ROCKS AND GEOLOGY

Grades 4-5 NMA Activities, Nevada State Science Education Standard Correlation. Referencing Science Standards 2005 http://www.doe.nv.gov/standards/standscience.html												
	N.5. A.1	N.5. A.2	N.5. A.3	N.5. B.1	N.5. B.3	P.5. A.1	P.5. A.2	P.5. A.3	E.5. C.1	E.5. C.2	E.5. C.3	E.5. C.4
Rocks and Geology General Information		X		X		X	X	X	X	X	X	X
Rocks and Geology Exercise	X	X	X	X	X							X

ROCKS AND GEOLOGY
GENERAL INFORMATION

Rocks are the foundation of the earth. Rock provides the firmament beneath our oceans and seas and it covers 28% of the earth's surface that we all call home.

When we travel any distance in any given direction, it is impossible not to see the tremendous variety in color, texture, and shape of the rocks around us.

Rocks are made up of 1 or more minerals. Limestone, for example, is composed primarily of the mineral calcite. Granite can be made up of the minerals quartz, orthoclase and plagioclase feldspars, hornblende, and biotite mica. Rocks are classified by their mineral composition as well as the environment in which they were formed. There are three major classifications of rocks: **igneous, sedimentary and metamorphic**.

A question? Which kind of rock came first? Think about it.....

The following sections describe the conditions and processes that create the landscape we admire and live on here on "terra firma."

IGNEOUS ROCKS

The millions of tons of molten rock that poured out of the volcano Paracutin or from the Mount St. Helens volcano illustrate one of the methods of formation of igneous rock.

Igneous (from fire) rocks are formed when bodies of hot liquid rock called **magma** located beneath the earth's crust, find their way upward through the crust by way of fissures of faults. If the magma reaches the earth's surface, it forms **extrusive igneous** rocks. If the magma cools before it reaches the surface, it forms bodies of rock called **intrusive igneous rocks or plutonic rocks**.

Extrusive igneous rocks are formed from volcanic activity. Most varieties are fine-grained because they cooled very rapidly upon exposure to the surface of the earth. **PUMICE** (Sample 1) is an example of an extrusive igneous rock. It is a light colored rock formed during violent volcanic episodes such as the Mount St. Helens eruptions of May 1980 or the formation of Mammoth Mountain in the Long Valley Caldera in California. Pumice can be compared to foam on a boiling kettle. It is composed mainly of volcanic glass (silica) and is full of air or gas bubbles (vesicular, in geologist lingo). Pumice is perhaps the only rock known in nature that floats on water. It is expelled rapidly by the volcanic eruption, cooling and hardening almost immediately. Other rocks formed from this type of volcanic eruption include obsidian and rhyolite.

Obsidian, sometimes called volcanic glass, results from the rapid cooling of magma. It is a dark, glassy rock that can transmit light when thin chips are found. A mass of this rock makes up Obsidian Cliff in Yellowstone National Park and it also occurs at Glass Mountain in Mono County, California, northeast, of Mammoth Mountain.

BASALT (Sample 2) is a dark-colored, heavy rock formed from thick, syrupy **lava flows**. The eruptions that create basalts are less violent than those that create rhyolite but can be equally destructive. Eruptions from the numerous Hawaiian volcanoes form extensive basalt lava flows. The Columbia Plateau in the northwestern United States, covered with 150,000 square miles of hardened basaltic lava, in places one mile thick, is one of the earth's greatest volcanic constructions.

Intrusive igneous rocks form beneath the surface of the earth where slow-moving magma bodies cool before they reach the surface. Intrusive magma forces its way into or between masses of older rock and cools very slowly. As a result of this slow cooling process, intrusive igneous rocks are coarse-grained (the mineral crystals are readily visible to the naked eye or with the assistance of a hand-lens or magnifying glass). These rocks are later exposed at the surface through the processes of uplift and erosion. Granite and diorite are two of the many varieties of intrusive igneous rocks.

