Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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Chocolate Chipping Away at the Rock Cycle

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Objective

Students will learn the three mains groups of rocks and rock cycle and be able to show how energy within the Earth is transferred within the Rock Cycle while doing various hands on activities and experiments that will connect food to the rock cycle.

Students will also be able to explain how internal energy of the Earth causes matter to cycle through the magma and the solid earth.

Introduction

This unit will be taught to a class of about 20-25 eighth grade students at Betsy Ross Arts Magnet School in New Haven, CT. The students in this science class are very diverse, coming from different backgrounds because it is an interdistrict magnet school. About twenty-five percent of the students come from surrounding suburban schools, another twenty-five percent live in the inner city neighborhood, and the other fifty percent come from other areas in the city.

To introduce students to rocks and the rock cycle the teacher will present information about the layers of the Earth and plate tectonics. Next, students will be organized into small groups to research basic information about rocks. There will be a variety of igneous, sedimentary, and metamorphic rocks that they can choose from and research. They will also learn what makes up their rock and where we can find these other minerals that make up these rocks. Eighth graders connect to factual information better when they can relate to it in a personal way, so they will be encouraged to find out how these rocks or minerals that make up their rocks are used and seen in their everyday lives. It is important for students to be hands-on with the different types of rocks, so if the classroom is not equipped with groups of rocks that the students can look at in class then Frey Scientific has a large variety of boxed rocks that can be purchased for the classroom.

Students will be prompted with suggestive websites to use that the teacher provides them and research they

will do will take place in the school's technology lab since many students do not have access to computers at home. The teacher will work with each group to be sure that they are finding the necessary facts about their rock. At the culmination of the research each group will present their info to the class. Since the school is an arts magnet school the rubric presenting their specific rock will include an artistic component such as visual arts, music, or theater.

What Makes Up the Earth and Plate Tectonics

The three main layers of the Earth are the crust, mantle, and the core. Each layer varies greatly in size, composition, temperature, and pressure. The crust makes up Earth's skin. It is about 5-70 km thick depending on where on Earth it is and it is a layer of solid rock that includes both dry land and the ocean floor. The mantle is made up of rock that is very hot, but solid. Scientists have divided the mantle into layers based on physical characteristics. They are the lithosphere, asthenosphere and lower mantle. It is nearly 3000 km thick. The core is made mostly of metals iron and nickel. It consists of two parts a liquid outer core and a solid inner core. Together they are 3,486 km thick and the outer core enables the Earth to have a magnetic field. (3)

The lithosphere is broken into tectonic plates. These plates carry not only the oceans but the continents. The theory of plate tectonics explains the formation, movement, and subduction (or sinking) of Earth's plates. As these plates move and shift they produce Earth's awesome looking landforms including volcanoes, mountain ranges, ocean trenches, and more importantly the rocks that we will come to learn about. (2)

Rocks Rock!

The first group project of the unit will introduce students to the different types of rocks that are involved in the rock cycle: igneous rocks, metamorphic rocks, and sedimentary rocks.

Students will learn basic information on the rock that they are assigned. This will include colors, shapes, textures, and the group of rock that their specific rock belongs to. They also will learn what makes up their rock and where we can find these other minerals that make up these rocks.

Rock Cycle

The rock cycle is a general model that describes how various geological processes create, modify, and influence rocks. This model suggests that the origin of all rocks can be ultimately traced back to the solidification of molten magma. Magma consists of a partially melted mixture of elements and compounds commonly found in rocks. Magma exists just beneath the solid crust of the Earth in what we call the mantle.

The first rocks to form on Earth were probably igneous rocks. All igneous rocks form from lava that has erupted onto Earth's surface or magma that hardens beneath Earth's surface.

All rock types can be broken down by weathering on Earth's surface. Those same rocks that were broken down are moved thanks to erosion. Some examples of erosion are streams, waves, glaciers, wind, and gravity. When these pieces of rocks are deposited they then go through the processes of compaction, which is the pressing down of rocks together (similar to pressing down a freshly made sandwich) and cementation (the gluing of rocks together by mud) which change these pieces of rock over long periods of time to produce

sedimentary rocks. (See Figure 2.)

Many geologic processes, such as mountain building, or plate movement can exert heat and pressure on both igneous and sedimentary rocks causing them to be altered physically or chemically. Rocks formed in this way are called metamorphic rocks.

