Introduction

Rocks and **minerals** form the basis of the soil that we walk upon. The study of their formations and their properties enable us to identify common rocks and minerals found in our environment.

As a result of physical and chemical processes, Earth's materials constantly change. Heat and pressure cause rocks to change from one form to another in a continuing cycle. The forces acting on Earth create many landforms and rock structures, which affect the topography of an area. Florida's most common rock is limestone. Reefs, caves, and sinkholes are features of our state's unique environment.

Properties of Minerals

Most of the solid part of Earth's crust consists of *minerals*. The most common minerals are formed from eight common elements. Minerals have five special characteristics, which are described below.

Mineral Characteristics

1. A mineral occurs naturally in Earth; it is not manufactured.
   Iron is a mineral because it is a naturally occurring substance found on Earth. Steel, however, is manufactured, so it is not a mineral.

2. Minerals are **inorganic**. They are not made from things that are living or were once living.
   Coal is *not* a mineral because it is **organic** and is composed of the remains of plants and animals.
   Quartz is a mineral because it is inorganic and is composed of the nonliving substances of iron and oxygen.

3. Minerals are always found as solids in Earth.

4. Minerals always have a definite chemical composition. They have the same kinds of atoms in the same proportions in every sample.

5. There is a definite geometrical arrangement or orderly pattern of atoms in most minerals. This orderly arrangement forms **crystals**.

Minerals from which **metals** or **nonmetals** can be removed in large enough amounts to be usable are called **ores**. Metals are minerals that can conduct heat and electricity and have a shine to them. Gold, silver, aluminum, and copper are examples of metals. Nonmetals are not shiny and do not conduct heat and electricity well. Nonmetals are often gases or soft solids. Some examples of nonmetals found in ores are sulfur, phosphorus, oxygen, and nitrogen.

Gems are rare minerals that are beautiful, long-lasting, and durable. Precious gems are very rare, beautiful, and valuable. These include diamonds and emeralds. Gems are usually cut into specific shapes. Other gems such as opals, turquoise, and topaz are semiprecious.

The shape of gems is a product of their structure. That is, a diamond is shaped a certain way because of the way its atoms are assembled. When two or more atoms are brought close enough together, an attractive force between the electrons of the atoms and/or the nucleus of the other atoms can result. If this force is strong enough to keep the atoms together, a chemical bond is said to be formed. Crystals are formed when atoms combine by sharing electrons in regular patterns as a substance (usually a liquid) is cooled. All rocks and minerals are formed from atoms sharing bonds with other atoms. This bonding or sharing of electrons produces a new chemical substance with different physical properties. For example, diamond and coal are composed of carbon atoms, but they have different physical properties resulting from the different type of bonds between the atoms.

Mineral Identification

Mineralogists are scientists who study and identify minerals. Some minerals can be recognized by their appearance. However, because so many minerals look alike, tests have been developed to help identify minerals. Knowing the properties of minerals makes it easier to identify them.

gems are rare minerals

Physical Properties

Many minerals can be identified by their physical properties, such as color, texture, hardness, or **luster**. Other minerals must be tested with chemicals to determine their identity. Below are some tests that can be performed to identify minerals by their physical properties.

Luster. Luster is usually determined by deciding whether the mineral is shiny (reflects light) or not. A **metallic mineral** (such as the metals silver or gold) is shiny and is said to have a metallic luster. Minerals that do not shine like a metal are said to have a nonmetallic luster. These **nonmetallic minerals** may look dull, pearly, glassy, silky, or transparent (light can pass through).

Color. The color of a mineral is one of the first physical properties to be observed. However, color can be used in determining only a few minerals—those which are always the same color. The mineral gold, which is a metallic yellow, is an example. Other minerals are turquoise (blue-green), sulfur (yellow), hematite (dark red), and azurite (deep blue). The color of many other minerals can change because of impurities in them. Also, several minerals can have the same color. Calcite, talc, and halite are all white, for example. So, to be sure, other tests are needed to identify minerals.

Shape. Many minerals can be identified by whether they have a crystal form. A crystal form is a regular, geometric pattern that creates flat faces. The different crystal forms also aid in identifying minerals. Crystalline form is not natural for all minerals. That is one reason to use other methods of identification.

Cleavage. The way a mineral breaks is described as either **cleavage** or **fracture**. Minerals cleave if they break along a smooth, flat plane. Some rocks cleave in only one direction, such as mica, which splits into thin sheets. Other rocks will show perfect cleavage in several directions. Feldspar splits in different directions, but nearly always at right angles.

A gentle tap of a hammer on the mineral will make it cleave or split. Some minerals do not split in a definite direction. When the break causes an irregular surface, it is called a *fracture*. The surface may be rough and curved with thin, jagged points. Quartz is a mineral that does not break in any certain pattern.

