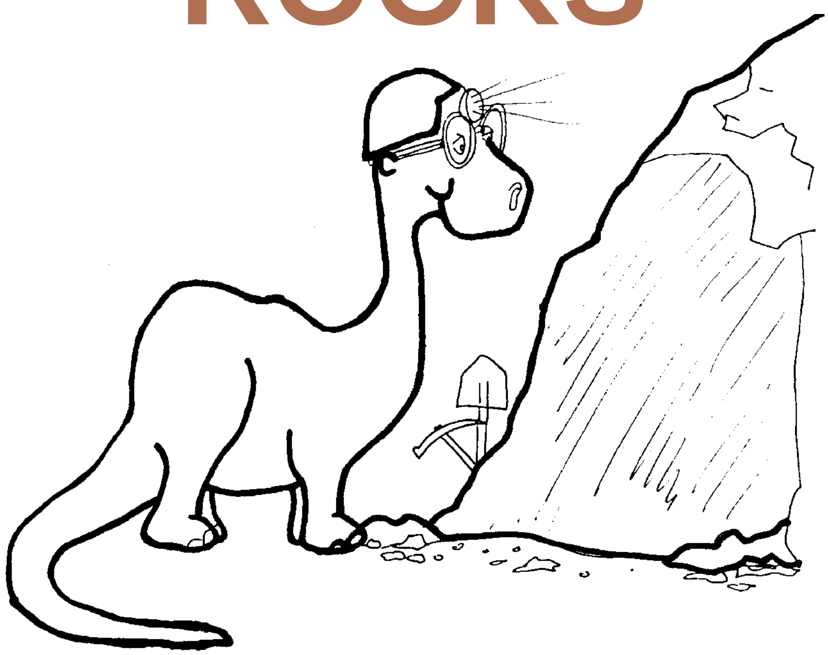
Rock Cycle

Understanding the Earth's Crust

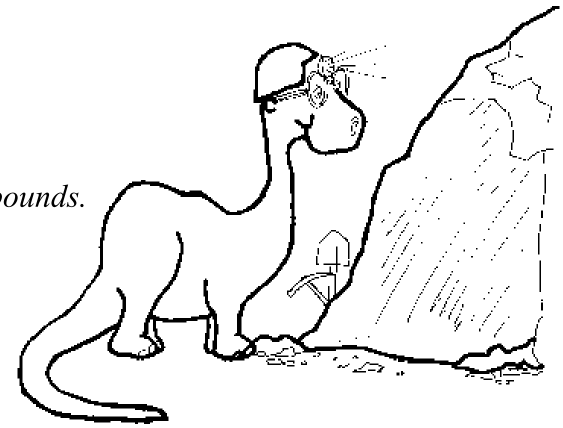
SIXTH GRADE

ROCKS



2 WEEKS
LESSON PLANS AND
ACTIVITIES

ROCK CYCLE
OVERVIEW OF SIXTH GRADE



CHEMISTRY

WEEK 1.
PRE: *Comparing different solutions.*
LAB: *Exploring how elements can be released from compounds.*
POST: *Analyzing the periodic table.*

MINERALS

WEEK 2.
PRE: *Exploring the composition of minerals.*
LAB: *Exploring the varieties of quartz.*
POST: *Exploring minerals made from silicon and oxygen.*

WEEK 3.
PRE: *Determining specific gravity.*
LAB: *Predicting the use of minerals.*
POST: *Comparing an ore with a mineral.*

ROCKS

WEEK 4.
PRE: *Discovering how rocks are formed by plate tectonics.*
LAB: *Distinguishing where rocks are located within the rock cycle.*
POST: *Writing a creative essay on rocks.*

WEEK 5.
PRE: *Discussing decorative uses of rocks.*
LAB: *Distinguishing between adhesives and cements.*
POST: *Comparing mined resources in the United States.*

PAST LIFE

WEEK 6.
PRE: *Exploring the importance of fossils.*
LAB: *Interpreting cores to understand stratigraphy.*
POST: *Discovering how paleontologists document evolution.*

ROCK CYCLE - ROCKS (6A)

PRE LAB

> Students use a worksheet to determine the environments where rocks are formed.

OBJECTIVES:

1. Discovering how rocks are formed through plate tectonics.
2. Comparing the formation of rocks.

Monument Valley, Arizona

VOCABULARY:

igneous
metamorphic
plate tectonics
rock cycle
sedimentary

MATERIALS:

none

BACKGROUND:

Minerals make up rocks. Rocks formed in igneous, metamorphic, and sedimentary environments. The minerals found within each rock help to identify and name the rock, but the rock textures, such grain size, are also used in naming and identification.