GRANITE (Sample 3) is easily recognized because of its speckled appearance. Close examination reveals that the speckling is caused by the different minerals granite is composed of. The light gray glassy mineral is quartz; the milky white or gray mineral is feldspar--in some samples the feldspar can be red or green (those special-colored granites are prized for building stone and for monuments and tombstone materials); the black shiny minerals could be platy mica or blocky hornblende. Granites are formed from magmas that are rich in silica and potassium; relatively poor in calcium, magnesium, and iron. Masses of granite can be found in the Rocky Mountains, the Adirondacks, the Black Hills of South Dakota, the White Mountains of New Hampshire, the Newberry Mountains in southern Nevada and many locations scattered throughout Nevada.

DIORITE (Sample 4) is also a speckled intrusive igneous rock but is noticeably darker in color than granite. The rock is coarse to medium grained with interlocking grains of dark gray plagioclase feldspar, greenish-black hornblende, and less than 10% quartz. Diorite is formed from magmas that are rich in iron, calcium, and magnesium; poor in silica and potassium. Large masses of diorite are found in intrusive igneous (plutonic) mountain ranges such as the Sierra Nevada, and the ranges of southern California and in many other locations world-wide.

The differences between extrusive igneous rocks and intrusive igneous rocks result from primarily from their mode of formation. Granite, pumice and rhyolite come from magmas of very similar composition; diorite and basalt come from magmas of very similar composition.

Igneous rocks were the first to appear during the earth-formation process.

SEDIMENTARY ROCKS

Sedimentary rocks are interesting because their methods of formation. These rocks can be built up under water by the deposition there of materials such as sand, clay, mud, pebbles, and gravel. These materials, called **sediments**, are brought to the waters of lakes and oceans by the streams or rivers that flow into them. Wind and moving glaciers of ice are also sediment transportation agents. Repeated freezing and thawing of water in fractures and pore spaces in rocks will cause them to break down over time. All of these processes are collectively known as **erosion**. Other sedimentary rocks are made from the remains of plants and animals such as algae, shells or ferns. Still others are derived from minerals such as salt or gypsum that were once dissolved in ocean or lake waters. As these sediments accumulate in layers or **beds**, the weight of the newest, youngest beds on top causes pressure on the older beds beneath forcing these older beds to stick together and to harden into rock. During this process, some natural cementing materials such as lime and quartz, found in ocean and lake waters, may help cement together coarser materials such as sand and gravel.

The kind of sedimentary rock produced depends on the kinds of materials deposited: Very fine grained muds or clays form **SHALE** (Sample 5). Cemented sands become **SANDSTONE** (Sample 6). Cemented pebbles or gravel form **CONGLOMERATE** (Sample 7). Clay and lime together form a rock called marl. Seashells provide the material for **LIMESTONE** (Sample 8). Decaying plant and animal remains from swamps and shallow lakes form the parent material for coal. Diatomite is a sedimentary rock composed of the silica-rich remains of algae, which are microscopic, single-celled plants that grow in lakes containing silica-laden water. Diatoms absorb silica from the water they live in and biologically secrete it to form their siliceous “frustules” or “tests” (shells) in a great variety of forms. There are approximately 50,000,000 diatoms in a cubic inch of diatomite.

Sedimentary rocks are very common. Many are easy to identify. Shale has a muddy smell when wet, just like the material it was formed from. Sandstone is obviously made of grains of sand (usually quartz). Sometimes the grains are loosely cemented and if two pieces of

sandstone are rubbed together, sand grains will be dislodged. Sandstones are often “well-sorted” which means that the sand grains are mostly all the same size or diameter. Conglomerate, on the other hand, is usually spoken of as “poorly-sorted” because the materials that make up the rock are of a variety of sizes ranging from clay-size to boulders. Limestone often has visible remains of animals, shells or plants called **fossils**. Sedimentary rocks are derived from previously existing rocks which are decomposed by one of the methods described in the first paragraph. Sedimentary rocks may be formed from igneous and metamorphic rocks (described later) or from older sedimentary rocks.