Streak. A streak test reveals the true color of the mineral. A streak is the color of the powdered mineral. You may have done something similar to a streak test if you used a soft stone to write on the sidewalk. To find the streak color, rub the unknown mineral on a hard, rough, white surface (like the unglazed side of a bathroom tile or a streak plate). It may leave a streak of color. The color of the streak is used to identify the mineral.

The color made by the streak test is always the same, but it may not be the same color as the larger piece of the mineral. Some minerals, however, streak the same color as they appear. For example, talc is white and its streak is white. The streaks of some minerals are different from their appearance. Hematite, for example, may be red or black, while the powder from the streak test is always cherry red. Also, the mineral iron pyrite is yellow, but it has a greenish-black streak.

Of course, for a mineral to leave a powder on the streak test, it must be softer than the streak plate. This is why minerals harder than a porcelain tile (measuring more than five on the **Mohs' Scale** of Hardness) will not leave a streak.

Specific Gravity. **Specific gravity** is useful in recognizing heavy mine[illegible] compared to an equal volume of water. For example, if a mineral weighs four times as much as an equal volume of water, its specific gravity is four.

Minerals which contain metals are usually dense. The density, or *heft*, is judged rather than actually measuring specific gravity.

Hardness. Hardness is one of the properties most useful in identifying a mineral. Hardness is a mineral's resistance to being scratched. In other words, "What can it scratch?" or "What can scratch it?" We test a mineral against other minerals. The harder mineral will always scratch a softer mineral.

A diamond is the hardest mineral.

A German mineralogist named Friedrich Mohs (1773-1839) worked out a scale of hardness. This scale—called *Mohs' scale*—is used to identify a mineral's hardness. Ten minerals whose hardness is known are arranged in the order of their increasing hardness. Each mineral is given a number

Mohs' Scale of Hardness

Hardness		Mineral
softest	1	talc
	2	gypsum
	3	calcite
	4	fluorite
	5	apatite
	6	feldspar
	7	quartz
	8	topaz
	9	corundum
hardest	10	diamond

from one to 10. Talc is the softest mineral, so it is given the number one. Diamond is the hardest mineral, so it is given the number 10.

A mineral will scratch any mineral with a lower number. If two minerals do not scratch each other, they have the same hardness. Diamonds will scratch all other minerals, and talc can be scratched by most other minerals.

If you are on a field trip collecting minerals, you may not be able to find other minerals needed to use for the hardness test. In such a situation a field scale can be used. The hardness determinations are not as exact as those using the minerals on Mohs' scale of hardness minerals, but they will be close enough for field use.

Field Scale of Hardness

Hardness		Test
softest	1	soft and greasy feeling, scratched easily with fingers
	2	scratched by fingernail with a lot of pressure
	3	scratched by a copper penny
	4	scratched easily by a knife
	5	scratched by a knife using a lot of pressure
	6	scratched by a steel file
	7	can scratch a steel file or piece of glass
	8	can scratch quartz
	9	(no good field tests for hardness above #8)
hardest	10	

Acid Test. There are many chemicals that could be used as a mineral test. One test often used is the hydrochloric acid (HCl) test. When HCl is put on a mineral, bubbles may occur. If bubbles are given off, then calcite is present. Hydrochloric acid detects the presence of oxygen or carbon.

The color a flame turns when a small amount of the mineral is placed in it tells what metals are present. For example, copper turns the flame green.

Other Tests. In addition to those tests described above, the shape and size of the crystals found in a mineral can assist in determining its identity. Also, magnetic properties may be present. Minerals that contain iron or magnetite are attracted by a magnet. Still other minerals have unusual or unique characteristics: halite has a salty taste; sulfur a definite smell; and jade, when tapped, will have a bell-like ring.

Mineral Identification	
Physical Properties	**Chemical Properties**
1. luster 2. color 3. shape 4. cleavage 5. streak 6. specific gravity 7. hardness	1. acid test 2. flame test

Major Types of Rocks

Rocks are composed of one or more minerals. About a dozen minerals are common rock-forming minerals. Elements such as oxygen, silicon, carbon, and sulfur combine with minerals to form many types of rocks. Rocks are classified into three groups, according to the way they were formed. These three groups of rocks are igneous, sedimentary, and metamorphic.

Igneous Rocks

The group of rocks known as igneous originate deep inside Earth. The word igneous means *fire-formed*. It is so hot in Earth's mantle that rocks and minerals melt and become liquid or molten material. This molten material inside Earth is called **magma**. **Igneous rocks** form when the magma cools and hardens.

igneous

Magma below the surface of Earth cools very slowly. The magma eventually becomes solid or crystallizes within Earth. These rocks would not be seen if not for erosion. Igneous rocks that are formed inside Earth are called **intrusive**. The crystals in intrusive igneous rock, such as granite, are large because the magma cooled slowly.