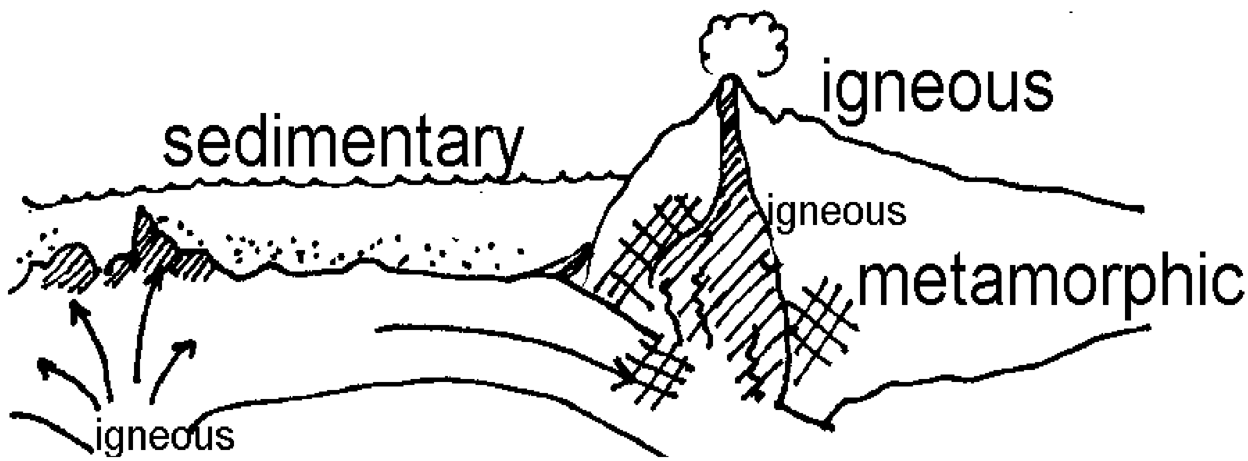
Igneous rocks are formed when rocks are melted and then cool. Magma can cool slowly inside the crust and upper mantle of the Earth, forming rocks like granite. Granite has large minerals that can be seen with the naked eye. These are called plutonic rocks. Quick cooling magmas are generally erupted onto the Earth's surface, called volcanic rocks. Igneous rocks are found where plates diverge, as lava rises and fills the gap between the plates. Igneous rocks also form where plates converge. The subducting plate melts as it sinks into the crust of the Earth, and the melt rises into the overriding plate forming volcanoes.

Metamorphic rocks are formed mainly in the lithosphere, wherever there is high pressure and high temperature. If the pressure and temperature are too high, metamorphic rock will melt and become magma. Metamorphic rocks are most abundant at convergent plate boundaries, but can occur in other areas where there are increased pressures and/or temperatures.

Sedimentary rocks form only on the surface of the Earth. Sedimentary rocks form in two main ways: (1) from clastic material (pieces of other rocks or fragments of skeletons) become cemented together, and (2) by chemical mechanisms including precipitation and evaporation. There are many environments associated with sedimentary rock formation, including oceans, lakes, deserts, rivers, beaches, and glaciers. They may form at all types of plate boundaries, but the thickest sedimentary rock accumulations occur at convergent plate boundaries. Fossils are associated with sedimentary rocks.

PROCEDURE:

1. Review rocks and rock forming environments. Use the illustration in the electronic presentation or draw the following diagram on the board and have the students predict where each type of rock formed.



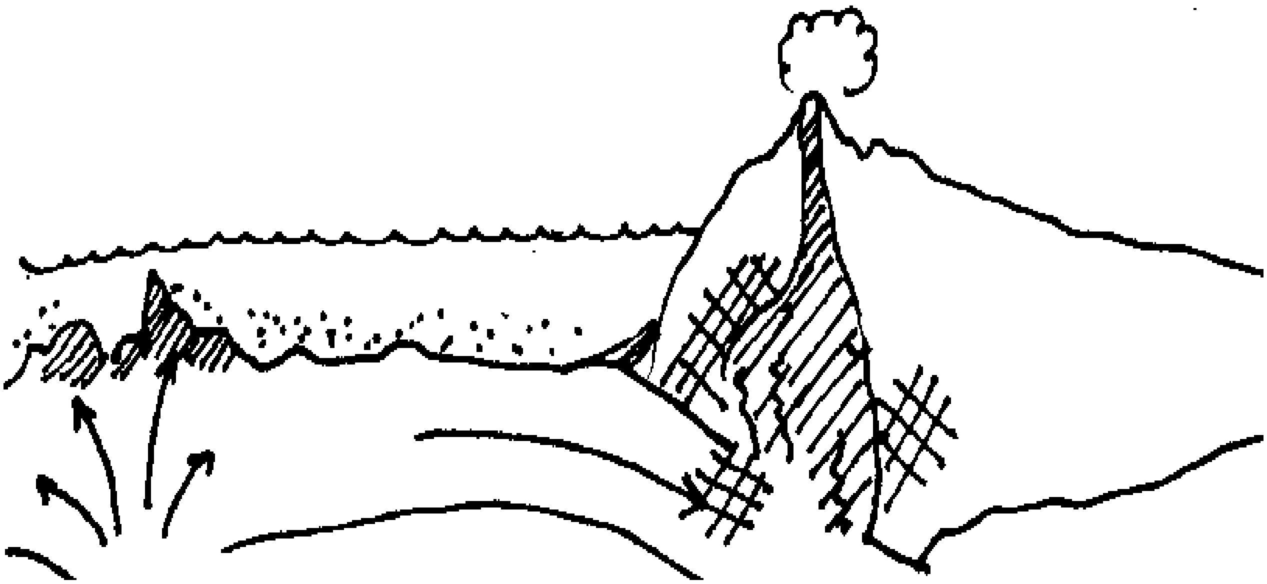
2. Remind the students that without the Plate Tectonic Cycle there would not be a rock cycle. Explain that the diagram only illustrates where the rocks formed, not where the rocks may be located now. As the plates move, they transport rocks away from where they formed.