Most sedimentary rocks have a banded, "layer cake" appearance which is due to the difference in materials which were deposited, layer by layer, one on top of another. Each layer tells a unique story about a particular location during various periods in geologic history as the layers are preserved in a chronologic sequence which can be studied, interpreted and age dated by geologists. One of the most spectacular examples of sedimentary "layer cake" rock formation is found in the walls of the Grand Canyon.

METAMORPHIC ROCKS

In general, it may be said that when any bedrock is subjected to greatly increased pressures or very high temperatures, or both, it may be changed in its physical and chemical properties to become metamorphic rock. Metamorphic means "a change in form." The pressure increase may be the result of movement of the earth's crust which crumples and folds the bedrock. Increased pressure may also result from deep burial of sediments as younger sediment beds are deposited over the top of them. Increases in temperatures may result from friction created by movement or from nearby sources of hot magma. Fluids are often present during the heading process which may alter or re-melt and completely recrystallize the previously existing rocks. Metamorphism can effect igneous and sedimentary rocks, and even metamorphic rocks that were formed earlier in time. **SCHIST** (Sample 9) is a metamorphic rock derived from sedimentary or older metamorphic rocks that have been altered by heat and pressure from nearby intrusive igneous bodies. Schist is identified by its platy appearance due to the parallel orientation of sheets or grains of minerals called **mica**.
Some other examples of metamorphic rocks and the rocks from which they were derived are as follows:

Metamorphic Rock	Derived From
SLATE	Shale
QUARTZITE (Sample 10)	Sandstone and other quartz-rich rocks
GNEISS (Sample 11)	Granite and other rocks
MARBLE (Sample 12)	Limestone
ANTHRACITE COAL	Bituminous Coal

Notice that the sample of gneiss has a speckled appearance like granite but that the mineral grains are oriented in parallel bands and the bands are alternately light and dark. The banding is a direct result of pressure and heating (but not to the melting point) which actually

changes the structure of the rock. Where there has been movement, mineral grains will turn and flow in the direction of movement.

Notice how much more durable the quartzite is compared to the sandstone. Marble has been converted from limestone and the result is a crystalline rock that is much prized as a building stone and as a carving stone for statuary. Quartzite and marble can often look alike. The hardness test will help identify one from the other: Quartzite is made up of quartz (hardness 7) and marble is composed of calcite (hardness 3). An excellent example of marble is found at the Crestmore quarry just outside Riverside, California. Notable occurrences of metamorphic rocks are found along the length of the San Andreas Fault.

*** For more information on how rocks are classified, two handy guides include:
"CLASSIFICATION OF ROCKS", Quarterly of the Colorado School of Mines, Volume 50, Number 1, January 1955, by Russell B. Travis,

AGI Data Sheets for Geology in the Field, Laboratory and Office", published by the American Geological Institute, www.agiweb.org

ROCKS AND GEOLOGY EXERCISE

PURPOSE:

This exercise will help students to learn about the diversity of rocks, the various environments they were formed in, and to identify where various rock types are found in nature.

MATERIALS NEEDED:

ROCKS AND GEOLOGY GENERAL INFORMATION HANDOUT
GEOLOGIC CONDITIONS DRAWING
STICK-ON DOTS (any size from 1/4" to 3/4")
12 SAMPLE ROCK KIT WITH IDENTIFICATION KEY INSERT

INTRODUCTION:

Rocks come in every shape, color, texture, and form imaginable. This diversity is due to many things: 1) The minerals they are composed of; 2) the environment they were formed in; 3) and the forces of nature that have acted upon them, to name only a few. With this exercise, the students will learn about a variety of geologic environments and will be able to match each of these environments with one of the rock samples included in the "Rock Kit".

INSTRUCTIONS:

Have the students read the "Rocks and Geology General Information" handout. The rocks that are talked about are divided into three categories: IGNEOUS, SEDIMENTARY, AND METAMORPHIC. They should also have the geologic conditions drawing handy so that they can refer to it when reading about a particular environment.

Next, have the students open up the Rock Kit. The rock samples are arranged by category: SAMPLES 1 THROUGH 4 ARE IGNEOUS, SAMPLES 5 THROUGH 8 ARE SEDIMENTARY, AND SAMPLES 9 THROUGH 12 ARE METAMORPHIC. The name of each sample and its number are shown on the label insert for the kit. (Try to avoid mixing up the samples as some of them look alike. RECOMMENDATION: Paint a small spot on each sample using white model paint and ink the sample number on the paint spot.)