Granite is the most common igneous rock. Its large crystals tell us that it was formed by cooling slowly below Earth's surface. Granite makes up much of the continental crust. It is strong and can be polished. It is used in many buildings and monuments. Granite varies in color from a light gray to a pinkish color, depending on the proportion of each of the minerals (quartz, feldspar, and mica) present in the granite.

Sometimes the molten material, magma, is pushed from deep within Earth to the surface of Earth from volcanoes. On occasion, the molten materials break through the surface. If this molten material escapes from a volcano, it is called **lava**. Lava flows on the surface. Lava usually cools very quickly, forming small crystals. Sometimes it cools so quickly that no crystals are formed.

The volcanic rocks formed when lava cools on Earth's surface and becomes solid are called **extrusive**. Basalt is a common extrusive igneous rock with small crystals. Basalt is found in areas where there were ancient lava flows. It is plentiful in the Hawaiian Islands and makes up much of the ocean's crust. Obsidian is another extrusive rock that forms when magma cools so quickly that no crystals form. It is black and glassy in appearance. Another extrusive rock is pumice. It cools so quickly that it has no crystals and has holes made by the gases escaping from the lava. It is the only rock that floats.

hardened lava

Sedimentary Rocks

The surface of Earth is always being broken into smaller and smaller pieces through a process called *weathering*. Broken pieces such as rocks, gravel, pebbles, sand, and clay are *rock fragment*s. Rock fragments ranging in size from large gravel to microscopic bits are moved from place to place by the agents of erosion: wind, water, gravity, and glaciers. Rock fragments will settle in one place and pile up. These rock fragments that pile up are known as **sediment**. Most sediment builds up under water. Sediment piles up in layers on top of layers and over time becomes cemented together.

Sediment can harden to form **sedimentary rocks**. Sedimentary rocks are formed in two ways: (1) When new sediment piles on top of old sediment, the pressure of the weight of the top layers will harden the layers below; and (2) dissolved minerals in the water can cement the sediment together. All sedimentary rocks are made of layers, with the oldest sediments on the bottom and the newest ones near the top.

Sedimentary rocks are divided into three groups according to where the sediments came from and how the rocks were formed. The first group of sedimentary rocks are made from pieces or fragments of rocks and are called **fragmental rocks**. Rocks formed from these deposits are called *clastic* sedimentary rocks. They are further classified by the size of the pieces of rock in them. Those made of small, sand-sized grains of rock are called *sandstones*. They become cemented together by minerals such as quartz that are dissolved in the water that flows over them. *Shale* is made from clay or mud, which has somewhat larger particles than sandstone. The particles in shale are flat and are easily broken apart into flat pieces. Some fragmental rocks have large pebbles mixed with mud and sand. They are called **conglomerates**.


sedimentary

A second type of sedimentary rock is called *organic*. Organic sedimentary rock forms when the remains of plants and animals harden into rock. For example, limestone is formed from the shells of sea animals. The coral reefs off the coast of Florida are made of limestone deposits. Coal is another organic rock formed from plants that lived millions of years ago.

The third type of sedimentary rock is *chemical*. Chemical sedimentary rocks are formed when water evaporates and leaves behind mineral deposits. Halite or rock salt is a chemical rock. Many chemical rocks are found near the Great Salt Lake in Utah.

Metamorphic Rocks

The word *metamorphic* comes from the Greek words meaning *change* and *form*. **Metamorphic rocks** are rocks that used to be a different kind and have changed over time. Metamorphic rocks are formed deep within Earth where the temperature is high and the pressure is great. Rocks are changed by heat, pressure, and chemical action.

metamorphic

Heat alone can change one kind of rock into another kind of rock. This heat is supplied by magma. Heat and pressure together can change rocks, too. Rocks can also be changed by chemical actions. Magma contains chemicals that can cause changes in the rocks it touches. The new rocks are harder and may look different, and the minerals in these rocks may change.

Igneous rocks and sedimentary rocks can change to form metamorphic rocks. Sedimentary rocks such as limestone, which is fairly light and grainy and can be rubbed to a smooth finish, may change into marble, which is heavy and can be polished into a glass-like luster. Shale, which feels like hard mud and crumbles under pressure, may change to slate, which is very hard, fine-grained, and brittle. Sandstone is a soft rock that is easily broken. It may change into quartzite, which is finer grained, harder, has a glass-like luster, and is not easily broken.

