Mining for Rocks and Minerals

What You Already Know

A mineral is a natural, nonliving, solid crystal that makes up rocks. All rocks are made from minerals. Most rocks are made up of combinations of different minerals. There are thousands of different minerals, but most rocks are made up of only a few of them. Each sample of the same type of rock always has the same minerals.

You can identify a mineral by testing its properties. A mineral’s properties include color, luster, hardness, streak, cleavage, and crystal shape.

Streak is the color of a rock’s powder when the rock is scratched across a special plate. The Mohs scale ranks a mineral’s hardness. Luster is the property of how a mineral reflects light. Minerals that break along smooth, flat surfaces have cleavage. Finally, a mineral’s crystal shape can sometimes help identify it.

A rock that contains valuable minerals is an ore. There are three different types of rocks: igneous, sedimentary, and metamorphic.
Igneous rock is rock that forms when magma or lava hardens. Sedimentary rock forms from layers of soil, bits of rock, shells, and dead plant and animal matter that press on each other for years and years. Metamorphic rock is rock that has been changed by heat and pressure.

Rocks are in a continuous process of being formed, destroyed, and formed again. This process is called the rock cycle.

In this book you will learn about the rocks and minerals that people have mined and continue to mine. Different people have been mining for thousands of years in different parts of the world. Keep reading to find out more!
Mining in the Past

People have been using rocks and minerals as resources for thousands of years. The term Stone Age describes the time period when humans first started using rocks and minerals as simple tools. At first, people just used what they found on the ground around them. The Stone Age began as early as 700,000 years ago in some parts of the world. It lasted until about ten thousand years ago.

In the Stone Age, most mining was for flint. Flint has several properties that made it valuable to Stone Age people. People could make good tools and sharp weapons from it. Flint also chips easily, which made it easy for people to shape and rework. And flint can be used to help start fires. Stone Age people discovered flint in beds of chalk buried underground. They used deer antlers, stone tools, and tools shaped from animal bones to dig it up.
The Copper Age

Copper was the first metal to be mined in large amounts in many parts of the world. People first created objects out of copper about eight thousand years ago. The ancient Egyptians were some of the first people to mine copper.

Copper mining slowly spread northwest through Europe. People living in Germany and parts of southeastern Europe began mining copper about five thousand years ago.

Copper proved to be better than flint. It is soft and easily shaped. It becomes hard after it is hammered. But copper is rarely found in its pure form. Arsenic, tin, and antimony are often mixed in with copper ores. Smelting, the process of melting away unwanted substances from metal ores, began soon after copper mining started. When people started smelting copper ores to make bronze, a mixture of copper and tin, the Bronze Age began.
The Bronze Age

As early as five thousand years ago, people in parts of Turkey were mining tin in order to make bronze. Around that time, Israel’s Timna Valley became a center of Bronze Age mining and smelting. Copper miners at Timna dug with stone tools to get at ore that was underground. In Faynan, Jordan, copper miners working about four thousand years ago mined as deep as 20 meters below the ground.

By a little over four thousand years ago, people throughout the world were making bronze. Just as copper was better than flint, bronze was stronger than tin or copper alone. Bronze can be poured into casts, or special shapes, after it is melted. It also becomes very hard when it cools. Such discoveries led people to experiment with mixing metals other than tin and copper, such as silver, lead, zinc, and mercury.
The Iron Age

Hematite is a mineral that contains iron. Scientists believe that over 40,000 years ago, people in Swaziland dug it from a cave to make dyes. Seven thousand years ago, in parts of England, people were digging iron from the ground. And scientists think that a little over four thousand years ago people in Turkey washed beach sands to remove iron from them. The iron was then sent to furnaces to be smelted.

Of iron, flint, copper, and bronze, iron is the strongest. So people switched to working with iron. This change marked the beginning of the Iron Age. By three thousand years ago, iron smelting had begun in many parts of the world. Some might say that we are still living in the Iron Age. Modern steel, for example, is a combination of iron and carbon.
Mining Today

Today most rocks and minerals are mined from far underground. How do miners and geologists find them?

Geologists often start by making a geologic map of an area. They look for faults and other features in Earth’s crust. When geologists find sedimentary rocks of a certain age, they can sometimes tell what minerals may have formed them.

Geologists use different tools to find rocks and minerals. They use Geiger counters to detect radioactive substances, such as uranium. They use gravimeters to show the density of different rocks. Magnetic ores are found using magnetometers.

