

GEOLOGY and NATURAL RESOURCE DEVELOPMENT

Geology is a study of the Earth and its history as recorded in the rocks. The study of geology involves understanding the relationship between the rocks of the crust of the Earth and envelopes of air and water. Geology is a study of processes—processes that form continents and ocean basins, mountains and oceanic deeps, glaciers and lakes, sand bars and rocky cliffs, and deposits of minerals, coal and oil and gas. Geologists study rocks to determine what the Earth was like thousands, millions, and billions of years ago. Geologists study volcanoes, lavas, earthquakes, and landslides. They discover how our mineral deposits formed. They give us theories on how the Earth was formed, how it developed, and what the core of the Earth is like. The Earth is about 4.5 billion years old. Geology tells us how the Earth has changed and continues to change. Hills are worn down to form lowlands that may be covered by the sea. Millions of years later, rocks from under the sea may be raised up to form high mountains. The Earth is the geologists' laboratory.

WHY IS AN UNDERSTANDING OF GEOLOGY IMPORTANT TO ME?

The Earth is where we live. We are dependent upon our Earth. Our water supply and our farm land formed by geologic processes. All our minerals, fuels, and construction materials come from the Earth's crust. The Earth will remain a nice place to live if we use our resources wisely and control our wastes and garbage. There are natural earth hazards like floods, landslides, earthquakes, and volcanic eruptions. The understanding of geology can lead us to the safest areas in which to build cities, dams, schools, or roads and tunnels. If we understand geologic processes we will know the best places to dispose of our wastes and garbage, and the best geologic environments for finding oil, gas, and coal.

If we understand geology we can learn ways to use the resources of the Earth and at the same time protect it from harm.

HOW DOES GEOLOGY RELATE TO MINERAL RESOURCES AND THEIR DEVELOPMENT?

Mineral resources are those minerals and other earth materials that supply the things we need and want. Look around you. Things made from mineral resources are in plain sight. Some are obvious, others are less obvious. Obviously, metal paper clips and building stone come from the Earth. Some things not so obvious—toothpaste, hair combs, chalk, cups and glasses—also come from the Earth. All plastics and many fibers of which our clothes are made come from coal or oil.

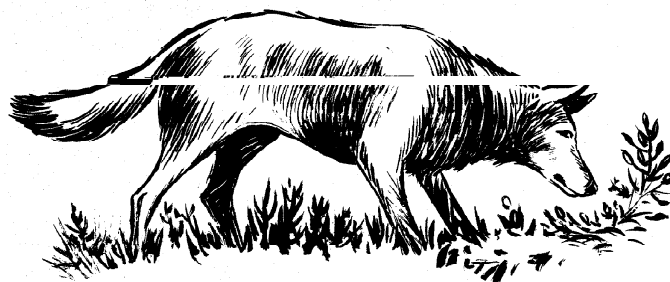
Mineral resources are so important to us that we count stages of history by them. We had the *Stone Age*, the *Bronze Age*, and the *Iron Age*.

By examining different kinds of rock formations and by studying the Earth's surface, geologists know the geologic environments in which mineral resources may be found.

For a long time people were able to find enough mineral resources on the surface of the Earth. This is not the case with many mineral resources today. Once a vein of silver or

a bed of coal has been mined, it cannot be replaced. This means we must plan well ahead to look for new mineral deposits.

Today, geologists use a variety of tools and instruments to help locate mineral resources. Airplanes and helicopters with photographic equipment are used by geologists. They also use magnetic and gravity-detecting equipment. This equipment gives information about the Earth's subsurface. Geologists sometimes use pictures taken from satellites in their search for hidden mineral resources.



In Canada, geologists have trained dogs to sniff out exploration clues. German Shepherd have been taught to use their excellent sense of smell to find sulfides of lead, zinc, copper, nickel, molybdenum, and silver.

HOW WERE MINERAL RESOURCES FORMED?

As the Earth changes, different types of rocks are formed. There are three types of rocks: igneous, sedimentary, and metamorphic.

Igneous rocks are formed from magma (hot melted rock) as it cools and becomes solid. As hot magma cools, minerals such as chromite (chrome is used in stainless steel) and platinum (used in catalytic converters) form.

Sedimentary rocks are formed from particles of older rocks. The particles are deposited in a body of water, a valley, or a low plain. The collection of particles is known as sediment. After the particles are deposited, new sediment is deposited on top burying the earlier deposited materials. When sediments are buried, they become cemented to form sedimentary rock. Limestone (used to make cement and statues) and clay (used to make dishes) are examples of sedimentary rocks.

Metamorphic rocks are formed in the Earth where there is high temperature and great pressure. The heat and pressure change one kind of rock into another kind of rock. This process of change is known as metamorphism. You can think of the change from brownie dough to brownies as metamorphism. Marble (used in buildings) is metamorphosed limestone. A mineral from which tungsten (light bulb filaments are made of tungsten) is produced is formed by metamorphism. As igneous, sedimentary, and metamorphic rocks are made, minerals may be so concentrated as to become resources for us to use.