All of the three rock types described above can be returned back to the inside of the Earth. Once in the Earth's interior, great pressures and temperatures melt the rock back into magma to begin the process of the rock cycle all over again. (1, 3)

Igneous Rocks

The word igneous comes from the Latin for fire, and all igneous rocks begin as a hot, fluid material. This material may have been lava erupted at the Earth's surface, or magma at shallow depths, or magma in deep bodies. Rock formed of lava is called extrusive; rock from shallow magma is called intrusive. (3)

The different types of igneous rocks are mostly divided apart by their texture and mineral composition. Texture describes the overall appearance of an igneous rock based on the size, shape, and arrangement of its interlocking crystals. Texture is a very important characteristic because it reveals a lot of information about where that rock had formed. Rapid cooling creates small crystals, where slow cooling creates large crystals. The rate of cooling is very slow in magma chambers deep within the Earth compared to the faster rate of cooling close to the Earth's surface. Igneous rocks that form rapidly at the surface have a fine-grained texture, where grains are too small to be seen by the naked eye. (1)

Coarse-grained textured rocks are formed when large masses of magma solidify below the surface. These have an appearance of a mass of inter-grown crystals, which are pretty much equal in size and large enough to be seen. A good example of a coarse-grained igneous rock is your common granite. (See Figure 1.)

Figure 1. A pink and black colored granite rock used in my classroom.

The third type of texture is created when there are different cooling rates going on within the rock. If magma that already contains some large crystals suddenly erupts at the surface of the Earth then the remaining portion of lava will then cool quickly. This rock will then have large crystals mixed in with small crystals and given the name porphyritic. A good example of this is andesite.

The last texture is created when there is such rapid cooling at the Earth's surface that the crystals don't have any time to grow. These are glassy textured igneous rock, and are created when there is not enough time for any crystalline structure to form. Obsidian is a common glassy textured rock that appears to be a dark piece of glass, also pumice resembles fine shards of glass but because it is vesicular it actually can float in water.

The mineral composition of an igneous rock depends on the chemicals of the magma from which it crystallizes. There are actually various eruptive stages of volcanoes and the same magma can actually produce many different types of igneous rocks. Since there are so many various ways igneous rocks can be broken down, geologists decide to put them into three categories; light, dark, and medium colored minerals.

Light colored rocks are referred to being as felsic. This is because there is mostly feldspar and silica found in these rocks and so they are very light colored. Granite is the best known intrusive igneous rock from this category and is great because it has a variety of uses, such as making tombstones, monuments, building stones, and kitchen countertops. When students are told of all the uses they will be amazed because granite is found practically everywhere! Dark colored rocks are referred to as being mafic. This is because there is mostly an abundance of magnesium and ferrum (Latin for iron) in them. They are very dark colored igneous rocks and basalt is a great example of this. Many volcanic islands are made from basalt which is the most common extrusive igneous rock. The final group has a composition falling somewhere in between light and dark colored, so it is said to have a medium or intermediate composition. (1, 2)

Sedimentary Rocks

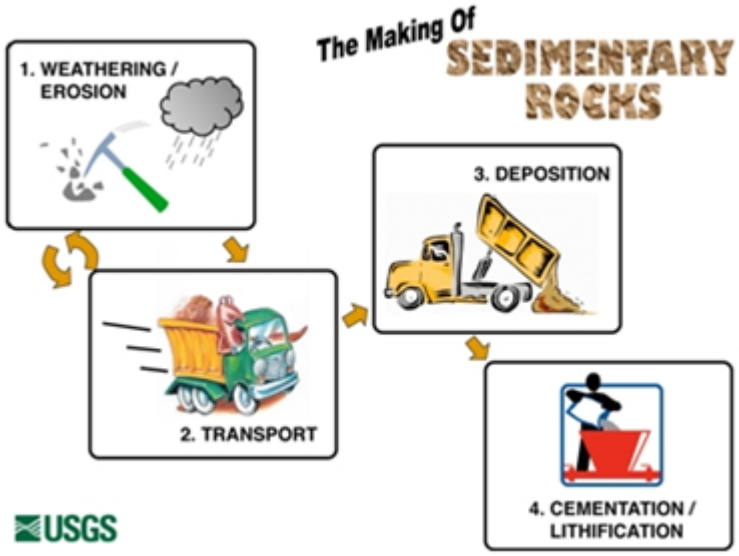

Figure 2. A basic outline of the sedimentary process.
http://education.usgs.gov/schoolyard/RockSedimentary.html

When weathering and erosion break down rocks, they leave behind sediments which are then carried away by forces such as gravity, water, or wind and then become compacted, cemented and deposit them into another areas turning them into a sedimentary rock. Scientists classify sedimentary rocks by how they were formed and how their texture is. These rocks can be placed into three groups; clastic, chemical, or organic.

