MINING

Worksheet 12

A worksheet produced by the Native Access to Engineering Programme

What is mining?

The Merriam-Webster Dictionary defines the verb to mine as

1a: to dig under to gain access
2a: to get (as ore) from the earth b : the extract from a source
3: to burrow beneath the surface of
5a: to dig into for ore or metal
  b: to process for obtaining a natural constituent

As the definition implies, mining is the process of extracting metal and mineral ores from the Earth.

An etching of coal miners.

Minerals

The chemical elements of the periodic table are the building blocks of minerals. There are about 3000 recognized minerals.

What minerals can you name?

Gold, Au

Nickel, Ni

Silver, Ag

Turquoise, $CuAl_6(PO_4)_4(OH)_8 5H2O$ set in Silver, Ag

Some minerals are composed entirely of one chemical element like gold, silver, mercury or copper. They are called native elements. Others are combinations of elements. Quartz for instance is a combination of silicon and oxygen, SiO2. Some minerals traditionally used by Aboriginal peoples include topaz, flint (a form of quartz) and copper. These days silver, gold and other minerals are used by artists to create jewelry and other objects.

What minerals are found near your community?

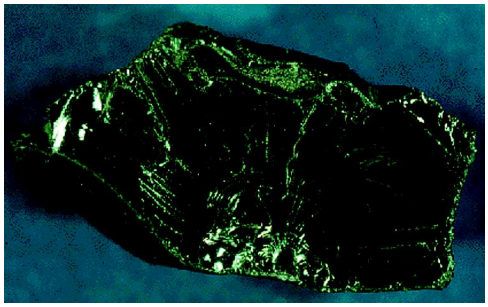
Rocks

Minerals are the building blocks of rocks. When mining on land, generally it is necessary to somehow separate the desirable minerals from other minerals in the rock.

There are 3 major rock groups.

Sedimentary rocks are formed when mineral sediment from erosion and weather is deposited by wind, water or ice. As these deposits build up and are buried they harden into layers.

You can see the layers in this shale, a type of sedimentary rock.



Obsidian is an igneous rock.

Igneous rocks are formed by the earth's volcanic activity.

Metamorphic rocks are sedimentary or igneous rocks which have been transformed by pressure, temperature and fluids deep within the Earth. Diamonds and marble are examples of metamorphic rock.

Understanding of the different types of rocks and minerals helps mining engineers and geologists decide where to look for ore deposits; high concentrations of minerals which are economical to mine.

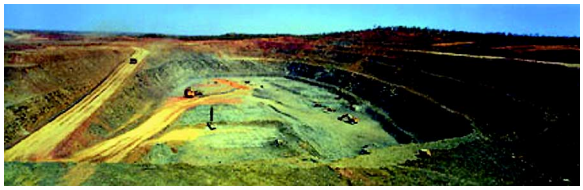
Types of mines

Minerals can be found on the surface of the earth, underground, on the ocean floor or even in sea water. The ocean floor and sea water actually hold an abundance of minerals, but, because minerals are also abundant on the land, surface and underground mining are most common.

What challenges would you face trying to mine in the ocean?

Surface mining is used when ore deposits lie relatively near the Earth's surface. There are 3 types of surface mining: open pit, strip and quarrying.

Open pits and quarries are very similar (quarries are generally for mining rock like granite) they tend to look like inverted stepped pyramids. The steps are actually called benches and in big mines they are 12-15m high and up to 40 m wide. Open pit mines can be more than 700m deep.



An open pit mine.

Strip mines are long trenches dug in the ground. One strip is dug and mined at a time. The waste material from newer strips is used to refill previous ones.


A miner working underground.

When ore deposits are far below the earth's surface, an underground mine is constructed. This type of mine is what we usually see in movies. It consists of a series of vertical (shafts) and horizontal tunnels (drifts) which allow miners and their machinery access to the ore deposit. Underground mines can be as deep as 4000m.

What do you think are the advantages and disadvantages of mining underground?

Mining and Aboriginal People

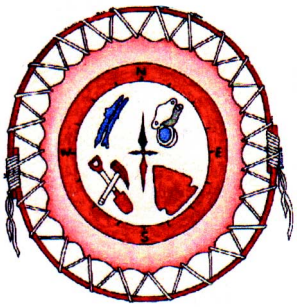
On Turtle Island mining predates contact with European people. Aboriginal peoples in many areas surface mined copper, using it for tools and decorative objects.

Did your ancestors practice mining? What objects did they make with it?

Since contact there has been an unfortunate history of misuse and abuse of mineral deposits on Aboriginal territories. Old mines have been abandoned and have leeched toxic chemicals into soil and water causing disease in the land and animals. Exploration has occurred without the permission of the peoples who are stewards of the land.

Mining engineers are involved in the planning, design and execution of all steps in the mining process. Because their work is intimately involved with the Earth, they work very closely with geologists, people who study the composition, structure and history of the Earth through rocks.

Why would the history of the Earth be important to mining?



The Mistissini Geological Resources Centre is run by the James Bay Cree of Northern Quebec with the goal of increasing economic development through mining. The Centre provides training, information and consulting services regarding prospecting, exploration and other mining activities. It also plays a role in ensuring that mining operations on Cree territory respect traditional land use and have no adverse affects on the people, the animals or the land.

