

Student Handout: Mining Case Study

WHAT IS MINING?

Mining is the extraction of valuable minerals or other geological materials from the earth such as metals, precious gems, coal, gravel, and more. Mining also includes the extraction of non-renewable resources such as petroleum and natural gas. Mining is a human activity that is a large part of both our history and our current life.

While mining is necessary to how our current society functions, it also has some *disadvantages*. It impacts local ecosystems and causes major environmental issues, such as water pollution. Mines impact the health of the fish and wildlife near the mines and connected waterways, which is an issue for many Indigenous communities who rely on the fish and wildlife for food.

HOW DOES IT IMPACT US?

Mining has a long history in the Northwest Territories. There are gold, zinc, and diamond mines like the Diavik and Ekati that are still active. However, there are also many abandoned mines throughout the north, such as the **Giant Mine** outside the City of Yellowknife, which continue to leach toxins into the environment. Both active and abandoned mines have raised some concerns about the different impacts on the environment. The people most concerned about the environmental impacts caused by abandoned mines and mining development are those who live on the land and see the changes the most: Indigenous Elders, land users and harvesters, and other community members. After years living on the land hunting, fishing, and harvesting, they know the land the best. These people have vast amounts of knowledge and wisdom about the environment.

KEY DEFINITIONS:

MINING: The extraction of valuable minerals or other geological materials from the earth such as metals, precious gems, coal, gravel, and more.

BIOACCUMULATION: process by which substances, particularly contaminants, accumulate in a living organism over time. The substance is often stored in the organism's fatty tissue.

ENVIRONMENTAL HEALTH: focuses on the interrelationships between people and their environments. It includes all abiotic and biotic factors that are needed to sustain life. The "environment" part of the term includes both the natural environment and spaces made by humans.

SEISMIC TESTING: when shock waves or dynamite explosions are used to understand what is just below the surface of the earth (subsurface). It is used to help find the best places to drill for oil and gas.



Old Giant Mine Headframe - Yellowknife, NWT

Photo Credit: David Dyet

QUESTIONS TO CONSIDER:

Below are some statements from Elders, land users, and community members about some of the concerns they have about the impacts of mining on the environment. Information about mining processes is also included. As you read the case study, consider the following questions:

1. What are some possible toxins associated with the development?
2. How might toxins bioaccumulate within the watershed or ecosystem?
3. What are some potential environmental health issues associated with mining?
4. What aquatic management concerns exist about this development? What stakeholders are involved in aquatic management? What factors do these stakeholders consider and prioritize when making decisions about mining?
5. How do communities benefit from the development in long and short terms?



DID YOU KNOW?

There are approximately 25 mines located throughout the Northwest Territories. However, only four mines are actively still operating: **Snap Lake Mine, Giant Mine, Ekati Mine, and Diavik Mine.**

INDIGENOUS KNOWLEDGE ABOUT MINING

The draining of lakes and rerouting of ground water as a result of diamond mining activity is a major concern. The Gahcho Kue Diamond Mine is less than 100 kms from the community of Lutsel K'e. The diamond mine affects both the Artillery Lake and Lockhart River, as it is located in the Lockhart River system.

...it's hard to get by sometimes. We aren't miners, we're bush people. It's really scary. What's happening at the mines. I know they say it's okay, it won't affect the environment, but when they're gone we're going to have to deal with it. I don't know what's going to happen there. - Joseph Catholique, Lutsel k'e area, p. 51, 2016-2017 Report

The Yellowknives Dene First Nations have been deeply involved in various kinds of research initiatives and consultations regarding the impacts of this mine on their health, culture, and livelihood. Their involvement and understanding of potential mining impacts has made people concerned about mining in other areas. In general, it is believed that where there are mines the fish are unhealthy and *where there are no mines the fish are healthy* (Yellowknives Dene First Nation Elder). Akaitcho area report, p. 54, 2016-2017 Report

Similar to concerns raised about mining in the north, in the 70s, 80s and 90s in the Dehcho area seismic testing was done that was detrimental to the fish population along the Mackenzie river. What someone from the community had to say on this issue:

A tugboat pushing three or fours barges would stop every kilometre or so and set off an explosion—blasting. Each blast sent water shooting up above the trees. There were many dead fish floating down the river. - Dehcho K'ehodi Program participant, Dehcho area, p. 36, 2016-2017 report



Giant Mine Remediation Project

Photo Credit: Kevin O'Reilly

MINING PROCESSES

Mining Diamonds (Adapted from: <https://www.shimansky.co.za/discover/about-diamonds/mining>)

Diamonds are usually found in a rock called "Kimberlite." There are several ways to mine diamonds from Kimberlite: open-pit mining, underground mining, and alluvial mining.

