

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, feldspar, hornblende, and biotite mica. Rocks are classified by their mineral composition as well as the environment in which they were formed.

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

Sedimentary Rocks

Sedimentary rocks are interesting because their methods of formation. These rocks can be built up under water by the depositing 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 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 1). Cemented sands become **SANDSTONE** (Sample 2). Cemented pebbles or gravel form

CONGLOMERATE (Sample 3). Clay and lime together form a rock called marl. Seashells provide the material for **LIMESTONE** (Sample 4). Decaying plant and animal remains from swamps and shallow lakes form the parent material for coal.

Sedimentary rocks are very common. Many are easy to identify. Sandstone is obviously made of grains of sand. Sometimes the grains are loosely joined and if two pieces are rubbed together, sand grains will be dislodged. Shale has a muddy smell when wet, just like the material it was formed from. 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.

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 or 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**.

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 5) is an example of an extrusive igneous rock. It is a light colored

rock formed during violent volcanic episodes such as Mount St. Helens 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 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.

BASALT (Sample 6) 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. These rocks are later exposed at the surface through the processes of uplift and erosion. Granite and gabbro are two of the many varieties of intrusive igneous rocks.

GRANITE (Sample 7) 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 mineral is 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, and the White Mountains of New Hampshire. Granites are also scattered throughout Nevada.

GABBRO (Sample 8) is also a speckled intrusive igneous rock but is noticeably darker in color. The principal minerals composing gabbro are gray feldspar and black hornblende or mica. There is generally very little or no quartz in gabbro. Gabbros are formed from magmas that are rich in calcium, magnesium, and iron; and poor in silica. They can be found as isolated bodies in intrusive igneous mountain ranges such as the Sierra Nevada, and the ranges of southern California. An interesting outcrop of gabbro occurs east of San Diego, California, where the material weathers into gabbro spheres from 3" to 1' across. The rock there is referred to as "orbicular gabbro".

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; gabbro and basalt come from magmas of very similar composition.

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. Metamorphism can effect igneous and sedimentary rocks, and even metamorphic rocks that were formed at an earlier 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:

<u>Metamorphic Rock</u>	<u>Derived From</u>
SLATE	Shale
QUARTZITE (Sample 10)	Sandstone
GNEISS (Sample 11)	Granite
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 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 hard crystalline rock that is much prized as a building stone and as a carving stone for statuary. 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 the classification of rocks, obtain a copy of: "CLASSIFICATION OF ROCKS", Quarterly of the Colorado School of Mines, Volume 50, Number 1, January 1955, by Russell B. Travis.

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