FIND IN VIRGINIA?

There are many amazing resources that come from this state! For example, sand and gravel that comes from the coastal plain is used for leveling roads, and aggregate (crushed stone) is used in construction. We have 130 aggregate mines in Virginia. Specifically, there are a few resources in Virginia that are worth discussing.

Feldspar:

The feldspar minerals are the most abundant group of minerals in the earth's crust. They come in many colors, including the blue green form we know as Amazonite. Currently in Virginia, feldspar is produced from anorthosite in the Piedmont, a mostly white igneous rock. Feldspar can withstand the high heat of a kiln without breaking and so it is often used in the manufacturing of ceramics.

Kyanite:

The mineral Kyanite has several industrial uses since it is hard and heat-resistant. It occurs in several kinds of metamorphic rock in the Blue Ridge and Piedmont, and has even been found as smaller particles in streams and sand in the Coastal Plain. Kyanite is the sharp greenish minerals found in rocks such as quartzite and schist. Once the kyanite is processed out of the parent rock, the sharp points are used as an abrasive to help shave down and shape ceramics and bricks.

Aggregate and building stone:

Crushed stone or aggregate is an essential part of the construction industry, and is a significant Virginian resource. It can be made from any type of rock that is mechanically broken into smaller fragments, and can be mined across the Commonwealth. In Virginia, limestone, dolomite, sandstone, quartzite, granite, gneiss, basalt, greenstone, aplite, slate, and marble are all quarried for use as crushed stone.

Virginian rocks can be also be used as building stones. Use of locally quarried stones is very important for the local architecture of Virginia. A particular example is the Hokie Stone. Hokie Stone is a gray dolomite-limestone rock found near Blacksburg, Virginia. Its name ("Hokie") refers to the Virginia Tech mascot, students and alumni alike









Coal:

Coal is a combustible carbonate rock, and one of the most significant resources in Virginia. The coalification process is explained above in this manual. Because coalification takes thousands to millions of years, this is considered a non-renewable resource. In Virginia, coal was first mined in the 18th century near Richmond, a type of coal that had formed from the Triassic Period (beginning about 245 million years ago). Since the 1950's, however, nearly all of Virginia's coal has come from the Appalachian Plateau in the southwestern part of the state. Today, coal powers over half of the electricity used in Virginia with one ton of coal powering one home for just 2.5 months.

A creative use of rocks and minerals is in art. Charcoal paintings date as far back as ca. 23,000 BCE, and charcoal sticks are a compressed form of coal, a sedimentary rock!

Have you ever tried to draw with charcoal? Do you think that it feels different to do art with natural materials than with artificial media?

Iron Ore:

While Iron Ore has not been actively mined in Virginia since 1942 (too costly!), it was vital to the development of the US and was mined in Virginia as early as 1609 by colonists in the Jamestown Settlement. Found in the Blue Ridge and Valley and Ridge areas, iron ore was extracted for railroads, factories, and armories. The iron ore in Virginia tends to be found in limestone with origins in the Devonian Period (419 million years ago).

Mica:

Mica, which has a paper like thin layers, can be found in pink, green, and browns. In Virginia, we are familiar with brown mica. Mica was mined in Virginia for 150 years but has not been mined since the early 20th century. Mined from pegmatite deposits in the piedmont area, it was used in paints, wall board mix, mold fillers, and as an additive to early plastics.







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Activities

1

IDENTIFYING ROCKS AND MINERALS

To begin, please take out all the rock and mineral samples from the box. To complete the activity, hand out the sheets and review the proper terminology (you will find these in the second section of this manual). Use the questions below to help inspire thorough inspections of the rock's properties. It is advisable to hand out two rocks per team, with a team of five or less people.

This activity can also be performed independently with any rock and/or mineral specimens from your personal collection.

When handling the rock or mineral, think of their qualities: Are they hard or do they crumble easily? Is it easy or difficult to scratch them? What is their color? Do they have a distinct shape, or is there any crystal shape growing on the specimen? Are there long bands or small bits of minerals?

Activity Sheet #1 – Properties of rocks and minerals

Mineral:	Color	Pattern	Hardness	Tenacity	Cleavage/Fracture
Anorthosite					
Granite					
Kyanite					
Mica					
Talc					
Limonite					
Amazonite					
Anthracite Coal					
Dolomite					

2

VOLCANIC "ROCK"

In order to learn more about the formation of igneous rocks, conduct our volcano experiment and create your very own model of an igneous "rock"! This activity allows you to learn about volcanoes, magma, lava, and igneous rocks. Please use the visual provided in this Box to explain the sections of volcanoes.