- **Open-Pit mining** involves removing layers of ground material just above Kimberlite rock. Next, explosives are used to break up the rock and the broken "ore" is transported to machinery to be processed.
- **Underground mining** is when miners tunnel through the Earth's crust to reach the Kimberlite. Two tunnels are built - one over the other - with funnels built to connect the two. Miners blast ore in the top tunnel which then falls and collects in the second tunnel. Loaders then collect the broken Kimberlite and transport it to the surface for processing.
- **Alluvial mining** is focused on extracting diamonds from Kimberlite that has been transported down streams and rivers. Over thousands of years the Kimberlite that reaches the surface has been eroded, and alluvial mining utilizes these downstream deposits. Diamonds are usually found in the gravel of layers of mud, clay, and underwater plant life. Large-scale mining involves diverting water behind a large wall and then collecting and hauling the Kimberlite material to a processing area.

FACTS ABOUT MINING IN CANADA:

In 2018, Canada was the world's third largest producer of diamonds (NRCAN, 2020)

In 2018, Canada's total primary exports of diamonds were valued at \$2.9 billion (NRCAN, 2020)

Gold is a precious metal and is most commonly used in jewellery. About 40% of gold is purchased by banks and investors for investment and financial stability purposes. Gold is Canada's most valuable mined mineral and is extracted in nine Canadian provinces and territories. Unlike diamonds, gold is continually being recycled. Gold can be melted down and used again!



NWT Archives/James Carmichael/N-2017-002.0021

NWT Mining Trolley

Photo Credit: James Carmichael

There are 5 steps needed to process the Kimberlite ore and extract diamonds.

1. **Crushing:** Large pieces of ore are crushed into small pieces, no more than 150mm. Another crusher is used to break down to even smaller pieces.
2. **Scrubbing:** Pieces of ore are scrubbed down to remove loose material, like sand, and then screened to ensure they are the correct size. Pieces of ore smaller than 1.5mm are discarded because it is too expensive to remove diamonds from such a small rock.
3. **Cyclonic Separation Plant:** A chemical solution of ferrosilicon powder and water is combined and mixed with the diamond-bearing ore. The mixture is then put into a cyclone machine where it is tumbled. The material with the highest density sinks to the bottom of the machine, and the less dense diamonds form a layer at the top.
4. **Recovery:** The diamond concentrate then goes through several processes that involve magnetic susceptibility, x-ray luminescence, and crystallographic laser fluorescence (science of determining the arrangement of atoms within crystals). The exact processes are decided on based on the unique properties of the diamonds, in order to separate the diamonds from other materials. Sensors detect flashes of light emitted by the diamonds and a microprocessor blasts air at the diamond which is spit into a collection box.
5. **Cleaned, Weighted, and Packaged:** Diamonds are removed from the collection box and cleaned with an acidic solution. The final stage is washing, weighing, and packaging diamonds for transportation.

REMEMBER THESE STEPS!

