

Ores to Minerals

Lesson 5 Cookie Mining

STUDENT LAB GUIDE

Name: _____

Date: _____ Class: _____

Guiding Questions

How are minerals obtained from the Earth's crust?

What is ore, and what processes refine minerals from raw ore?

What factors influence mining and refining operations?

How are minerals distributed in the Earth's crust?

What is restoration? Is it effective, and why is it important?

Are minerals a renewable resource?

Description

The chocolate chips represent valuable mineral deposits on Earth. As a mining company, you wish to extract the raw ore and refine it to obtain the mineral within without causing undue harm to the surrounding environment. You also wish your business to be efficient and profitable. In today's activity, you will model the process of surface mining using a chocolate chip cookie and commonly available tools, like a paperclip.

Introduction

Obtaining Minerals

Minerals are generally found embedded in rocks in the Earth's crust. People obtain solid minerals mostly by mining, or the extraction of raw ore. Ore is a deposit in Earth's crust of one or more valuable minerals embedded into rock. The most valuable ore deposits contain minerals crucial to industry and trade. Mining takes a lot of planning. The desired mineral must be located, and the land must be leased or purchased. Permits are needed, and there are laws that must be obeyed—huge fines may be imposed for improper mining practices, such as contaminating drinking water or violations of health and safety standards.

Extraction

To obtain raw ore, miners must **extract** chunks of rocks and bring them to the surface so that the minerals can be taken out and processed for use. How raw ore is extracted depends on the type of mineral and the mining technique.

Refinement

Refinement is the process used to remove all undesirable “waste” components and separate the desired mineral. Refining raw ore can include many steps, but generally, the raw ore is crushed and ground, which breaks the large rocks into much smaller pieces. The smaller pieces are often washed with water and heated in a process called **smelting**. An electrical process called **electrolysis** may also be used, in which metals, oxygen, and any desired oxides are separated. The processes can vary depending on the types of minerals and their properties.

Mineral Distribution

Certain minerals only develop in specific locations due to past geological processes like volcanic activity, plate tectonics, weathering, and erosion. Due to the movement of the rocky sections of the Earth’s crust that float on a layer of molten rock called **tectonic plates**, certain minerals are more prevalent near subduction zones where tectonic plates overlap. **Weathering**, the breakdown of rocks or minerals, can concentrate certain minerals by removing other materials in the weathering process. **Erosion** carries away the other material in the rock, leaving the concentrated minerals more exposed. Minerals can also be localized because they are deposited into layers over time if they themselves erode from weathered rock.

The Mining Business

The business of mining has become a valuable industry. Companies take up the extraction and refinement processes and sell or trade the refined minerals for profit, often in worldwide markets. The market system is complex, and usually, trade intermediaries are necessary as a go-between for a mining company and a purchaser. Prices are determined by geographic factors, geopolitical forces, the rarity of the mineral, and its status as “critical,” or essential.

Types of Mining

Some minerals are closer to the surface and some are embedded deeply into the Earth’s crust. The type of mining operation depends on the location of the desired minerals.

- **Underground mining** requires digging tunnels or shafts deep into Earth’s crust. Miners must be transported up and down, and raw ore must be brought to the surface.
- **Surface mining** takes place on the surface, or very near, which makes it safer. Surface mining doesn’t require air shaft ventilation, electricity rigging, or water piping, which makes it easier and faster. There are several types of surface mining: strip mining, open-pit mining, mountain-top removal, and dredging.
 - **Strip mining:** The surface is pulled away from the mineral that’s being extracted. Huge machines, called excavators, are used to scrape away the surface and expose the mineral for extraction. Then, the surface is filled in with the unused rubble.
 - **Open-pit mining:** Open-pit mines are commonly called quarries. In open-pit mining, the surface is once again removed and ore containing the desired mineral is collected, but the mine is not filled back in.
 - **Mountain-top removal:** Explosives are used at a mountaintop to blast out the raw ore. The raw ore moves downhill and collects where it can be retrieved for processing. This method is controversial, as it greatly affects the environment and the mountaintop cannot be replaced or renewed.
 - **Dredging:** On water, such as a river, a scoop lifts ore up on a conveyor belt where it is transported for immediate processing. The unwanted water material is then dropped back into the water.

Renewable versus Nonrenewable

Many of Earth’s resources are **renewable** because they will replenish over time. However, resources like oil, coal, and minerals are not renewable. **Nonrenewable** resources formed millions of years ago and have been lying in the Earth’s crust all this time. Once the resource is obtained, it is gone from the Earth’s crust forever.