Clastic sedimentary rocks are created when large pieces of gravel are cemented together creating one rock. Usually, these types of rock are very coarse, or large grained. Two examples of this type are conglomerate and breccia. Both of these rocks look like they are just made from pieces of other rocks. The only difference is, is that conglomerate will have rounded edges while breccia has sharp edges.

Chemical sedimentary rocks are created when their sediments come from material that is in a form of a solution and brought to lakes, or another body of water. Eventually these chemicals sediments harden and

create rocks. These rocks can have a range of fine texture to coarse texture but all are composed with some kind of chemical sediment, whether it is halite or calcite. Some familiar chemical sedimentary rocks include rock salt (what plows uses when cleaning up the snow covered streets in the winter), chalk (what teachers use on the chalkboard!), and flint (when out in the woods this is good to have to start a fire).

The last group of sedimentary rocks is organic. These rocks are made from living plants and other organisms that were compacted and cemented together to form a rock. A popular sedimentary rock students will be familiar with is coal. Coal forms from dead plans that decompose, usually areas rich in moisture and soil such as swamp areas. This type of rock also goes through several stages in order for it to form.

All three types of sedimentary rocks have an appearance to them that can clearly be seen so they aren't confused with igneous or metamorphic rocks. Many sedimentary rocks have a clearly distinguished layered appearance, such as this sandstone shown (See Figure 3.)

Figure 3. A piece of sandstone rock. Notice the distinct layers in the rock. (picture courtesy of: republicans.resourcescommittee.house.gov)

And others have fossils in them, whether they are from shells or stems and leaves, such as limestone. (See Figure 4.) (1, 2, 3)

Figure 4. A limestone rock with pieces of shells in it. (picture courtesy of: republicans.resourcescommittee.house.gov)

Metamorphic Rocks

Metamorphic rocks are rocks that have been changed with the help of heat and pressure. During the process of metamorphism, rocks are usually affected by these two processes at the same time.

The most important agent out of the two is heat. It allows chemical reactions to occur and change minerals within the rock or it can make new ones. Rocks can receive heat, in two ways. They can heat up from inside

the Earth or when rocks are moved on Earth's surface toward warmer temperatures.

Pressure increases with depth just like heat does inside the Earth. When there is great pressure it creates any space between minerals to be reduced or even changes the minerals from one type to another. Pressure and heat have changed this igneous granite rock into a metamorphic gneiss rock. (See Figure 5.)

Figure 5. Left is an igneous rock, granite. On the right is a metamorphic rock, gneiss.

(picture courtesy of: http://www.nvcc.edu/home/cbentley/shenandoah/index.htm)

Metamorphic rocks are categorized into two main groups: foliated and non-foliated. Foliated rocks have a banded appearance, while non-foliated rocks do not have a banded appearance. A commonly used foliated metamorphic rock is slate. Students will be able to relate to slate because they can actually see it in their classrooms when a teacher writes on the chalkboard. Since slate can easily be cut into large, flat slabs it is useful for chalkboard, and roof and floor tiles. A commonly used non-foliated rock is marble. It has many interlocking crystals so there is no layered appearance but it found in many monuments and statues. A popular marble statue that students will be familiar with is the statue of Abraham Lincoln in the Lincoln Memorial in Washington, D.C. (2, 3)

Activities and Lessons

Activities to enhance students learning will be a variety of different activities that include hands on labs. Students will make their own "rock cycle" fudge mixing ingredients together creating their own edible "rocks". Students will also recreate the rock cycle by acting out different parts of it while using a variety of chocolate chips.

The final lab activity for this unit will have students look at a variety of different cookies and rocks and compare and contrast them. They will work in groups on their activity and when finished all students will present their findings to the class.