Resources Needed:

- alcohol
- baking soda
- sugar
- sand/dirt/or plaster volcano

Instructions:

- Use a thick ceramic bowl, a foil pie pan atop a trivet, or some sort of plate that can tolerate high heat. You can create a "volcano" out of sand or dirt, as long as it has a shallow crater top for air flow and provides a good visual.

- Mix 4 tablespoons powdered sugar with 1 tablespoon baking soda in (can change size of portions, but ratio should stay the same). Pour the sugar and soda mixture into the depression. Pour the alcohol or other fuel into the sand to wet it and then ignite the mound, using a lighter or match.

- Small blackened balls should appear on the surface as a sign that the contents have been lit properly. Once ignited, the contents will begin to form a long black mass. It will serve as a model of an extrusive igneous rock. Allow 15-20 minutes for the "rock" to solidify. The end result is a spongy product, but it does break down into ash with gentle to medium pressure

Helpful Hints: If you are having pairs of students perform this activity, I would suggest lowering your ingredients from tablespoons to teaspoons.

This activity will yield an open flame, and have vapors, so be safe and practice smart behavior. Never pour alcohol on open flames. Please do this in a well ventilated area (perhaps practice before trying with your students). If you use pure ethanol, sugar, and baking soda, then there is nothing toxic about this project.

3

YUMMY SEDIMENTARY AND METAMORPHIC ROCKS

This activity allows you to learn (hands-on!) about two parts of the rock cycle. The sedimentary aspect reinforces the need for lots of pressure, while the metamorphic aspect exemplifies the need for lots of heat and pressure to make visible changes.

Resources needed:

- Starburst candy
- Aluminum foil (in squares)
- Wax paper (in squares)

Possibly: Toaster over (please use oven mitts and a drying rack or towels for this portion)

Instructions:

- Place one square of aluminum foil on the desk with a square of wax paper on top. Hand out three starbursts per student.

- As the students to unwrap the starburst and stack them on top of the wax square in a vertical column. Wrap the wax paper and foil around the starburst. Using a textbook or just their hands, or even standing on the column – encourage students to push down on the candy. This acts as the significant amount of pressure necessary for layers or sediment to glue together and form a rock.

- When unwrapped they can see how the stack became one combined starburst.

- For the next step – have the students re-wrap the starburst "rock". To conduct enough heat you can try putting the foil packets in a warm window, use a toaster oven, or even encourage kids to sit on the packet to generate heat. You don't want the starburst to melt, but to be warmed enough so that they are malleable. At this point, have the students push at different points to reenact the metamorphic changes that happen to a rock.

- When done, unwrap and see how the candies all look different. Metamorphosis means "big change" and from start to finish, that's what students should see.

4

MINING MINERALS

Mining MInerals allows you to learn (hands-on!) about extracting minerals from hard bedrock This activity replicates how Kyanite and Feldspar have to be mined, though without the large equipment. Also this activity can introduce the economics of mining.

Note: if made too far in advance, the sprinkles sweat/melt into the play dough leaving a sticky wet mess. Plan to make these bricks right before the activity.

Resources Needed:

- Play Dough
- Sprinkles
- Paper Plate
- Toothpicks

Instructions:

- To make the bricks: Pour about ¼- ½ cup of sprinkles onto the plate. Take small balls of play dough and press into the sprinkles. Form the ball into a square (after putting in sprinkles) so that there will be some sprinkles on the inside and outside of play dough. Bricks should measure between ½ -1 inch squared.
- Hand out the play dough bricks to groups of 2 and give each group two toothpicks. Instruct the teams to scratch around the sprinkles to pull them out as cleanly as possible.

If you would like to discuss the economics of mining, you can consider:

- Each brick has the cost of $5 for purchasing land rights to mine.
- Each minute that it takes to finish the mining job costs $1 for “labor costs”. Each sprinkle counts as $4.
- Have the group tally up their mineral gains, and the total cost of the labor costs and land cost. Subtract the labor/land total from their total mineral gains.
- Use this as an opportunity to discuss Virginia mineral resources, and the cost both environmental and economical to the process of mining and refining minerals for human use.