3. Have students complete the worksheet.

ROCK CYCLE - ROCKS (6A) PRE LAB

CAN YOU LOCATE WHERE ROCKS ARE FORMED?

Use red to designate IGNEOUS ROCKS, blue for SEDIMENTARY ROCKS, and green for METAMORPHIC ROCKS.



1. Igneous rocks are formed:

____
____
____
____

2. Sedimentary rocks are formed:

____
____
____
____

3. Metamorphic rocks are formed:

____
____
____
____

ROCK CYCLE - ROCKS (6A)

LAB

> Students discover where rocks are made in the Rock Cycle.

OBJECTIVES:

1. Exploring the complexity of the Rock Cycle.
2. Distinguishing where different rock types are located within the Rock Cycle.

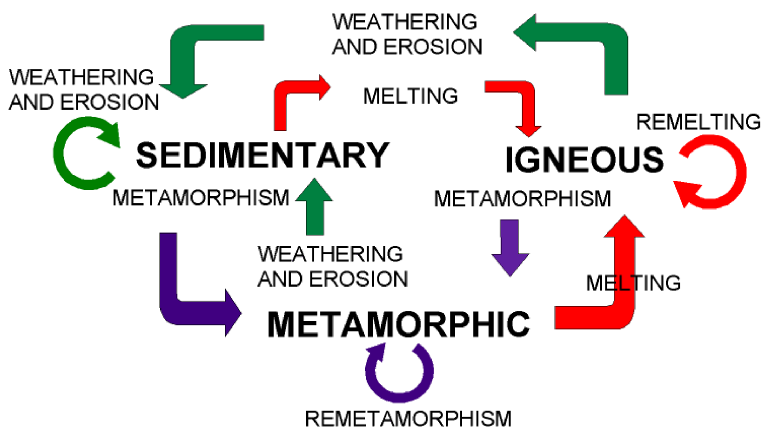
VOCABULARY:

erosion
melt
pressure

MATERIALS:

Rock Cycle - Rocks (6A)

BACKGROUND:



Rock Cycle

In many books, the Rock Cycle is oversimplified. Statements like "igneous rocks can become sedimentary and metamorphic;" " sedimentary rocks can become igneous and metamorphic;" or "metamorphic can become sedimentary and igneous" are common.

The Rock cycle is much more complicated. This is illustrated on the diagram above. The large counterclockwise arrows show the general trend of the Rock Cycle. First, igneous rock forms from magma. This rock is then uplifted, weathered, and eroded on the Earth's surface, forming sedimentary rock. The sedimentary rock is eventually buried within the crust of the Earth, where pressure and temperature finally change it into metamorphic rock. Eventually, some metamorphic rock may melt, beginning the cycle again.

However, the smaller arrow indicate other paths of rock formation. Essentially, any rock type can be melted, weathered, or metamorphosed to make any other rock type. Moreover, a rock can be remade into the same type of rock, i.e., a metamorphic rock can be remetamorphosed. Rock formation is dynamic and very complicated.

The Rock Cycle is tightly interwoven with the Plate Tectonic Cycle, in that most rocks form at plate boundaries. In general, igneous rocks and metamorphic rocks form most abundantly at divergent and convergent plate boundaries. Sedimentary rocks can form anywhere on the Earth's surface, but the thickest accumulations are associated with convergent plate boundaries, where volcanoes and mountain ranges form. Sedimentary rocks also cover most of the ocean floor.

PROCEDURE:

1. Go over the Rock Cycle diagram on the student's worksheet. Fill in the processes like "melt," "erosion," or any other word from the Rock Cycle diagram.

