Curriculum Connections
Special Supplement for PDAC Mining Matters News!

Engineer and Build an Underground Mine

Combine the *Earth and Space Systems* curriculum with *Structures and Mechanisms* by having your student construct a model of an underground mine. This activity has the potential to stimulate your student's imagination. Consider treating this activity as an engineering challenge to engage your students. Using their model, students will be able to show others how it is possible to extract ore from the ground to obtain the desired mineral. The difficulty with this activity is that some of the students cannot visualize the drifts and shafts going through solid rock. The concepts of drifts and shafts going through solid rock might be easy to explain by describing how ants might go about extracting raisins from a raisin loaf. The ants would have to bore through the loaf, retrieve a raisin and retreat the same way they entered. Further trips to retrieve raisins would probably mean reusing the same holes that they had made previously. The poster entitled **An Underground Mine**, found in your ***Deeper and Deeper*** or ***Mining Matters II*** kits, illustrates many aspects of mining and mineral processing, and will be very helpful in illustrating this challenging concept.

Suggested Duration

2 to 3 hours

Safety Considerations

This activity requires that iron filings be mixed with flour and water. If this activity is completed over several days, it is very important that the dish and mixing equipment used to prepare this mixture is cleaned while the mixture is still wet. **NEVER** dispose of iron filings down the sink. When airborne, iron filings present a health hazard by irritating the lungs and eyes. Care should be taken to ensure that only the teacher handles unmixed iron filings. Eye protection must be used. Respiration protection should not be needed in normal laboratory handling. Spills can be swept up and iron filings may be reused or placed in the garbage. Iron filings may be purchased from a provider of scientific supplies and equipment.

Curriculum Connections

Earth and Space Systems: Grade 7 - The Earth's Crust

- communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., design and build models to illustrate different mining techniques)
- investigate some of the ways in which humans have altered the landscape to meet their needs and assess the environmental and economic consequences
- identify earth resources used by humans to manufacture products (e.g., iron ore is used to make steel products) and discuss what happens to the products when they are no longer useful

Structures and Mechanisms: Grade 7 - Structural Strength and Stability

- use appropriate techniques and materials while making structures that have mechanisms
- formulate questions about and identify needs and problems related to the strength of structures, and explore possible answers and solutions
- tell the "story" of a product used every day, identifying the need it meets and describing its production, use, and eventual disposal
- use their knowledge of materials in designing and making structures that will stand up to stress

Prepare to Venture Underground!

Engineer and Build an Underground Mine

Information Bulletin

Mining means extracting valuable rock from the Earth. When the rock is valuable because it contains metal or minerals, it is called an **OREBODY**. If the orebody is buried deep in the Earth, miners must dig tunnels to the orebody. Such an operation is called an **UNDERGROUND MINE**. The vertical tunnel to the area of the orebody is called a **SHAFT**. Inside the shaft an elevator or **CAGE** is used to transport the miners and equipment from the surface to the underground workings and a bucket or **SKIP** is used to lift the broken rock and ore from underground. Other vertical tunnels called **VENTILATION SHAFTS** bring fresh air to the mine. Horizontal tunnels called **DRIFTS** provide access from the shaft to the orebody. Dynamite is used to break up the rock. Broken rock is loaded into a **SCOOP**, a large machine that combines a front-end loader and a truck. It is driven back to the shaft where the ore is dumped and lifted to the surface in the skip.

Mined ore contains both metals and minerals of value as well as other minerals of no value. The two are often evenly mixed in the ore and must be separated to form a **CONCENTRATE** of the valuable mineral. After separation, the minerals of no value are usually called **TAILINGS**.

The first step in separating the valuable minerals almost always involves crushing the rock to a fine powder. The rock is broken up in large crushers and pulverized in large rotating drums containing hard balls or rods. The process of producing the fine powder is called **MILLING** and the process takes place in a **MILL**. This process is like grinding wheat or oats to make flour.