Rock Research Activity

To introduce students to rocks they will pick one rock from any group, and learn basic information about that rock. Make sure that the rocks they research are common and have enough information about them. Good examples are slate (found in chalkboards), pumice (used in salons), granite (found in buildings and monuments), and marble (famous statues and monuments). They will work in groups of 2 or 3 and make an 11X15 poster board of their rock. They will have to find out what makes up the rock, where we can find this

rock, and what can actually be done with this rock. Especially relating it to their lives so that they can make a connection to what they are researching Students will do all their research in the school's technology lab and design their poster board in class. Some good websites for students to research can be found at the end of the unit. This activity should take 1 class period of 45 minutes to research, and then another class period to design and finish their poster. Students will present their findings to the class and the rubric (found at the end of the unit) will include basic facts about their rock, name, shape, texture, colors, where it is found on Earth, what can be done with it, etc.

After students learn and become familiar with the rocks they will be able to explain how all rocks are linked together by the rock cycle. They will be able to physically make their own "rocks" using everyday kitchen items that they are familiar with and then be able to eat them. Also, students will perform a hands-on activity in which they re-enact the rock cycle using a variety of chocolate chips and manipulate them so they coincide with each part of the rock cycle.

Igneous Rock Activity

Lesson Objective: Students will be able to explain what happens to igneous rocks inside the Earth through a teacher demonstration.

Students will be introduced to igneous rock and the different types. The teacher will bring in some strawberries and some chocolate fruit dip. The dip can be found in the produce department in your local supermarket. The fruit dip actually is pieces of chocolate, which the teacher will show the students. These bits of chocolate will be parts of rocks and when placed under extreme heat can change forms. The chocolate can be placed on a hot plate while the teacher mixes or can be placed in a microwave. When it is taken off of the heat source the teacher will ask the students what happened to the rocks? Why? The teacher will ask students to dip a strawberry in the now hot, liquid chocolate and place their strawberry on a piece of wax paper. Let the strawberry sit until the end of class and have the students see what happened to the chocolate. Ask them what did the pieces of "rock" turn into when heated? When they cooled what happened? Students will be able to understand that when magma or lava cools (chocolate), it forms igneous rocks (chocolate covered strawberry). At the end of class the students can then enjoy their chocolate strawberry "igneous" rock!

Sedimentary Rock Activity

Lesson Objective: Students will be able to explain what happens when sediments get glued and compressed together to form a sedimentary rock. An example of a good recipe to use in the class can be found at the end of the unit.

Most students are familiar with puffed rice cereal and heated marshmallows and what happens when they are combined. Students will already know that sedimentary rocks are formed through a process of sediments breaking down, moving, depositing themselves somewhere else and being compressed to form a rock. The teacher will use different colors of puffed rice as the sediments. The marshmallows will be heated and before combining them ask the students what will happen when these ingredients are mixed and compressed together into a pan. They will be able to see that these treats are made just like sedimentary rocks are made on Earth. Except these sediments are delicious and can be made in their own kitchen!

Chocolate Chipping Away at the Rock Cycle Activity

Lesson Objective: This lesson will reinforce the main concepts of rocks and the rock cycle by giving students a

hands-on, visual reinforcement of the intricacies of the rock cycle.

Initiation: Before the investigation begins, assess student's prior knowledge about the rocks and the rock cycle. Give each group a large piece of chart paper and ask students to record in words or pictures what they know from our current study of rocks and the rock cycle. After about 5 minutes, each group is given an opportunity to share two pieces of information they have recorded, such as the three types of rocks, their origins, or the processes that form them.

After all the groups have shared their information, students review the questions on the Activity worksheet (provided at the end of the Unit). Students should be collaborating within their teams in order to get the answers to the questions, but each student will have their own worksheet to fill out.

Materials: hot plates (1 per group), coffee mug (1 per group), a 2 X 4 block of wood(1 per group), 4 different colors of candy baking chips, such as milk chocolate, white chocolate, peanut butter, and butterscotch(place about 50ml in a small cup or bag for easy distribution), wax paper, aluminum foil, aluminum tray, plastic knives, plastic cups, oven mitts, aprons, and goggles.