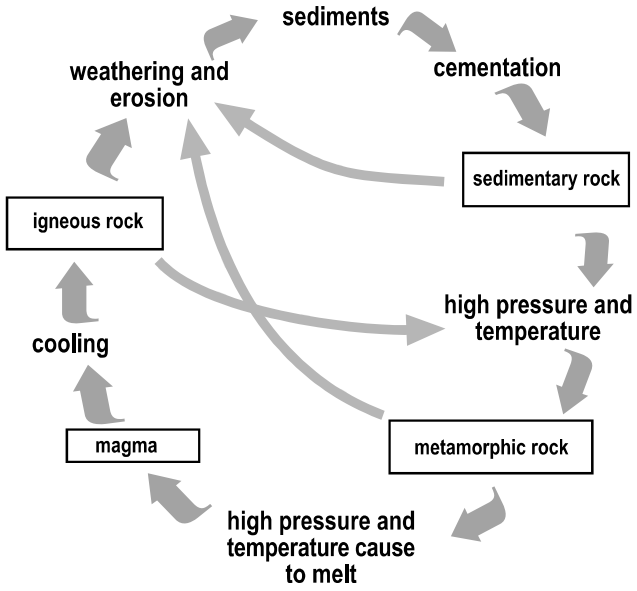
Granite is an igneous rock with a mixture of large and small crystals found in several colors. It may change into gneiss (pronounced *nice*), which is streaked and composed of very small crystals of many colors.

The Rock Cycle

The continuous changing of rocks from one form to another is called the **rock cycle**. Igneous rocks are the ancestor of all rocks. Wind and water caused some of the igneous rock to be broken down to eventually form sedimentary rock. Some of the igneous and sedimentary rocks became buried deep in Earth. The high temperature and pressure caused them to be changed into metamorphic rocks. Eventually the metamorphic rocks

will be exposed to the surface of Earth again and be broken down into sediments by wind and water. All three types of rocks may become buried so deeply that they become a liquid, and magma will be formed again. When the magma cools, it will form igneous rock, and the cycle will repeat again and again.

The Rock Cycle



Major Florida Rock Formations

Limestone is by far the most abundant rock formation in Florida. It lies under the land in all of the state. Limestone is a sedimentary rock composed of calcium carbonate ($CaCO_3$). Florida limestones range from hard and compact to soft and chalky. They range in color from white or light gray to a light grayish brown. Limestone may be easily identified by applying a drop of hydrochloric acid, which causes the calcite particles to bubble.

Limestone in the state is divided into several types. Key Largo limestone is found in the Florida Keys and contains fossil corals. Another type of limestone is oolite. Oolites are small rounded grains which look like fish eggs. These grains are formed by the deposition of layers of calcite around tiny particles, such as sand grains or shell fragments. It is found in several southern Florida counties.

Another type of Florida limestone is coquina. Coquina limestone is composed of shells and quartz sand grains that have been cemented together. Coquina has long been used as a building stone in Florida and is used today in architecture because of its unusual beauty. As you would expect, coquina is rarely found far from the coast.

In many areas of north and central Florida, underground water dissolves the limestone and carries it away, forming underground caves and caverns. During periods of drought, the roofs of these underground structures sometimes cave in, forming sinkholes.

Florida produces millions of tons of limestone and other minerals each year. Limestone production is a major industry in Florida. Most of the limestone produced in the state is crushed for use in making roads and concrete. It is also used as a conditioner for soil in agriculture, riprap (broken stone for foundations), and building stone walls.

Dolomite, common clay, kaolin (china clay), fuller's earth, and quartz sand are other common Florida rocks. These valuable natural resources are important for the state's economy. (See chart below for information about the uses of these rocks.)

Rocks	Uses
limestone	roads, concrete, cement, fertilizer, soil conditioner
dolomite	agricultural lime, cut stone
common clay	roads, brick, cement
kaolin	ceramics, tile, rubber, plastics, paper, paint
fuller's earth	absorbent (kitty litter, oil dry), insecticides, soaps, plastics, paints

Summary

Earth's crust is composed of elements which combine to form minerals. Minerals have five essential characteristics: naturally formed, inorganic, solid, a definite chemical formula, and an orderly arrangement of atoms. Minerals are identified by their physical properties, including luster, color, shape, cleavage, streak, specific gravity, hardness, and certain other tests.

Rocks are composed of one or more minerals. The three major types of rocks are igneous, sedimentary, and metamorphic. Rocks are continually changing from one form to another through the rock cycle.

Florida's rock formations consist of mostly limestone. Key Largo, oolite, and coquina are three of the different types. Florida's other rock formations include dolomite, common clay, kaolin, fuller's earth, and quartz sand. These natural resources are important for the state's economy.

Interesting rock formations found in the United States.