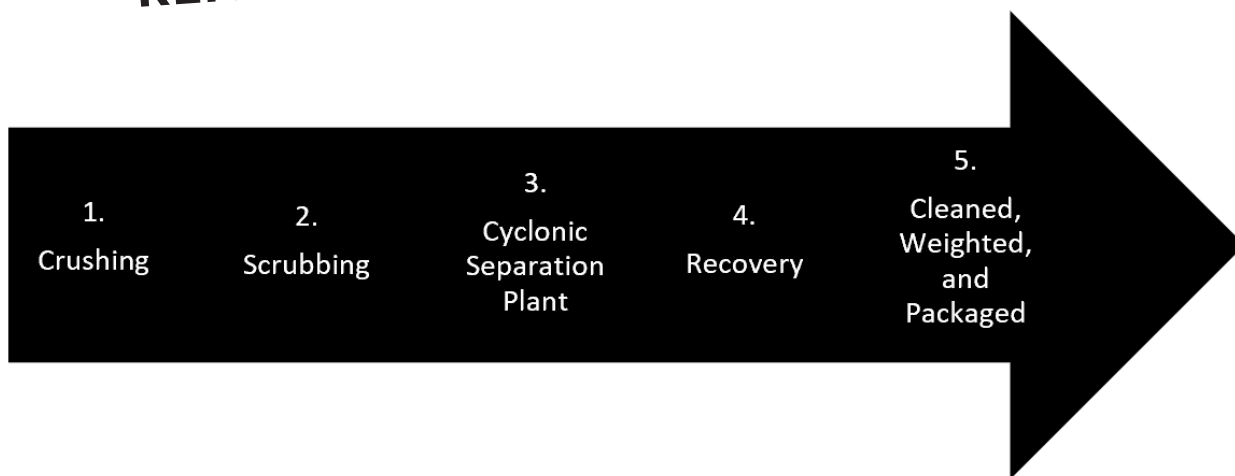


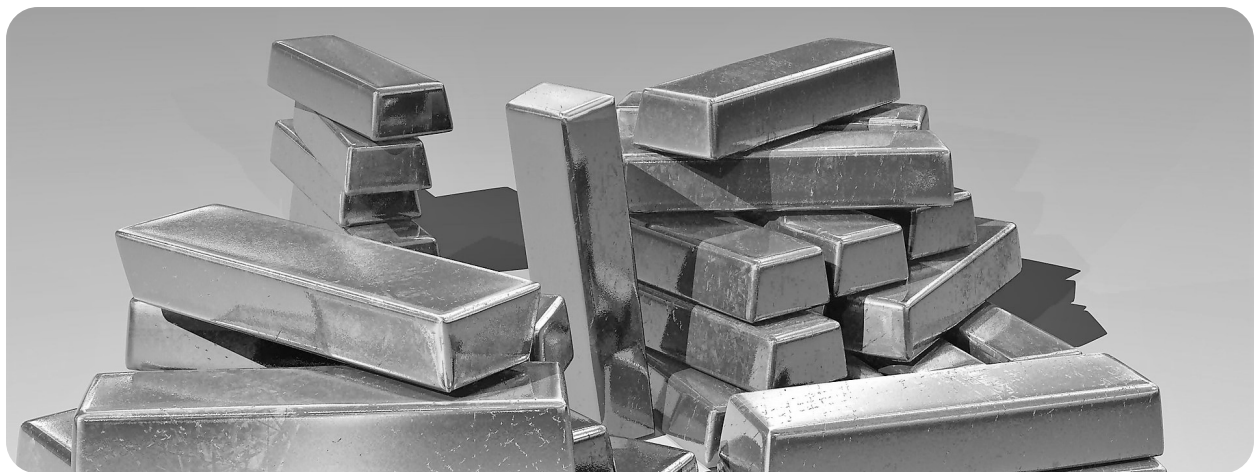
Figure 1: 5-Steps needed to process Kimberlite Ore and extract diamonds.

Extracting Gold

(adapted from: <https://science.howstuffworks.com/gold4.htm>)

Removing gold-bearing rock material from the ground is the first step in gold mining. Next, mining companies use a complicated process to extract gold from the material.

1. **Crushing:** Miners break down large pieces of rock into smaller pieces. "Crusher" machines break the rock down into sizes about the size of road gravel. This material is then put into rotating drums along with steel balls. This process grinds up the rock and turns it into a slurry or powder.
2. **Leaching:** The slurry or powder is mixed with water to form a pulp. This mixture is put into leaching tanks where the gold is dissolved out of the rock using a chemical solvent. Most often, miners use cyanide in this process. When cyanide is used it is combined with oxygen in a process known as "carbon-in-pulp." The chemical reaction of cyanide and oxygen interacting causes the gold to dissolve. Miners insert filters which helps in separating the gold-bearing carbon from other materials.
3. **Stripping:** The gold-bearing carbon is moved to a stripping vessel where a hot, corrosive solution separates the gold from the carbon. More filters are used to remove the carbon grains, which can be recycled for future gold extraction. Next, the gold-bearing solution enters the electrowinning stage which recovers the gold from the leaching chemicals. This happens when miners pour the gold solution into a container known as a "cell" and strong electric currents are used to remove the gold.
4. **Smelting:** This stage results in nearly pure gold. The remaining gold material is put into a furnace at 2,100 degrees F (1,149 degrees C). A chemical mixture called "flux" is added to the molten material which separates gold from any remaining non-gold material. Molds are used to transform the liquid into gold bars. Low-purity bars are sent to other refineries for future processing.



Bricks of Gold

Photo Credit: Steve Bidmead



Aerial View of an Open-Pit Mine

Photo Credit: Dion Beetson

ENVIRONMENTAL IMPACTS

In general, mining can pollute water and air, disrupt wildlife, and permanently change natural environmental systems. Chemicals used while processing diamonds and extracting gold can leak into bedrock or nearby waterways. This results in poisoned water, as well as fish and other species that bioaccumulate toxins overtime. People that rely on food harvested from the land are at risk of consuming the chemicals either through drinking the water or consuming animals that have the toxins stored in their body tissues. This can cause serious health problems. Industrial developments also require large amounts of water, which can result in changes to the waterways natural flow and water levels.

Roadways built to support industrial development can result in wildlife habitat degradation and fragmentation. Degradation happens when humans convert natural areas into landscapes like cropland, urban centres, or areas for infrastructure (e.g. roads, dams, powerlines). Habitat fragmentation happens when an animal's habitat is cut into smaller pieces due to human development. If fragmentation occurs it means an animal may no longer have access to enough space to access the food, water, and shelter it needs. Wildlife also face dangers of being struck by machinery or vehicles, or being "destroyed" if they get too close to human settlements. Caribou, wolverine, bears, ptarmigan, and fish, are some of the animals that are the most impacted by mines

ECONOMIC CONSIDERATIONS

Many people think diamonds are only used for jewellery. However, 80% of the world's diamond production (by weight) is used in industrial and research applications. Diamonds are also used to dissipate heat in electronic devices. This is because diamonds have the highest thermal conductivity of any material at room temperature. Next time you use a cell phone or computer, think about the role a diamond plays in its operation!