Procedure: Have students cover their work area with wax paper. Gloves and aprons should be put on. Chocolate chips will be divided into piles and the students will carefully shave off pieces of them but keep them separated by color. They will then make an aluminum foil tray and place one color of chips in the tray. They will press down the shavings with their block of wood until their chips turn into a flat pancake. When it is flattened they will then place their foil on the floor and place a large book on top of it, and then have a group member stand on the book for about 2 minutes. After 2 minutes they will answer their questions, and then repeat the process for the other colored chips. Students will then have a layered pancake when finished with all their chips. They will take their layered pancake and place it carefully into another aluminum tray where it will be melted by the hot plate. They will have some other questions to answer (refer to Appendix B), and then take their patty off when their chips have melted and let them cool.

Once groups have finished their investigation and cleaned their work areas, groups spend three to five minutes discussing their findings. Students can address what concepts were reinforced by the activity, such as how one or more minerals form a rock, the processes of weathering and erosion, and the three types of rocks. An entire class discussion on these concepts can be done; also the answers to the activity worksheet can be shared and discussed. The goal for the three investigation questions is for students to transfer their prior knowledge of rocks and the rock cycle to the steps in the activity by identifying what represents the different types of rock, the steps of the rock cycle, and the processes and Earth forces that are involved.

Rock Cycle Fudge Activity

Lesson Objective: Students will be able to identify the different processes of the rock cycle while making rock cycle fudge. This is to be an enjoyable activity done when their unit on rocks is complete!

Initiation: Teacher will begin by asking students how weathering and erosion affect rocks. All answers will be accepted (about 4-5) and recorded on the chalkboard or overhead to refer to during lesson closure.

Materials: Microwave, microwave-safe bowls, plastic baggie, large spoons, wax paper, a few sets of measuring spoons and cups, evaporated milk, sugar, margarine, mini-marshmallows, pecans or walnuts, semi-sweet chocolate chips, and vanilla extract

Procedure: Assign students to groups of two or three to work together. Read directions aloud (refer to Appendix) to the class. Ask students if there are any questions about the procedure.

Students will measure and add the evaporated milk, sugar, and margarine to their bowl. They will mix them with their spoon. After mixing well they will give to the teacher to have it placed in the microwave for about 30-45 seconds, then stir it again. This part will be repeated about 3-4 more times, re-heating and mixing. While one student is mixing, the other student can get prepared for the rest of the activity. The nuts (if used) can be broken down into small pieces while in a plastic bag. The chocolate chips, and marshmallows will be measured and added to their bowl with the rest of their ingredients, the vanilla extract being last. Each student can take turns mixing until their fudge has combined. While this is occurring the teacher can check for understanding by asking the groups what is exactly occurring now? Or how is this similar to the rock cycle? While a student holds the bowl another uses the spoon to scrape their "magma" onto their wax paper. Another sheet of the wax paper will be added on top of their cooling rocks and then will be labeled with students' names and their class period. Finally they will carry their sheet of igneous rocks to a cooling area, like the refrigerator in the science prep room. The rocks will need to set for 24 hours on a nice flat spot in the refrigerator. Then the fudge can be sliced and divided among the group members the next day in class.

Appendix A: Implementing District Standards

New Haven Public Schools Science Standards:

Energy in the Earth's Systems - How do external and internal sources of energy

affect Earth's systems?

The Changing Earth - How do materials cycle through the Earth's systems?

Appendix B: Instruction/Answer Sheet for Chocolate Chipping Away at the Rock Cycle Activity

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Chocolate Chipping Away at the Rock Cycle

Understanding and hands on investigation of how chocolate chips can be changed just like the rock cycle changes rocks

Materials:

Hot plates

Coffee mug

4 different colors of chocolate chips

milk chocolate

butterscotch

white chocolate

dark chocolate

Wax paper

Piece of aluminum foil

Plastic knife

2X4 piece of wood

Plastic cup

Pot holders

Goggles

Apron

Directions:

1. Put on apron and gloves.
2. Cover your lab desk with a piece of wax paper.
3. Collect 4 small medicine cups containing the 4 different colored chocolate chips.
4. CAREFULLY use your plastic knife to shave down each chip into small pieces. One person can do one type of chip while another group member can work on another. Make sure not to mix your chips.
5. Take your piece of aluminum foil and place one color of chocolate chip on half of the sheet and fold the other half over the chips.
6. Using your mug press the shavings into a flat patty.
7. Take your aluminum foil and put it on the floor and place your large piece of wood on top for about 2-3 minutes. Stand still so not to rip the aluminum foil and your chips leak out.
8. Place your foil back on your lab desk and carefully open it.