Give each student 12 stick-on dots. They can label each dot with a number from 1 to 12, or they can write in the name of each rock type (or abbreviate the names) from the rock kit on the dot.

Have the students stick a dot for each rock type where they think it would occur on the geologic conditions sheet. The “Rocks and Geology General Information” handout provides a number of clues which will be helpful:

IGNEOUS ROCKS

Sample 1 - Pumice - Very light-weight "foamy" extrusive igneous rock formed during an explosive volcanic event. Place dot next to the large smoking volcano.

Sample 2 - Basalt - Heavy, dark-colored extrusive igneous rock resulting from thick non-explosive lava flows. These rocks formed Hawaii, for example. Place dot next to one of the islands in the ocean.

Sample 3 - Granite - Light-colored intrusive igneous rock. It came from magma deep within the earth and cooled before it reached the surface. Place dot on or next to the volcano where "intrusive igneous rocks" are shown.

Sample 4 - Diorite - Dark-colored intrusive igneous rock. It has a higher iron content than the granite so it is darker in color and more dense than granite. It cooled within the earth and was exposed on the surface because of faulting, uplift, and erosion. Place dot on or near to the mountain on the right side of the drawing.

SEDIMENTARY ROCKS

Sample 5 - Shale - Formed by accumulation of mud. Place dot near edge of ocean.

Sample 6 - Sandstone - Formed by erosion of older rock and transported by water and wind. Place dot between volcano and mountain where the drawing shows "sedimentary rocks".

Sample 7 - Conglomerate - Made up of cemented pebbles, gravel, and sand. Place dot at the base of the intrusive igneous rock mountain where the sedimentary rocks make contact.

Sample 8 - Limestone - Formed from shells of ocean creatures. Place dot in the ocean where "sedimentary rocks" is shown on the drawing.