Many rich mineral deposits lie on or under First Nations territories that are the subject of land claims negotiations. As the claims are settled, Aboriginal people with an expertise in geology, mineralogy and mining engineering will be well placed to contribute to the economic development of their communities through mining.

Prospecting and Exploration

To have a mine, you have to find something worth mining. The search for ore deposits is called prospecting.

How do you find minerals which are sometimes thousands of feet under the Earth?

A geologist takes a close look at exposed rock.

Mining engineers and geologists use a number of methods for prospecting. Direct observation of a site, can sometimes indicate the potential for ore deposits. More often samples of sediment, soil and water must be gathered and analyzed for traces of minerals that would indicate larger deposits under ground. Aerial and satellite imagery are also examined. Only the most promising sites are explored more thoroughly by trenching or probe holes.

Trenching is used when deposits are found fairly near the surface. A backhoe or other digging machine will remove topsoil to expose rock and minerals beneath for further study.

Probe holes are used for deeper deposits. Engineers use a drill with a hollow bit to drill hundreds or even thousands of meters into the ground and extract samples of what is actually there. Probe hole core samples are usually about 50mm in diameter. By drilling a grid of probe holes, engineers and geologists can map the deposit – depth, quality, shape, size, orientation – making mine planning easier.

The results of exploration determine whether there is enough ore available for cost-effective mining.

What elements do you think contribute to profitable mining?

Planning

In planning a mine, a mining engineer – or more likely an entire team of engineers and scientists – has to consider all aspects of the operation from construction through operation, closure and clean-up of the surrounding environment.

Many mines are located far from any town or village which can supply services, so they become like little towns themselves. In fact, in the late 1800s and early 1900s it was not unusual for towns to spring up around ore finds almost over night. In the Kootenay Mountains of BC many towns were built around silver mines; when the mines closed so did the towns.

Engineers examine plans for a proposed mine.

Do you know what these abandoned towns are commonly called?

In addition to the actual mining pit or tunnels, engineers must supply electricity, water, waste disposal, and living quarters for the workers. They must also build roads or airstrips so that the workers can come and go, and so that mined materials can be moved out for processing or sale. Sometimes mined ore is processed on the same site and so engineers must plan for this activity as well.

Another important step in panning is the reclamation plan. This is a detailed report on how the mine site will be cleaned up and restored once mining operations are completed.

Most important in the planning process is safety and consideration for the local environment.

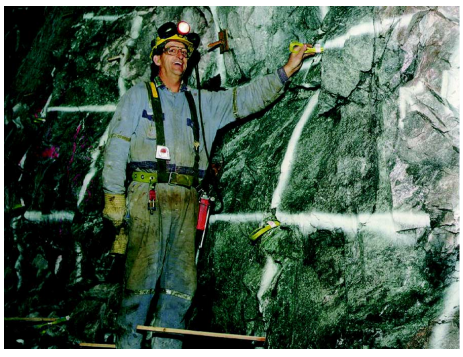
What kind of safety and environmental concerns do you think are specific to mining?

Operation

A mining operation is mostly centered on removing ore from the ground. While old movies show miners extracting ore from the ground using pick axes and hammers, these days ore is usually removed with a combination of machines and explosives. There are essentially five steps in any mining operation: drilling, blasting, loading and hauling, scaling, and reinforcing.

In large mines, **drilling** is done by large machines fitted with special drill bits which are very strong and can cut through rock quickly. These bits are used to make blast holes in the rock in which explosives can be placed. Other holes (usually larger than the blast holes) are drilled into the rock so that there is expansion room for the material broken by the explosives. Drills may also be used to remove ore.

A miner drilling into mine rock.



A blasting engineer fills a wall with charges

For **blasting**, chemical explosives are placed in the prepared holes. When ignited these chemicals produce very high gas pressures inside the hole which breaks the rock along existing weaknesses. Dynamite was used for mine blasting for many years but has been replaced by a mixture of 3 parts ammonium nitrate, NH_4NO_3, and 1 part fuel oil, CH_2.

Can you figure out what is produced by the reaction of ammonium nitrate and fuel oil? Why would the reaction products be important?

Huge trucks are used to haul large amounts of ore from the mine site for processing.

Once the rock has been broken, the ore has to be **haul**ed away for processing. In surface mining ore is **load**ed onto trucks some of which can hold nearly 200 tonnes! Depending on the depth and type of mine, trucks may also be used to remove ore from inside underground mines. If the mine is too deep for trucks, belt conveyors or other mechanized hauling systems are used to bring the ore to the surface where it is then loaded onto trucks.

Scaling is the process of clearing a newly blasted area of loose rock.

Why do you think scaling is important?

Finally, a blasted area is **reinforced** to provide the newly exposed rock with extra strength. Reinforcing can be provided in a number of ways: steel bolts can be inserted into the rock face, or a system of beams and columns (made from concrete, wood or hydraulic props) can be used to support the rock.

Operation of a mine also involves maintaining all of the services required to run the mine, so there must be adequate lighting, ventilation and access in both surface and underground mines.