Geologists drill sample cores or trenches to bring up dirt and rocks from an area. They study the samples to determine how deep a mine should go. Engineers then use computers to design the best mine for that location and mineral type.
Engineers study many features of an area before choosing the type of mine needed. They study the soil on the surface, along with the overburden, or unusable rock. This material must be taken away before miners can get at the valuable ore. They also consider the amount of groundwater there, and how water will drain from the mine. Finally, the engineers must decide what materials are needed to build the mine, and how the mine will be supplied with fresh air.

Along with the engineers’ studies, geologists try to figure out the grade, or quality, of the ore that will be mined. They estimate the quantity of ore that is there, and the milling, or processing, needed before the minerals can be sold. Once a mining company decides to build a mine, they need to choose whether to build a surface mine or an underground mine.
Types of Mines

People have developed several types of mines since mining began. The first mines that people dug were surface mines.

Surface mines are the least expensive mines to build. But digging them can cause a huge amount of damage to the land. Miners have to cut down trees and scrape off grass, shrubs, and topsoil. Then they must remove the top layers of rock to reach the ore that is below. Today the topsoil and top layers of rocks are saved and then replaced once the surface mine has been used up. But in the past, once miners were done mining a surface mine, they would just leave it as it was.

More Surface Mining

Open-pit mining and strip mining are two of the most common types of surface mining. Often a machine called a crusher will be built at the site of an open-pit mine. The crusher crushes the ore taken from the mine. The ore is then taken to a nearby processing plant to be heated. The heating removes the valuable minerals from the crushed ore.

Quarrying is another term for open-pit mining that is done close to the surface. Quarries are dug to remove rocks that do not need to be processed. Granite is often removed in large blocks from a quarry. Gravel and sand are also quarried.

Placer mining, which is when minerals are removed from the sediments found on river bottoms, is another type of surface mining. Placer mining is especially useful for mining gold, and was widely used during the California gold rush.
Underground Mines

Underground mining is usually more expensive than surface mining. This is because underground mines need entrances to get to the ore and passages to remove it.

An adit is a horizontal, ground-level tunnel into a hill or mountain. It is a type of mine. A shaft is a vertical tunnel that goes straight down into an underground mine.

Miners often break up the rocks in underground mines by blasting them with dynamite. They put the broken-up rock into buckets or on elevators or conveyors to move it to the surface. As the ore is removed, supports are built to keep the mine from collapsing.

Sometimes small railways are built to transport the ore from one end of a tunnel to a conveyor. The conveyor then takes the ore to the surface.
Underground coal mines are often built using a method called room-and-pillar. The coal is removed from certain areas, but pillars of coal are left behind to support the mine’s roof. Because of the value of the coal, a room-and-pillar mine can later be turned into a special kind of mine called a retreat mine. In a retreat mine, the pillars are removed, causing parts of the mine’s roof to collapse. You might think that these collapses would be a danger to the miners. But the miners do not have to leave the mine while the collapses are happening.

Another type of underground mining involves drilling holes called boreholes. Miners drill boreholes into an ore. Using high-pressure hoses, they blast the ore with water. The water breaks up the mineral and mixes with it. Miners pump the mixture to a tank on the surface. The minerals settle at the bottom of the tank. The water is pumped back into the mine.
Mining in the United States

Mining in the United States is a big business. According to the National Mining Association (NMA), in 2003 there were about 14,300 working mines in the United States. At the time, those mines employed about 320,000 people. The coal, metals, and minerals dug from underground in 2003 by mines in the United States were worth a total of $57 billion. Ranked in order, the top five coal mining states in 2003 were Wyoming, West Virginia, Kentucky, Pennsylvania, and Texas. The top five mineral producing states that year were California, Nevada, Arizona, Texas, and Florida.
Gold Rush!

There have been four major mining “rushes” in recent North American history. There was the California gold rush of 1848-1849, the Colorado gold rush of 1858-1859, the discovery of silver in northern Nevada in 1859, and the 1896-1900 gold rush in Canada’s Yukon Territory. Of these rushes, the California gold rush is the most famous. On January 24, 1848, John Marshall found gold on California’s American River. News of the find spread rapidly. By 1849, thousands of people were flooding into California seeking gold.

At first, the miners panned for gold directly out of rivers. When that gold was removed, the miners dammed the rivers. The damming left streambeds dry, allowing miners to get at harder-to-reach gold. In the early 1850s, the miners started blasting the streambeds with water from hoses. This wrecked river environments, but helped the miners locate more gold.
**Mining Coal**

In 2003, coal made up one-third of the value of all minerals mined in the United States. About two thousand coal mines in the United States were active that year. This was about one-seventh of all mines in the United States.