Safety warnings:

5

MINING SIMULATION

Name:
Date:

I. Identify the Problem:

Rocks are hard! Some rocks are valuable! Valuable rocks are usually stuck inside other hard rocks! How do people get the valuable rocks out of the hard rocks in order to provide resources and make a profit?

II. Background Research:

The formation of igneous and metamorphic rocks can be a complicated process with many changes in temperature, pressure, movement of materials and other factors that result in the huge array of rocks that we see around us. Some rocks and minerals are valuable because they are rare like diamonds. Some rocks are valuable because they can be used for things like granite in construction

In order to get these valuable materials out of rock, there is really only one way, dig. Your job today is to simulate digging for valuable rocks such as feldspar, kyanite, and gems.

IV. Experimental Design/Data Collection:

1. *Formulate a plan for how to use your money. Here are the rules:*
   - A. *Each mineable chunk of "land" costs $1,000,000.*
   - B. *Each piece of mining equipment costs $5,000,000*
   - C. *Each minute that you mine costs $500,000 in labor.*
   - D. *Each valuable mineral you are able to excavate is worth $100,000*
   - E. *Each ultra rare mineral is worth $500,000.*
   - F. *You may only excavate with the mining equipment, nothing else*
   - F. *The group with the most money wins!*
   - G. *Each group starts off with $30,000,000*
2. *Come see me and tell me what you want to purchase.*
3. *Update your data table with your current money and take your supplies.*
4. *DO NOT START MINING UNTIL EVERYONE IS READY!*
5. *Once time begins, start mining and record on your paper when you stop to do your final calculations*
6. *Do your final calculations and clean up!*

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V. Data Analysis

Starting Money	$30,000,000	
Equipment Purchased	_____ x $5,000,000	_____
Land Purchased	_____ x $1,000,000 =	_____
Time Spent Mining (max 10 minutes)	- _____ x $500,000 =	_____
Valuable Minerals Recovered	+ _____ x $100,000	_____

VI. Conclusion

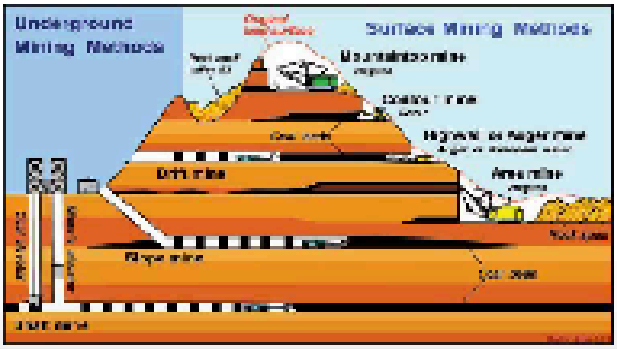
1. *What is your grand total after running your mining operation?*

2. *Consider the environment that remains now that you have mined your land. Now think about the fact that in the real world, mining is just as invasive a process. Discuss with your group some pros and cons of mining (think economic, environmental, etc.). Write two short paragraphs. One giving reasons you think mining is a good idea and worth it. One giving reasons you think mining is a bad idea and not worth it. You do NOT need to make a final decision as to whether mining should or shouldn't happen as the issue certainly depends on more factors (mining what, where, etc.). Use the pictures below for ideas.*









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This group is:

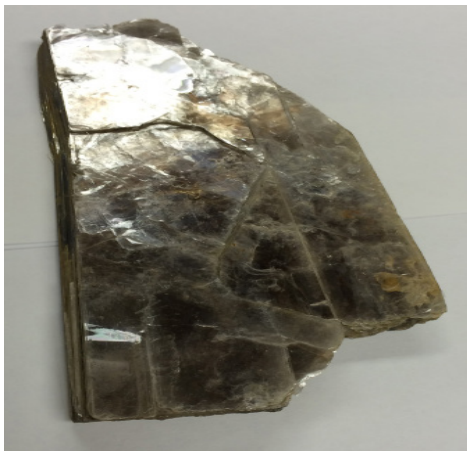
Round	1	2	3
How much land do you want?	_____ x $1,000,000	_____ x $1,000,000	_____ x $1,000,000
How many pieces of equipment?	_____ x $5,000,000	_____ x $5,000,000	_____ x $5,000,000
How long do you want to mine?	_____ x $500,000	_____ x $500,000	_____ x $500,000
How much will this round cost you?			
How many normal minerals did you find?	_____x $100,000	_____x $100,000	_____x $100,000
How many rare minerals did you find?	x $500,000	x $500,000	x $500,000
How much money did you earn?			