Reclamation

In surface mining, after mining operations are over, the environmental harm is minimized and mined lands are returned to beneficial use. Examples of reclamation activities include filling in open pits with rubble and soil, adding walls and drainage to ensure limited erosion, planting native vegetation, repurposing the use of the land into something beneficial (like a nature preserve), and reintroducing animal species to a restored habitat. Reclamation is expensive, and surface mining companies generally must have a reclamation plan before beginning operations.

Requirements

- You must buy/lease the land that you will be mining.
- The cookie represents the land you will be mining and the chocolate chips represent the desired minerals you wish to sell or trade.
- You are surface mining, so you must work from above; this means that you may not flip the cookie over.
- You must pay the workers for their work. So, you must time the mining efforts to determine how much you need to pay for labor.
- Use only the tool(s) you purchase to touch the cookie during mining, unless directed otherwise.
- You will have to pay for the restoration of the land, so try to keep the cookie intact while mining.

Materials

1

Student Worksheet

2

Student Slides

3

Student Lab Guide

4

Timer

5

Ruler with centimeters

6

Chocolate chip cookie, soft and large

7

Extraction tools (scoopula, scientific spatula, toothpick, straw, plastic knife, chopstick, safety pin, nail, paper clip, etc.)

Instructions

- Count the squares in the grid on the graph paper in the “Data” section of the Student Worksheet. This is the land you must purchase for your mining operations. Each square of the grid measures 1 square centimeter (cm²) and costs you \$1 to purchase. Record the land purchase cost in Table 2: Profit and Loss (P&L).
- Place the chocolate chip cookie onto the graph paper, trace it, and find its area. Record this area in square centimeters (cm²) in Table 1: Mining Areas and Times as the initial area before mining. You may wish to measure the cookie’s diameter and calculate the area using the equation $A = \pi \left(\frac{D}{2}\right)^2$ where A is the area and D is the cookie diameter.
- Purchase the first tool you will use. Record its cost in Table 2: Profit and Loss (P&L) as an equipment cost. You may only use this tool to touch the cookie when you begin mining.
- Begin mining: Press “Start” on your timer. Use the chosen tool to extract the chocolate chips. Try to remove the small crumbs that cling to the chocolate chips, but do not discard the crumbs. When you have obtained all the mineral deposits, make sure to stop your timer. Record the amount of time in seconds in Table 1: Mining Areas and Times.
- Calculate the cost of labor assuming that 1 second costs \$1, and record that information in Table 2: Profit and Loss (P&L).
- Extract the minerals from the raw ore: To do this, use your fingers to remove all the small crumbs from the chocolate chips. These small crumbs can be returned to the cookie leftovers.
- Determine the amount of refined mineral: Move the chocolate chips to one side of the graph paper, pushing them close together but not on top of one another. Use the straight edge of the ruler to form the chocolate chips into a square shape. Count the squares on the graph paper or determine the area of the square shape by measuring its length and width and using the area equation $A = L \times W$ where A is area, L is length, and W is width. Record the area of the chocolate chips in square centimeters in Table 1: Mining Areas and Times.
- Determine the profit from selling the mineral: Each square centimeter adds \$400 to your profits. You may estimate

Cost	
Scoopula	\$120
Scientific Spatula	\$110
Plastic Knife	\$100
Paper Clip	\$90
Toothpick	\$80
Safety Pin	\$70
Nail	\$60
Straw	\$50
Chopstick	\$40
Other	Teacher-Assigned

halves and quarters as needed. Calculate the profits by using the following equation to multiply the value of each square centimeter by the area of the mineral: $Profit = \$400/sq\ cm \times area\ of\ chocolate\ chips\ (sq\ cm)$. Record the sale profit in Table 2: Profit and Loss (P&L).

- Begin restoration by assessing the damaged area: Push the remaining pieces of the cookie back together and fill in any tiny cracks with crumbs. You may use your fingers or any tool to do this. Determine the area of the cookie remains for restoration and record this in Table 1: Mining Areas and Times.
- Determine the cost of restoration: Calculate the costs for the mining company to repair the damages to the environment. Each square centimeter costs \$50 to restore. Use the following equation to multiply the cost per square centimeter by the damaged area: $Restoration\ Cost = \$50/sq\ cm \times damaged\ area\ (sq\ cm)$. Record the cost of restoration in Table 2: Profit and Loss (P&L).
- Calculate the net earnings: Tally the values in Table 2: Profit and Loss (P&L) to find out how profitable the mining and refining business was.