The amount of pressure placed on coal determines its grade. There are four grades of coal. The highest grade of coal is anthracite. Anthracite coal burns cleaner and contains more energy than other coals. Bituminous coal, often referred to as soft coal, is the grade below anthracite. Subbituminous coal has a dull black color. It has significantly less energy than bituminous or anthracite. Finally, there is lignite coal. Lignite coal takes less time to form than the other three grades, but contains less energy.

Coal was first mined in California in 1855. Coal production stopped in the mid-1900s when oil and gas were discovered in the state. It began again in the 1980s because of California’s unique lignite coal. Lignite mined in California’s Amador County contains montan wax, a wax from certain fossil plants. This type of lignite is rare, but important for industrial use.
**Mining Diamond**

Coal and diamond have very different properties. Diamond is always arranged in a crystal structure. The structure of coal varies. Diamond is the hardest known substance. Coal is much softer. Coal is usually black in color, but diamond is almost see-through. Despite these differences, coal and diamond are both formed from carbon.

Very few diamonds have ever been found in the United States. The world’s leading producers of diamonds are South Africa, Canada, Australia, Russia, and Botswana. Diamond is found in kimberlite, a heavy and dark type of igneous rock that forms pipes deep beneath the ground.

Miners mine for diamonds by digging shafts close to kimberlite pipes. Then they dig tunnels from the shafts to the pipes and build elevators. The elevators move the kimberlite to the surface, where it is processed.

Diamonds that are found on the seafloor are brought to the surface using a large hose connected to a barge. The hose works like a vacuum cleaner to suck up gravel that contains diamonds.
**Mining Gold and Silver**

In spite of the amount of gold and silver taken out of the ground during different rushes, there is still a lot that has yet to be found in the United States. The gold mined in the United States in 2003 was worth $3 billion. Most of this gold came from Nevada. The silver mined that year in the United States was valued at about $180 million.

Gold mines have been dug thousands of meters deep to get at gold deposits. One shaft in a gold mine in South Africa descends nearly four thousand meters below the surface!

Some gold is removed from ores by smelting them. At other times, mercury, which combines with gold, is used to pull gold out of ore. Cyanide is also used to remove gold from ore by dissolving the gold. The mixture of gold and cyanide is then treated with zinc to remove the gold.
People often think of silver and gold as being linked because both metals have been used throughout history as money. Silver mining goes back thousands of years. An important difference between silver and gold is that silver is often found in other minerals. During the Bronze Age, metalworkers smelted lead ores to get silver. Silver can also be smelted from copper and zinc ores.

A method called flotation separation is often used to remove silver from its ore. Flotation separation is now the most commonly used way of removing mineral from ore. In this method, the ore is mixed with water and special chemicals that repel silver from water. The silver then attaches to air bubbles in the water, and floats to the surface of the mixture. When it gets to the surface, it is removed.
When a Mine Closes

What happens when a layer of ore that is being mined stops or gives out? In most cases, the mine has to close. When no more valuable minerals can be found to sell, an owner cannot keep removing rocks that have little value.

As chemists have learned new methods for separating metals from ore, mining has become profitable again at some old mines. Mining companies also use new methods to separate minerals from ore they have already processed.

If a mine is never going to be opened again, people now expect the miners to restore the land to its original look. To do this, engineers work to control how the land around the mine drains, in order to prevent water pollution and the land from settling. They reseed native plants, and restore streams, rivers, and wetlands that have been affected by mining.

Mining will always be controversial because it can damage the environment. Scientists have found better ways to clean up the messes some mines have caused. This includes preventing toxic chemicals from seeping into the ground and water near a mine.

Many old mines in different parts of the world have polluted the surrounding environment as substances have leaked out of them. Unfortunately, cleaning up old mines can be very costly. One challenge for the future will be to find new ways to safely and cheaply operate mines.
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<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>adit</td>
<td>a type of mine that is a horizontal, ground-level entrance to a hill or mountain</td>
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<tr>
<td>anthracite</td>
<td>the highest grade of coal, it contains the most energy and takes the longest time to form</td>
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<tr>
<td>bituminous</td>
<td>the grade of coal beneath anthracite</td>
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<tr>
<td>bronze</td>
<td>a mixture of copper and tin, made by smelting</td>
</tr>
<tr>
<td>kimberlite</td>
<td>a heavy and dark kind of igneous rock that contains diamond</td>
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<tr>
<td>lignite</td>
<td>the lowest grade of coal, it takes the least time to form but contains the lowest amount of energy</td>
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<tr>
<td>overburden</td>
<td>the unusable rock that must be removed to get at a valuable ore</td>
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<tr>
<td>room-and-pillar</td>
<td>a type of underground mine where rooms are created by leaving behind pillars of ore</td>
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<td>smelting</td>
<td>the process of melting metal ores to remove unwanted substances</td>
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