2. Set up examination specimens of each of the rocks listed below. Write the list of rock types and symbols (below) on the board. Explain the origin and environment of formation of each rock. Be sure to tell the students that these are just some of the places where these rock types can form. Tell the students to locate where each type of rock would form on the plate tectonic diagram. The rock cycle and plate tectonic diagrams above show the answers. There may be multiple answers for each rock type.

mudstone (M) = sedimentary rock; fine grained, formed in oceans, lakes, deltas
conglomerate (C) = sedimentary rock; course grained, formed in rivers
sandstone (SS) = sedimentary rock; medium grained, formed in oceans, lakes, rivers
marble (M) = metamorphic rock; from limestone, formed under increased pressure and temperature
serpentinite (Ser) = metamorphic rock; state rock, high pressure, low temperature
schist (Sc) = metamorphic rock; shiny surface, temperature and pressure
gneiss (Gn) = metamorphic rock; banded, pressure and temperature
pumice (P) = igneous rock; light in weight, volcanic eruption
granite (G) = igneous rock; large minerals. magma chamber
obsidian (O) = igneous rock; cooled quickly from lava from volcanoes
basalt (B) = igneous rock; small minerals, volcanoes

3. Review the answers with the whole class. Emphasize that the diagram the students have completed shows just some of the possible range of rock-forming environments.

ROCK CYCLE - ROCKS (6A) LAB

PROBLEM: How are rocks formed on the crust of the Earth?
PREDICTION:____
PROCEDURE: The rock cycle describes the processes by which rocks become other types of rocks by melting. erosion, and changes in temperature, and pressure in or on the Earth. Look at the rocks at the different stations around the room. Try to place the rocks in the correct positions in the two diagrams below: the rock cycle and the plate tectonic cycle. Use the symbols for each rock type on each diagram.

Rocks on display: pumice **(P)**, sandstone **(SS)**, conglomerate **(C)**, granite **(G)**, serpentinite **(Ser)**, marble **(M),** mudstone with shells **(MS)**, sand **(S),** obsidian **(O)**, basalt **(B)**, gneiss **(GN)**, schist **(SC)**

ROCK CYCLE

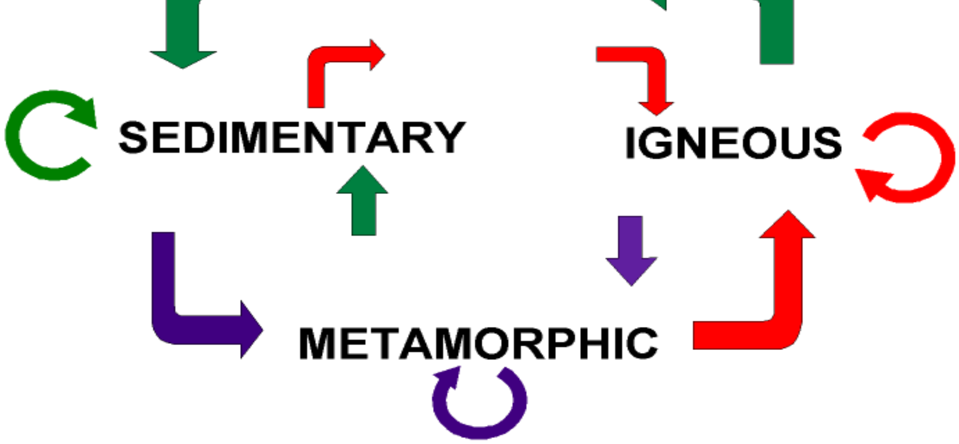
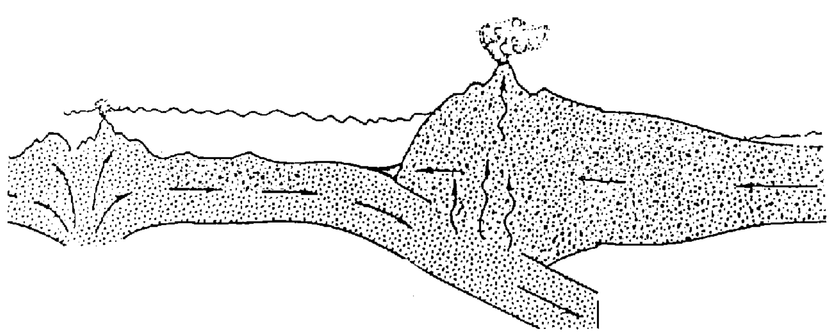


PLATE TECTONIC CYCLE



CONCLUSION: How are the plate tectonic and rock cycles related?
____

ROCK CYCLE - ROCKS (6A)

POST LAB

Students use the internet to research a storyline.

OBJECTIVES:

1. Writing a creative essay on rocks.
2. Developing stories that revolve around rock facts.

VOCABULARY:

erosion
melt
pressure

MATERIALS:

Internet

BACKGROUND:

Many writers have not only a command of words, but have a sense of how the words are used in different fields. For example, Hemingway and Steinbeck were both masters of using scientific facts to help weave a story. Learning about science is very applicable to many fields that involve writing. Journalists, television reporters, newscasters, and people who listen or watch news need to weave scientific information into their stories and understanding. Ignorance of basic scientific facts may make their stories inaccurate.