Two procedures are commonly used to separate the valuable and non-valuable minerals from the milled ore. When mixed with a liquid, heavier minerals sink and therefore can be separated from lighter minerals. This procedure is called **HEAVY-MEDIA SEPARATION**. This process could be used to separate heavier chalcopyrite from lighter quartz. If the valuable minerals are magnetic, they can be separated from the minerals of no value by passing the crushed ore under a powerful magnet. This procedure is called **MAGNETIC SEPARATION**.

Once the valuable metals have been separated or concentrated, the left over material (rock fragments, dust and chemicals) is called **TAILINGS**. Mining companies work hard to ensure that these tailings are managed effectively and responsibly. Such efforts are necessary because the real-life tailings may contain dangerous chemicals that could leak into streams and lakes. Some tailings contain minerals such as pyrite. As pyrite is exposed to water from rain and other sources, it can make the water somewhat acidic and this acid water can drain into streams and lakes.

In the early part of the century, people, including mining people, did not understand that material such as tailings could cause serious damage to the environment. Now, mine tailings are kept in specially designed ponds. The base of the pond is lined with heavy plastic or dense clay. Any water leaving the pond is chemically treated to remove acids or dangerous chemicals. The tailings are eventually covered with soil and planted with grass and trees. Strict government rules are applied to tailings. Some mining companies have even stricter internal rules.

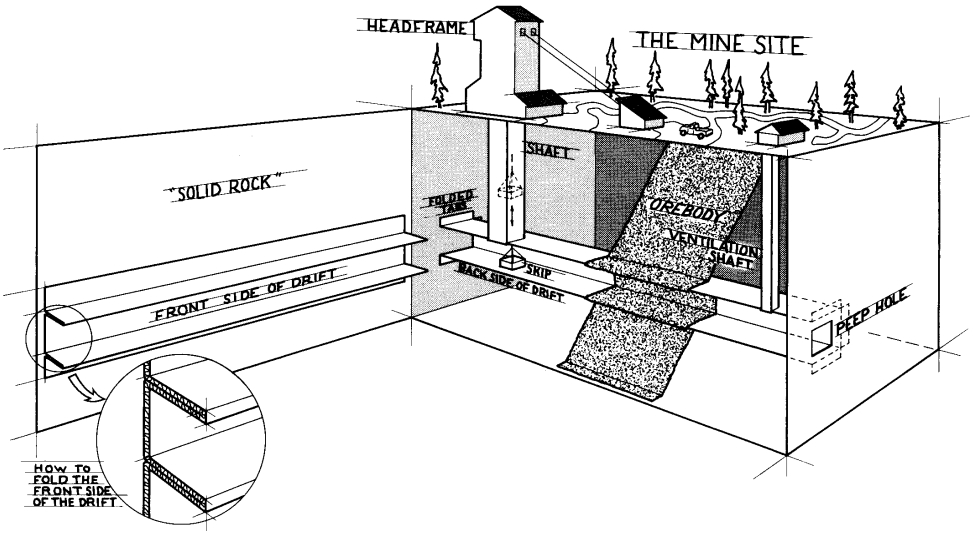
After underground mining is completed, the reclamation process includes filling all the opened areas with sand, cement or waste rock. The shafts are capped (plugged) and the buildings at the surface are removed. The small areas used for the buildings are replanted with grass and trees and very little evidence of the mine remains.

What to Do

1. Each group will need a cardboard box to make the model. The materials that you will need as well as the structures that you must construct are as follows:

Construction	Material Needed
Mine Site	Cardboard box
Head Frame	Cardboard/construction paper/popsicle sticks
Buildings on Site	Cardboard/construction paper/miniature toy buildings
Trucks	Construction paper/miniature toy trucks
Trees	Construction paper/miniature toy trees/twigs
Shaft	Cardboard/construction paper/cardboard tubes
Cage/Skip	Cardboard/construction paper/string
Ventilation Shaft	Cardboard/construction paper/cardboard tubes
Drift Ore host rock	Cardboard/cardboard tubes Aluminum foil
Mineralization	Mixture of 50 mL of flour, 50 mL of water and 20 mL of iron filings
Rock	Construction paper/newspaper/painted fibre fill
Other supplies	Masking tape or duct tape, paint, flashlight

Diagram of completed model

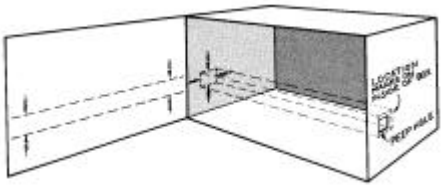


Follow the steps below to build your mine!