Starting Balance	$30,000,000
Initial Purchases	
Round 1 Earnings	+
Round 2 Purchases	-
Round 2 Earnings	+
Round 3 Purchases	-
Round 3 Earnings	+

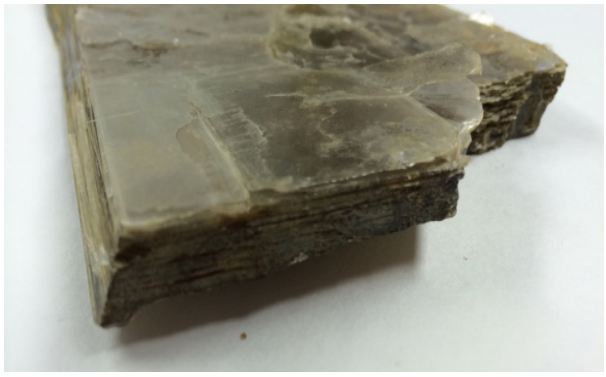
Your final value is...

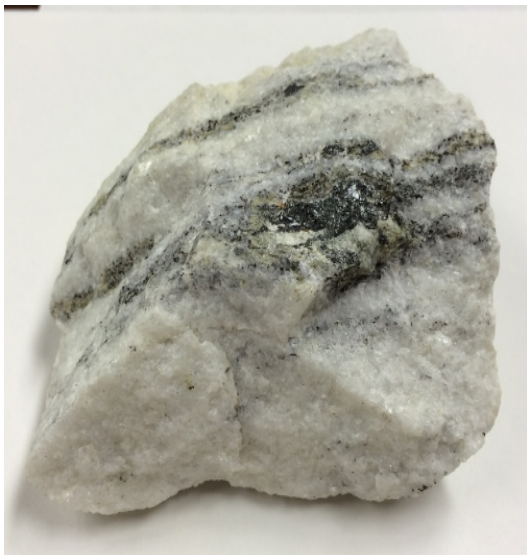
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Specimens included in the box



MICA





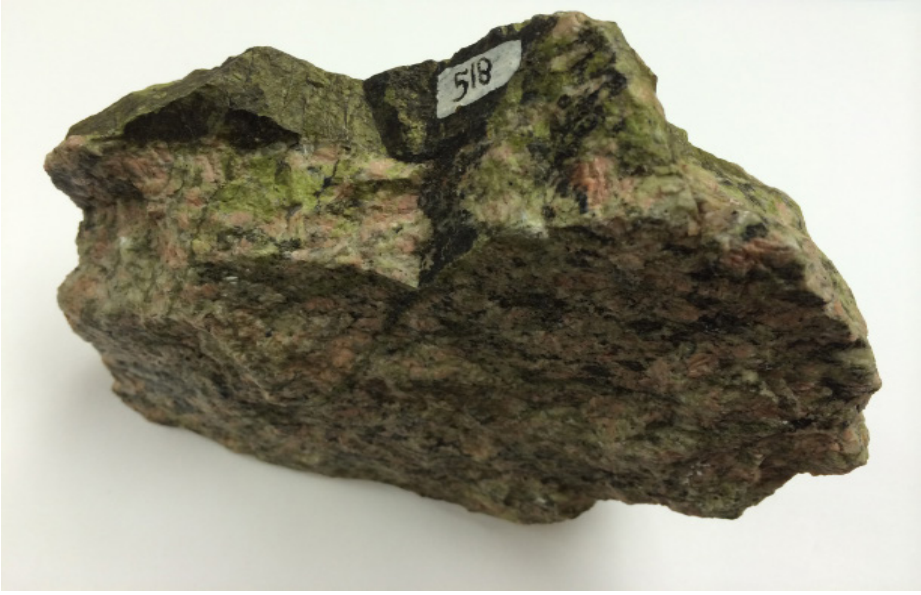
ANORTHOSITE



ANTHRACITE



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UNAKITE

TALC





KYANITE

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DOLOMITE

SHALE





GRANITE

LIMONITE





MARBLE

AMAZONITE



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SANDSTONE





SANDSTONE (PIEDMONT)

RED SANDSTONE