PROCEDURE:

1. This activity is not serious reporting. The students will practice weaving scientific facts into a story. This is a creative essay exercise on MILDRED METAMORPHIC. Tell the students the following story:

THE CASE OF THE MIXED UP ROCK

Metamorphic rocks have changed. Why? They were once igneous or sedimentary rocks, but have changed under heat and pressure. Sometimes metamorphic rocks feel "different," but they do not know why. Mildred Metamorphic is visiting her rock doctor to cope with her past life. Write a story about her "mixed up" emotions when she finds out that she might have had more than one life.

Have students decide whether Mildred was an igneous or a sedimentary rock in her first life.

2. Guide the students so that they include some of the following information:

FIRST LIFE

IGNEOUS - life was hot, but cooled down later inside the Earth; or had to escape to the surface to cool down quickly.

SEDIMENTARY - life was wet, but dried up; life was full of movement and broken pieces; might involve fossils

SECOND LIFE

METAMORPHIC - life changed; became a punk rocker; pressure was great; life got a little hot, but is stable now

3. Discuss with the students some of the facts they need to weave into their stories, and then let them discuss other possibilities. Other class members can give ideas that might spark an interest in other students. You may want to have your students conduct an internet search for information about the different types of rocks to get storyline ideas. Use different search engines to look up "rock."

4. You may also want students to illustrate their essay. You might want to have students join forces to create an essay. One can draw a "rock" and the other one writes the story.

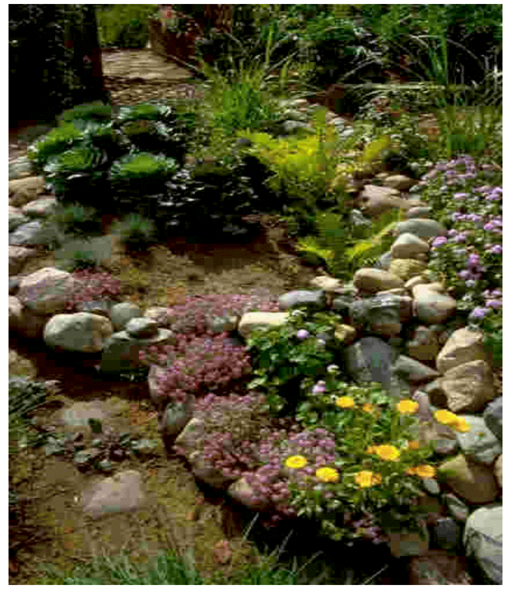
ROCK CYCLE - ROCKS (6B)

PRE LAB

Students design a rock garden.

OBJECTIVES:

1. Exploring decorative uses of rocks.
2. Designing a landscape for urban living.



a rock garden

VOCABULARY:

concrete
decorative
landscape

MATERIALS:

examples of decorative rocks
magazines that show landscaping

BACKGROUND:

Rocks are not only interesting geologically, but they are also an important source of revenue. Ask your students why different rocks are important. Some of the students may answer that rare and important minerals such as gold and silver can be found in rocks. Many students, however, may not realize that rocks are important to the basic structure of a city.

For example, landscaping and gardening use many different types of rocks. However, many stores that sell rocks often call them by names that are different from what a geologist would use.

PROCEDURE:

1. Have your students imagine a world without rocks. There would be no bricks, concrete buildings, roads, and many other familiar items. Cemeteries would be without gravestones. Bathrooms would be without marble. Explain to the students that mineral resources such as copper, silver, oil, and iron must be mined in order to make the materials that we use at home, play, or work.