Ventilation is really important for the people working in the mine, but what else is it required for?

Environmental concerns

While mining activity can be very good for economic growth, it is an activity which directly impacts the land. Great care must be taken in order to ensure that historical and sacred sites, as well as migration routes, trap lines and the environment are protected before mining starts.

One of the main environmental problems associated with mining is acidic drainage. When waste rock (or tailings) from a mining operation is exposed to water and air, sulphides – a combination of sulfur and other minerals – in the rock react to produce sulfuric acid. This acid can leech into the nearby soil or watershed dragging poisonous heavy metals such as lead, zinc, copper, arsenic, selenium, mercury, and cadmium into the ground and surface water.

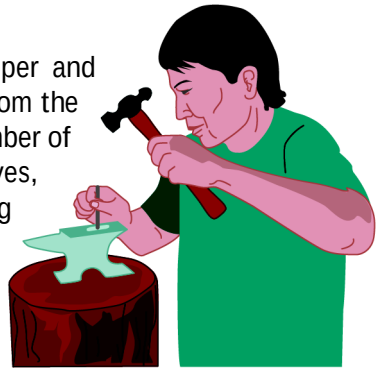
What effect do you think acidic drainage might have on community hunting or fishing?

There is another major problem related to tailings. Sometimes this waste rock contains very small amounts of desirable minerals, like gold or silver, but not enough in any one rock piece for processing. If, however, there is a large enough amount of waste rock, and mines can produce thousands of tonnes per day, there is an economical way to remove the desired mineral from the tailings. It involves pouring a cyanide solution over the rocks. The cyanide seeps into the rock and chemically removes the gold or silver, which is then collected and sold. The problem is that tailings are generally just piled up on land close to the mine so when the cyanide is poured over the rocks it drains into the surrounding land making the land toxic.

These examples are just a few of the ways that mining can have negative affects on the surrounding environment. Fortunately, with planning these and other impacts can be avoided.

What we get from mining

Gold, silver, aluminum, salt, diamonds, potash, sulfur, copper and uranium are just a few of the minerals which we can extract from the Earth. From their processing we get an almost countless number of products which we use in our lives everyday – stoves, snowmobiles, jewelry, computers, satellites, hunting equipment, cars, utensils, tools, trucks, art work and even clothing.



How many common metals and mineral products do you see or use daily? What would be more difficult about your life if there was no mining?

Mining has many benefits in our daily lives, but like other human activities which impact the land, it is an activity which must be undertaken with care and an understanding of the Earth.

References

Canadian Geological Survey
www.nrcan.gc.ca/cgs
Centre for Disease Control, Cyanide
http://www.atsdr.cdc.gov/tfacts8.html
Encyclopedia Britannica
www.brittannica.com
Junior Rockhound magazine
www.canadianrockhound.com/junior_aboutrocks.html
NativeTech
www.nativetech.org
Natural Resources Canada
www.nrcan.gc.ca
Northern perspectives
www.carc.org
US Geological Survey
www.usgs.gov

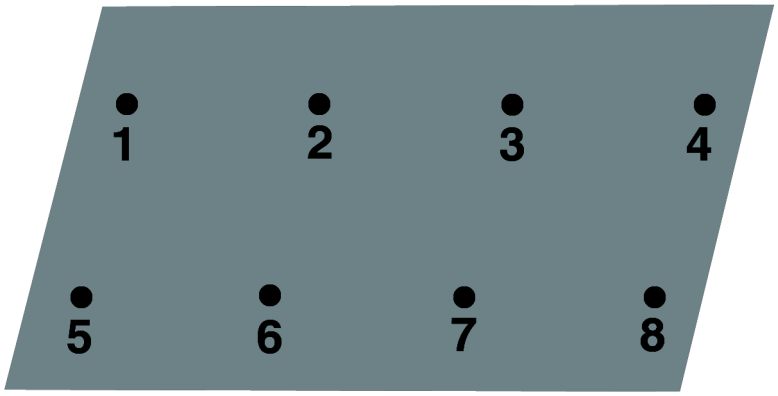
Thanks to Alfred Loon, Cree Regional Authority, for his help regarding the Mistissini Geological Resources Centre.

Math Problems

1. You are a mining engineer who has just opened a firm in your community. Prospecting has indicated that there may be significant gold deposits on your community's land. You take a team of people out to gather core samples, the results are listed in the table below.

Probe hole	High gold concentration (meters below surface)
1	7m – 20m
2	8m – 25m
3	9m – 30m
4	10m – 32m
5	15m – 18m
6	17m – 22m
7	17m – 22m
8	17m – 28m

Your core samples were laid out as follows. There is 10 m between holes, east-west and north-south.



Draw a rough map of what the ore deposit looks like. What conclusions can you draw from the map?

2. Your community runs an iron mine. On average 1500 tonnes of rock are removed from the mine each day for processing. You are selling the raw materials to a plant which is currently producing 1,000kg steel beams for construction. The material you mine is about 43% waste. It takes 1,080kg of raw iron to produce 1 beam. How many beams does the plants produce from the one day's worth of material from your mine?