Answer the following questions:

1. What happened to your chips?
2. What type of rock did you form after step number 6?
3. What did your piece of wood represent in this activity? What about the person standing on the piece of wood represent?

You will do steps 5 through 8 for each of the colored chips. After you have a layered patty of each color you will place them altogether in an aluminum tray.

1. Put on goggles if they already haven't been on!
2. Place your aluminum tray on the hot plate, be very careful! It is HOT!
3. Let your chip shavings melt, this may take a bit, so be patient!

Answer the following questions:

1. What has happened to the chips?
2. What does the hot plate represent?

After your chips have melted, turn off the hot plate and remove the tray to an area given to you by the teacher. Let your chip patty cool! Be careful not to mix any shavings while transporting them!

Answer the following questions:

1. What type of rock do the cooled chips simulate?
2. Draw a rock cycle diagram and replace the regular steps with those from your candy chip lab. Explain why this lab does not explain how the rock cycle really happens in nature.

Appendix C: Checklist for Rock Research Activity

Rock Research Scoring Rubric

Name(s): _____

Rock _____

Project Includes:

5 points each

Name of the rock _____

Shape(s) ____

Texture _____

Color(s) _____

Where it is found on Earth _____

What can be done/used with this rock _____

Neatness _____

Creativity _____

Extra 5 points if found something unique about the rock ____

Total ___

Appendix D: Directions for Making Rock Cycle Fudge

Get into groups of 3 or 4. Don't worry; there will be enough fudge for everyone in your group!

Get the following ingredients ready at your lab station! You will need:

1/3 cup silt (evaporated milk)

1 cup quartz crystals (sugar)

1 tbs. sediments (margarine)

1 cup limestone pieces (mini marshmallows)

1/4 cup sandstone pieces (pecans)

3/4 cup basalt pieces (chocolate chips)

1/2 tsp. (vanilla extract)

Add the evaporated milk, sugar, and margarine to a mixing bowl.

Stir until it has a smooth consistency.

In a separate bowl, put one cup of marshmallows, 1/4 cup of pecan pieces, 3/4 cup of semi-sweet chocolate chips, and 1/2 teaspoon of vanilla extract.

Take the evaporated milk, sugar, and margarine mixture and give it to the teacher so they can put it in the microwave for 45 seconds on high.

Take it out and stir it smooth and repeat this until it has been heated for 45 seconds three times. (Make sure, someone in your group keeps track!)

After the third heating, pour in the marshmallows, chocolate chips, pecan, and vanilla extract and stir.

Everything should melt to a smooth consistency. If by chance it is not thick enough, microwave it for another 15-20 seconds.

Pour the liquid fudge onto a piece of wax paper on a shallow aluminum pan. Refrigerate and enjoy later. Usually works best if you let it refrigerate overnight, and then eat it the next day!

Appendix E: Recipe for Sedimentary Rocks

This recipe will make enough "sedimentary rocks" for a class of about 20.

1/2 cup butter or margarine

4 cups puffed rice cereal

6 cups mini marshmallows

(You can also use chocolate chips, or different colored marshmallows for different "sediments"!)

In a large saucepan, melt butter or margarine on low heat. Add mini marshmallows, cook and stir until marshmallows are melted, remove from heat. Add puffed rice cereal and stir until well coated! Pour or scoop mixture into a lightly greased pan or onto wax paper. Let sit for 10 minutes and then cut into your sedimentary rock squares.

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4. Wolke, Robert. What Einstein Told His Cook. W.W. Norton & Co. 2002.
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7. Carlson, Diane H., and Plummer, Charles C. Physical Geology: Earth Revealed. McGraw Hill. 2008.
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Recommended Websites

1. http://eziniearticles.com/?Rocks-And-Rock-Cycle&id=848755

Overview of each type of Rock and how the Rock Cycle works

2. http://www.classzone.com/books/earth_science/terc/content/investigations/es0602/es0602page02.cfm

Detailed Interactive Rock Cycle Animation

3. http://www.minsocam.org/MSA/K12/K_12.html

Mineralogy 4 Kids website that helps students learn about rocks and minerals

4. www.freyscientific.com

Great site to order on-line or order a catalog to received boxed rock sets for the classroom

5. http://www.windows.ucar.edu/tour/link=/earth/geology/rocks_intro.html&edu=mid

Describes the rock cycle and each of the types of rocks