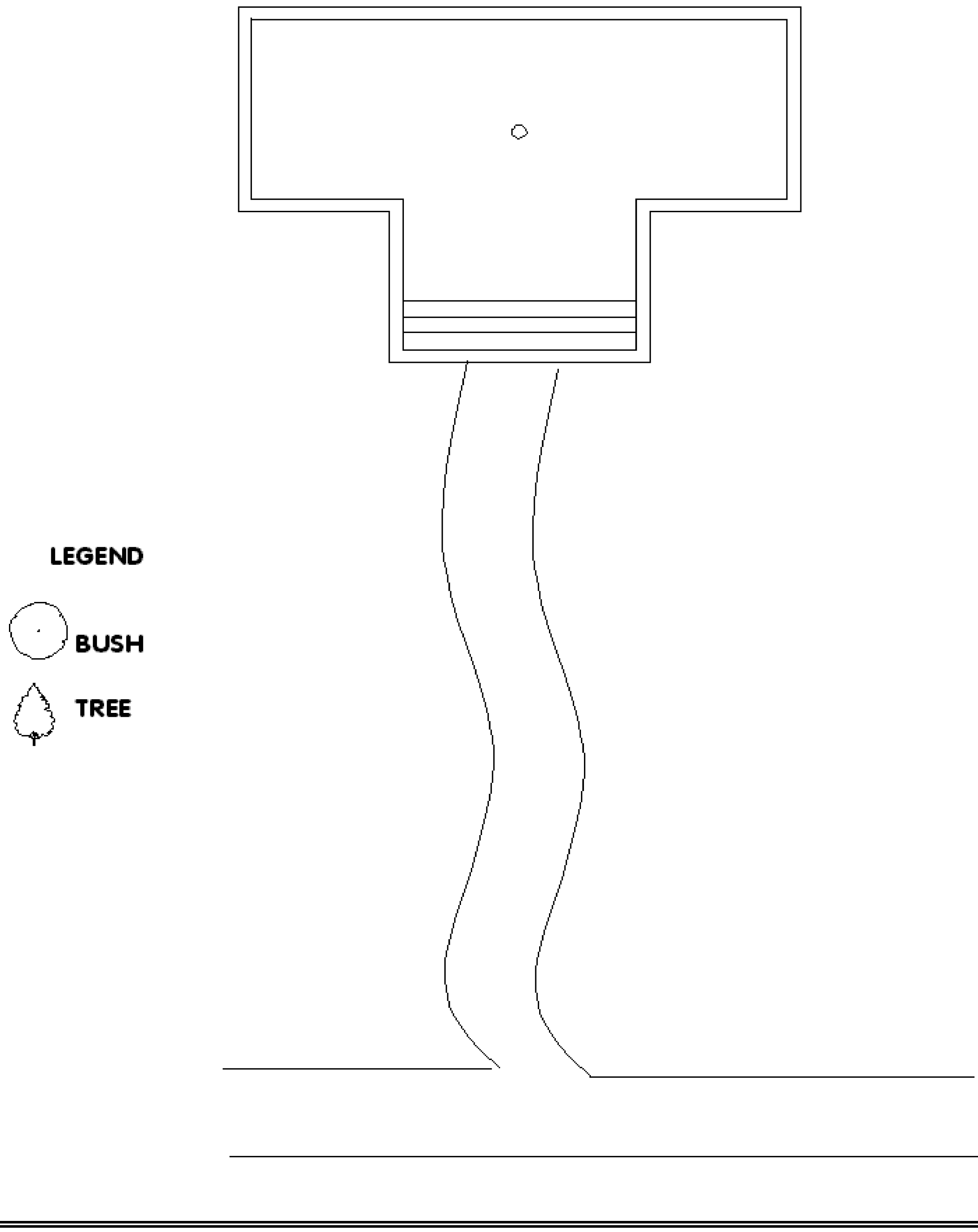
2. Write the legend below on the board. You may want to add more materials that are appropriate to your area. Decide as a group what the symbol should be for each material. If you have examples of these rocks, show them to the class.

GEOLOGIC NAME	COMMERCIAL NAME	SYMBOL
PUMICE	FEATHER ROCK	
SCORIA	RED LAVA ROCK	
BASALT	BLACK LAVA	
DOLOMITE	DOLOMITE	
GRANITE	GRANITE	
SHRUBS	SHRUBS	
RIVER PEBBLES	BLACK AND WHITE	

3. Have the students design a "rock" garden. Use the worksheet to help guide students. You may want to use a layout of the your school. You may want to make this a weekend homework assignment so the students can go out in the neighborhood to investigate if anyone has landscaped their home with rocks. Students can also go to a local nursery or landscaping store and discover all the rocks they sell.

ROCK CYCLE - ROCKS (6B) PRE LAB

Design a landscape that would make this building look exciting. Use your imagination. Think of color, how people would walk from one door to another, and artistically pleasing situations. Use shrubs, trees, or flowers to help design the perfect place.



ROCK CYCLE - ROCKS (6B)

LAB

Students make concrete and adhesives.

OBJECTIVES:

1. Exploring how to make cement.
2. Distinguishing between adhesives and cements.

VOCABULARY:

adhesion
cement
concrete
hydration

MATERIALS:

plaster of Paris
flour
concrete mix
wax paper
styrofoam tray
water
mixing bowls
spoon
Swift-GH microscope

Pouring concrete

BACKGROUND:

The name "cement" generally refers to a chemical "binder" or adhesive. Adhesives bond materials as they dry out of an organic solvent or by a polymeric chemical reaction. The chemical and physical processes of adhesion, and therefore of cement, are not completely understood.

