

The Great Canadian Cookie Mine

Contributor's Information:

Modified by Tracy Webb from original SATIS activity; updated 2022
Horton High School

Appropriate Grade level(s): 7 - 12

Time: 2 40-minute periods or 1 75-minute period

Introduction:

When prospectors and field geologists discover rocks containing valuable minerals, they need to determine whether there is enough to actually mine. Rocks with economic value are called ores, and these can vary greatly in mineral percentage. Before a mine is developed, the ore must be carefully studied to decide the amount of the overall resource (how many years can it be mined) and the percentage of mineral in the ore (is it consistent and high enough to be worth the cost of mining). There are other important factors, such as environmental impact assessments, safety considerations for the miners, processing and transportation issues and world market values.

In this activity, you are employed by a mining research lab and have just received one or two samples of an ore. Your assessment of the economic value is an important factor in whether a new mine will be developed or not. The ore contains a dark mineral within a lighter-coloured "rock". You have to separate the mineral from the waste products, and consider whether its percentage is high enough to mine. With this particular mineral, you know that it has to be at least 30% or else it isn't worth mining.

Geologist Role Play

To "mine" a mineral from an "ore" using chocolate chip cookies, to determine the percentage of mineral and assess economic viability; to become aware of the various factors that influence the economical value of a mineral

Materials Required:

Balance, weighing papers (muffin paper cups), spatulas or toothpicks, paper towel, chocolate chip cookies

What to Do:

- 1. Before you begin to separate the mineral from the waste, measure the mass of your cookie sample(s) and record your values in the data table below.**
2. Determine a method for separating the "mineral" from the "rock" sample. Describe your process in words. Carefully extract your mineral.

3. When you have separated the mineral from the waste, measure the mass of the mineral and the waste. Calculate the percent of chocolate chips found in the cookie, and then the percent of waste left over. **Include data from at least one other person.**

Sample	A) Mass of whole cookie	B) Mass of "mineral" chips	C) Mass of waste	% Chips in cookie (B/A)	% of waste
1.					
2.					
3.					

3. A) Compare your results with one or two other people. Does the amount of mineral seem to be about the same in each rock sample? Why or why not?

B) From the table, what is the percentage of mineral (chocolate chips) in the ore (whole cookie)?

C) Would this sample represent an ore that is economically valuable? Explain.

4. A) From the table, what is the percentage of waste rock in the ore sample? In a real mine, would it be possible to put the waste back into the hole made during the mining of the ore? Is there enough to fill the hole?

B) How could this affect the environment?

5. If a second "ore sample" is available, try to see if you can separate the mineral more efficiently. Record your results on the data table. What did you discover?

Optional: If the brand of cookie is different, does this give different results? Explain.

Summary: List the main concepts (at least two) that you have learned from this activity.

Extension:

Copper Mining in New Guinea – a Case Study

Introduction:

In Papua New Guinea, there was a huge open-pit copper mine and processing facility at Panguna in central Bougainville, which operated from 1972 – 1989. Every day, approximately 220 000 tonnes of ore was processed and reduced to yield about 500 tonnes of pure copper metal (1000 kg = 1 tonne). The amount of waste rock was significant and poses a serious problem to the environment. During processing, the ore is crushed and ground into a fine powder, which allows the copper metal to be extracted. These powdered wastes were found washing into the Kawerong river along a 35 km stretch, and some of the waste formed a large delta where the river enters the sea.

The amount of copper was not the key economic value of the Bougainville mine strangely enough. As in many mining operations, the mine also produced amounts of other valuable metals, such as gold and silver. Over the 17 years of producing a concentrate of three million tonnes of copper, the mine also had 306 tonnes of gold and 784 tonnes of silver. Today, Bougainville Copper's main objective is to work cooperatively with community with the goal of resuming exploration and implement sustainable mining practices of the copper, gold and silver resources at Panguna

Imagine the size of a standard 2 kg bag of sugar – to get this amount of pure copper, you need 1000 kg of raw copper ore.

1000 kg raw copper ore ⇒	500 kg copper ore ↓ ⇒	8 kg copper ↓ concentrate ⇒	2 kg pure copper ↓
Byproducts of refining:	_____ kg waste	_____ kg waste	_____ kg waste

Questions:

1. From the table, calculate the percentage of pure copper in the ore.
2. Calculate the percentage of copper in the tonnes of rock mined each day from the Bougainville Mine. Given the standard required value of 0.02% copper, does this meet the percentage required for the mine to make a profit?
3. Determine what factors affect the environment by open pit mining and list. How can these factors be altered or changed?
4. Many factors may affect the economic life of a mine, such as safety for the miners, the environment, cost of production compared to profit values, amount of resource available, ease of extraction and transportation. Research one of these factors and summarize your findings in a paragraph.

Conclusion:**Teacher References:****Performance Assessment:**

- Students will be able to calculate the percentage of their cookie ore and present their assessment of the economic viability as compared to the case study values.
- They will be able to demonstrate their understanding of copper mining and the relative amount of pure copper extracted from the ore.
- Students should be able to assess environmental impacts of mining and show awareness of short and long term effects.

Additional Suggestions:

- Use two or more different brands of cookies to show the difference in percent of chocolate – relative to differences of mineral concentrations in the ore.
- Compare to other copper mines and/or mining practices in general. Research other mine production values to compare economically to the Bougainville mine, such as the Bingham Mine in the USA.
- Assess the economic impact of mines relative to the environment and society, such as the Texas Gulf, Schumacher, Dome, Porcupine and other mines in the Timmins area, Ontario.

Other Resources:

<https://www.bcl.com.pg/history-panguna-mine/>