The Earth is always changing. Rocks are slowly worn down by the forces of weathering and erosion. Rocks can be lifted or pushed downward. They also can be moved sideways and tilted.

For example, dead trees and plants accumulate in bogs and later are buried between layers of clay and mud. The layers become sedimentary rock. The dead trees and plants are slowly changed to coal. We might say metamorphosed to coal. Oil and gas also formed in sedimentary rock, came from decayed animals and plants.

Today, these processes continue. New coal beds are being formed in bogs and swamps, mineral deposits are being created on ocean floors by volcanic activity. Our Earth is, indeed, an exciting place to be!

WHAT IS MINERAL RESOURCE DEVELOPMENT?

Mineral resource development is finding, removing, and processing valuable mineral resources from our Earth. Mineral resources may be solid (coal or copper), liquid (petroleum), or gaseous (natural gas).

When a mineral resource is developed, it is taken from the Earth and changed into a usable form. All the work involved in doing this has one aim: to provide us with the products we need or want in our everyday lives.

A mineral resource is developed ONLY when enough of it is found concentrated in one location and its removal and processing can be done profitably. Exploration for mineral resources is a very risky business and much of it is unsuccessful. Mineral resources are scarce and difficult to find. Great sums of money are spent for years before any money is ever made by a company on its mining or drilling operations. Mineral resources can be developed only if their extraction can pay for the investment, labor and machinery, and taxes. If there is no profit left over, there is no reason to invest in such a risky business.

WHAT MUST HAPPEN TO A MINERAL RESOURCE BEFORE IT BECOMES USEFUL?

Mineral and energy resources are the ingredients in nearly all of the products we use everyday. These resources must go through a number of steps or processes before usable items can be produced. We call these steps the journey from prospect to production.

EXPLORATION. First, the mineral and energy resources must be found! The people who look for these resources are called geologists. They explore the Earth to find deposits or wells that can be produced.

EXTRACTION. After the resources are located, they must be removed from the Earth. This process is called extraction. People build surface or underground mines to extract mineral resources. To get oil, holes are drilled deep into the Earth. Mining and drilling are two ways we extract and produce mineral resources.

PROCESSING. Valuable minerals are in ordinary looking rock when they are taken from the Earth. They are often hidden as tiny particles in the rock. The valuable minerals are removed from the rock and concentrated. This is called processing or crushing, grinding, and milling.

REFINING. Some minerals have to be smelted and refined before they can be made into useful products. When oil is pumped from the Earth, it is in crude form. The crude oil is sent to a refinery where it is processed into oils, solvents, fuels, and petrochemicals.

MANUFACTURING. After the mineral and energy resources are refined, these raw materials are made into products. Their transformation into consumer products is almost limitless. Products ranging from fertilizers to plastic; from bicycles to airplanes are made by man and machinery. This is called manufacturing.

MARKETING. Once the products are made, they are sold or marketed. When you need a product, you usually go to a store. Marketing is when some product is sold to someone. The mineral and energy resource company sells the mineral resource to a manufacturer. The manufacturer makes a product and sells it to stores. The stores then sell the product to us.

DIG A LITTLE DEEPER!

The word **geology** comes from Greek words. Find out what they are and their meaning.

There are many branches of geology, such as geochemistry, geophysics, and mineralogy. Do some research and find more branches of geology and find out what each branch studies.

If you were a geologist, what tools and equipment would you need? What qualifications do you need to become a geologist?

For a wonderful imaginary trip through the inside of the Earth read *How to Dig a Hole to the Other Side of the World* by Faith McNulty (Harper & Row, 1979).

Be a **ROCKHOUND!** Start collecting rocks and minerals. Identify your rocks by using reference books from the library. Maybe you can meet a geologist who will help you. Share your collection with the class.

Make a list of 10 rocks and minerals and, using a book from your school library classify the rocks. Example: granite—igneous; limestone—sedimentary; marble—metamorphic.

Why can't we just find a mineral resource and use it as is instead of having to process it?

Choose one thing in your classroom or home that you like to use. Try to find what mineral resources it contains.

Find out more about the "Ages." Choose the Stone Age; Bronze Age; or Iron Age—and list at least five important facts about it.

Take a field trip through your neighborhood and record as many different uses of rocks and minerals as you can.

Some elements have strange sounding names. Look up molybdenum, vanadium, beryllium, selenium, and zirconium. What can you find out about each? In what products are they used?

Imagine that you are involved in one of the activities listed below. Write a description of the setting using each of your senses. Describe what it looks like, what it smells like, what it sounds like, what it feels like, and what it tastes like. Try to write a vivid description of your setting so it will actually "come alive" to another person who might read it.