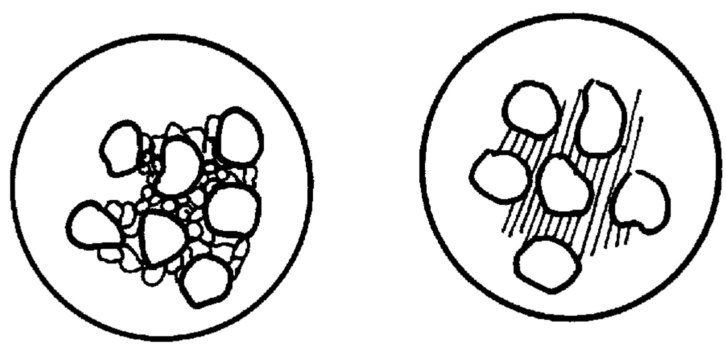
In contrast, in geology cementation refers to the hardening and welding together of sedimentary fragments such as sand by the precipitation of minerals in the spaces between the fragments. The particles are not glued together, but held in place by the precipitated minerals. The most common mineral is quartz, but calcite, other carbonates, iron oxides, and clay minerals also form cement.

The concrete used in the building industry forms the same way as geological cements. Concrete is made of rocks, sand, and cement. It is one of the most inexpensive, widely used, and durable building materials available. Man-made geological cements have been used for a long time. Cement dates back more than 5,000 years to the construction of the Great Pyramids in Egypt. The cement used by the Egyptians was a "calcined" gypsum (dried to remove water), which today is commonly known as plaster of Paris. The Mycenaeans and Phoenicians realized that the calcined gypsum cement was not very strong, and found that a lime-based ("lime" = CaO) cement was much stronger and durable. This lime-based cement is very similar to the cement in modern concrete. The most impressive use of concrete in the ancient world was by the Romans, who improved the strength of the cement and used it to construct most of their famous monuments and buildings.

In 1824, Joseph Aspdin developed a process for measuring out limestone and clay, converting them to powder, heating the powder, and then grinding them into another powder finer than flour. He found that if he mixed this cement with water and aggregate, i.e., a mixture of sand and rock, the resulting material had nearly twice the strength of many natural mineral cements. This cement was named "Portland cement" because the limestone was mined on the English island of Portland.

Modern concrete is mixed in proportions that are expressed in three numbers. For example, 1:2:3 means one part Portland cement, two parts of clean sand, and three parts gravel or pebbles (often called aggregate).

A common misconception about concrete is that it hardens or dries through evaporation. Actually, concrete hardens because of chemical reactions that take place when water is added to the dry concrete mixture. These produce new chemical compounds that lock in water between their molecules. This process, known as hydration, forms crystals that bind the concrete mixture together. These new crystals fill in the spaces between the aggregate, cement, and sand. The speed of hydration depends on the temperature, amount of water, and the fineness of the cement.



The process of hydration takes curing time. The concrete mixture can lose up to half of its strength if it is not kept wet during the first 7 days after pouring. The full hydration time for common cement is about 28 days. The longer the curing time, the more hydration takes, place and the stronger the concrete becomes. Concrete thus becomes stronger as it grows older. In this lab, the students learn the difference between cementation and adhesion. This will emphasize that cementation is the process used in creating sedimentary rocks.

PROCEDURE:

1. Before lab, prepare laboratory materials for each student group.

2. Have the students make adhesive and cement mixtures, following the worksheet

instructions. The students will see that the plaster of Paris and concrete form solids by hydration. The flour and water paste is an adhesive formed by evaporation of the water.

3. Tell the students to measure the mixtures accurately or the end product may not solidify properly. If the students add too much or too little water, make sure that they record their observations. You can then discuss the "failures" and "successes" and their causes.

4. The concrete mix might take a day to completely dry. Have students observe it over time. Looking at the mixture with a microscope will help.

ROCK CYCLE - ROCKS (6B) LAB

PROBLEM: What is the difference between cementation and adhesion?

PREDICTION: ____

PROCEDURE: Materials: plaster of Paris, spoon, water, mix bowl, concrete mix

Mix the following substances as listed on the graph below. After you mix each mixture, please clean your spoon and mixing bowl in a small tub of water. DO NOT CLEAN IN THE SINK. You will clog the drain because the cement will harden in water. Record your observations. You will need to finish your lab sheet after the concrete dries.

SPOONFULS	**SUBSTANCE**	**WATER** (spoonfuls)	**OBSERVATIONS**
1	PLASTER OF PARIS	1	
1	PLASTER OF PARIS	½	
1	PLASTER OF PARIS	3/4	
3	CONCRETE MIX	3	
1	FLOUR	½	

CONCLUSION: Which of the mixtures of plaster of Paris worked the best?
____

Summarize the difference between adhesives and cements.

____
____

ROCK CYCLE - ROCKS (6B)

POST LAB

Students research the geologic resources of the United States.

OBJECTIVES:

1. Exploring a state's geologic resources.
2. Comparing mined resources of the United States.

VOCABULARY:

economic
mining
petroleum
resource

Copper mines in Arizona.