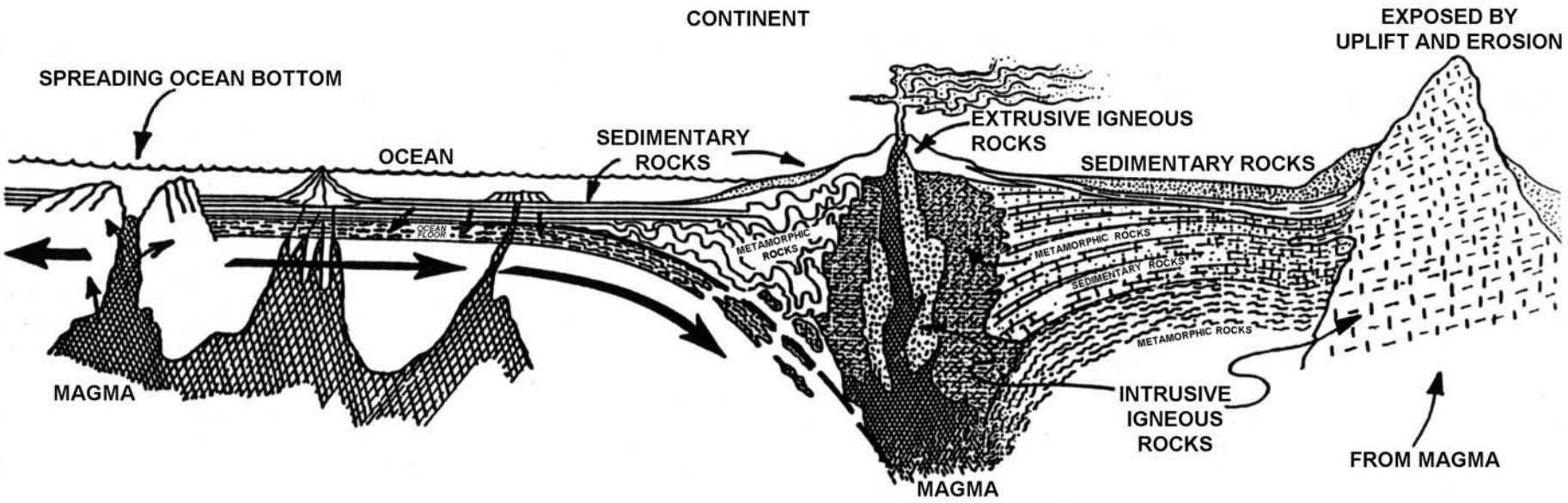
METAMORPHIC ROCKS

Sample 9 - Schist - This rock is formed as a result of heat and pressure associated with intrusive igneous rock bodies that affect surrounding sedimentary and/or metamorphic rocks. Place dot in the area of metamorphic rocks next to the intrusive igneous body on right side of the volcano.

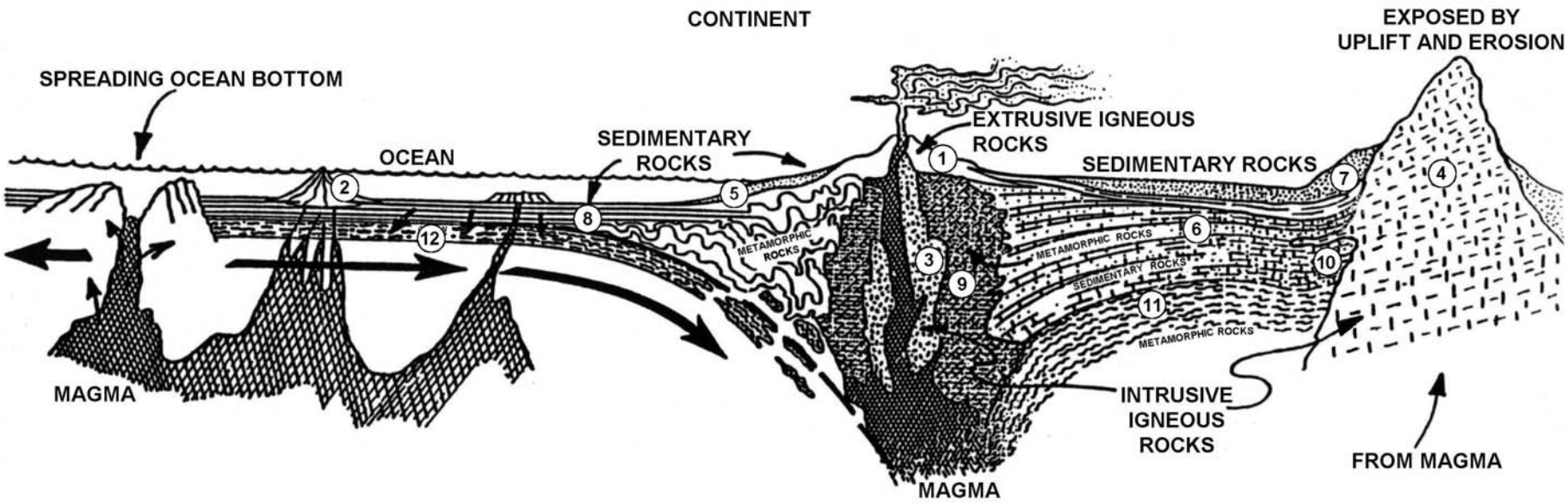
Sample 10 - Quartzite - This rock was formerly sandstone that has been changed by the effects of deep burial and heat. Place dot between the volcano and the mountain where "metamorphic rocks" is indicated.

Sample 11 - Gneiss (Pronounced "nice") - Formed from the effects of heat and extreme pressure on granite, diorite or other intrusive igneous rocks. Place dot near the base of the mountain where "metamorphic rocks" is shown.

Sample 12 - Marble - Marble is formed from limestone that has been physically changed by deep burial and the effects of high temperature. Place dot near the "ocean floor" on the drawing.



Geologic conditions at the margin of a continent according to the concept of spreading ocean bottoms. The ocean floor (left) is moving toward and beneath the continent (right) where its rocks are being metamorphased, melted, and welded to the continent.



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