Step 1: Prepare your box, the **mine site**, by taping all sides closed.

Step 2: Cut open one side of the box to make a "door".

Step 3: Locate the position of a **drift** by measuring and drawing horizontal lines on the inside of the "door" Draw corresponding marks on the insides of the sides of the box as shown below. Cut a "peep hole" out of the right side of the box at your marks.



Step 4: Your drift has two sides (back side and front side). Create both sides of your drift by either folding cardboard as shown in the completed model illustration or by cutting a stiff cardboard tube in half lengthwise. When folding the cardboard it helps to use a strong straight edge, like the edge of a tabletop, to ensure you get a straight edge.

Step 5: Using your drift location marks as guides, glue the front side of the drift to the "door". Attach the back side of the drift by gluing the folded tabs at both ends to the sides of the box. Ensure that the back side of the drift lines up with the "peep hole".

Step 6: Make a shaft out of cardboard by folding four sides into a tube or by using a round cardboard tube. Make a hole in the top of the box slightly larger than the shaft, directly above the left end of the drift. Cut a corresponding hole in the top of the drift. Lower the shaft through the surface to the top of the drift at the hole. In a real mine, the shaft is dug down through solid rock to the drift level and then the drifts are dug horizontally.

Step 7: Make a smaller **ventilation shaft** in your mine by repeating Step 6 on the right end of the drift.

Step 8: Make a **headframe** (building at the top of the shaft) and place it over the shaft hole. A small building for fans should be made for the top of the ventilation shaft. Make a cage/slip out of string and construction paper. Be sure that it is small enough to fit through the shaft.

Step 9: It's time to make the **orebody**! Take a sheet of aluminum foil (**ore host rock**) long enough to extend from the top of the box to the bottom of the box with at least 15 cm extra. Fold the foil to a width approximately 10 to 15 cm. Tape the foil to the inside of the box top and to the top of the drift. Press the foil into the drift along the top, back and bottom allowing the remaining foil to extend to the bottom of the box. Secure with tape at the bottom of the drift and box.

Step 10: Have your teacher prepare the flour, water and iron filing mixture (**mineralizaton**) as indicated on the table. Spread the mixture on the foil before it gets too dry! Be sure to spread the mixture on the foil in the drift also. Allow this mixture to dry. The dish and mixing equipment used to prepare the mixture of iron filings, flour and water is cleaned while the mixture is still wet. **NEVER** dispose of iron filings down the sink.

Step 11: While the orebody is drying, carefully fill the remaining open spaces in the box with shredded newspaper or painted fibre fill. This will give the impression that the drift is actually passing through solid rock. Complete your model by painting the surface and placing trees and trucks to represent a real mine.

Step 12: When the "door" of the model is closed, peek into the mine by shinning a flashlight into the "peep hole". This really gives you the feeling of being underground.

Try these Learning Extensions

- Extract the mineralization (dried flour paste mixture) from your mine by chipping the ore from the host rock. Transport the ore to the skip and raise it to the surface.
- Devise a method to recover the iron filings from the other mined material, remembering that iron filings are made from magnetite, a very heavy and magnetic mineral.
- Think of ways to safely manage the left over material (**tailings**) after you separate the iron filings from the flour paste mixture (e.g. water filtration, disposal methods). **NEVER** dispose of iron filings down the sink.
- Use your model to deliver a presentation to your classmates about the processes of mining and milling. Describe how ore is taken from the ground (mined) and processed (milled).