MATERIALS:

Internet

BACKGROUND:

A country is as rich as its resources. It is a well known statement, that states "everything is either grown or mined." Agriculture and mining industry are important to the economy of every country. Both industries sustains the overall industry and provides products that can be exported for wealth. Mining includes not only minerals like gold, silver, or copper but petroleum, coal, and even aggregate (gravel, sand).

In the United States some states have more resources than others. For instance there are many states that mine coal, but some are noted for specific parts of the coal mining industry. Wyoming is the state with the most coal production. West Virginia is the state with the most underground coal production. Kentucky is the state with the most coal mines. Pennsylvania is the state with the most anthracite (hard) coal production. Alabama is the state with highest average price for coal. Virginia is the state with the earliest commercial production.

Coal mining in Texas

Specific states also have an overall mining industry. For example, California is rich in natural resources. The mining industry contributes several billion dollars per year to the state's economy. In addition, California is the third largest producer of gas and oil in the country. The most important mining industry in California is the cement and sand/gravel industry, which generates over one billion dollars of revenue per year. Many countries and other states do not have the rich sand and gravel deposits that California does, so the state exports these materials as far away as Japan and Australia. Another large mining industry in California are boron-bearing mineral mines in the southern part of the state. Other important resources include gold, tungsten, gypsum, pumice, silver, quartz, diatomite, lime, and talc.

PROCEDURE:

1. Use this summary to emphasize the importance of the mining industry. This is very rarely discussed. Ask students what they think is the most important mining resource that California has. They will probably answer gold, and will be surprised that it is sand and gravel.

2. You may want the students to compare and contrast the mining products of the various states.

ALABAMA coal, petroleum, natural gas, stone, iron ore, limestone
ALASKA petroleum, natural gas, sand and gravel, stone, gold
ARIZONA copper, molybdenum, coal, sand and gravel
ARKANSAS petroleum, natural gas, sand and gravel, diamonds
CALIFORNIA petroleum, sand and gravel, boron
COLORADO petroleum, natural gas, coal, molybdenum
CONNECTICUT stone, sand and gravel
DELAWARE sand and gravel, magnesium products
FLORIDA phosphate rock, petroleum, stone
GEORGIA clays, stone, sand and gravel
HAWAII stone, sand and gravel
IDAHO silver, phosphate rock, lead, zinc, gold
ILLINOIS coal, petroleum, stone
INDIANA coal, stone
IOWA stone, sand and gravel
KANSAS stone, sand and gravel
KENTUCKY coal, stone, petroleum, sand and gravel
LOUISIANA natural gas, petroleum, sulfur, salt, sand and gravel
MAINE sand and gravel, garnet
MARYLAND coal, stone, sand and gravel, clays
MASSACHUSETTS stone, sand and gravel, clays
MICHIGAN copper, iron ore, petroleum, natural gas, sand and gravel
MINNESOTA iron ore, sand and gravel, stone
MISSISSIPPI petroleum, natural gas, sand and gravel, clays

MISSOURI lead, stone
MONTANA petroleum, coal, copper, natural gas, silver
NEBRASKA petroleum, sand and gravel
NEVADA gold, mercury, magnesite, barite, silver, sand and gravel
NEW HAMPSHIRE sand and gravel, stone
NEW JERSEY stone, sand and gravel, zinc
NEW MEXICO natural gas, petroleum, uranium, copper, silver, gold
NEW YORK stone, sand and gravel, salt
NORTH CAROLINA stone, phosphate rock, sand and gravel
NORTH DAKOTA petroleum, coal, natural gas, sand and gravel
OHIO coal, petroleum, natural gas, stone, lime
OKLAHOMA petroleum, natural gas, coal, stone
OREGON sand and gravel, stone, nickel, pumice
PENNSYLVANIA coal, stone
RHODE ISLAND sand and gravel, stone
SOUTH CAROLINA stone, clays
SOUTH DAKOTA gold, stone
TENNESSEE coal, stone, zinc
TEXAS petroleum, natural gas
UTAH petroleum, coal, copper, uranium, gold
VERMONT stone, asbestos, talc
VIRGINIA coal, stone, lime, sand and gravel
WASHINGTON coal, sand and gravel, stone, gold
WEST VIRGINIA coal, natural gas, petroleum, stone, sand and gravel
WISCONSIN sand and gravel, stone
WYOMING petroleum, coal, uranium, natural gas, clays

3. As a homework assignment, have the students research the local mining industry, or have them compare the resources the United States has compared to other countries. The students will be surprised at how "rich" the United States is. The internet is a great way to search for information on each of the states. A good place to start is the United States Geological Survey site, at http://minerals.usgs.gov/minerals/ and the Office of Surface Mining, at http://www.osmre.gov/osm.htm.