Economic Feasibility Study

Overview

In this activity, students will analyze proportional relationships and use them to solve real-world problems. Students will conduct an economic feasibility study to compare production of copper at a mine site to determine if the deposits will be profitable at a particular copper selling price. They will also identify items made of copper and manufacturers that use copper in their products.

Topic: **Natural Resources**

Real World Science Topics

- Natural resource distribution
- Mining

Objective

After completing this activity, students will be able to evaluate economic feasibility by using variables and proportional reasoning to solve real-world problems.

NGSS Three-Dimensions

Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
Analyzing and Interpreting Data • Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.	**ESS3.A: Natural Resources** • Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Common Core State Standards-Mathematics

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.
7.RP.A.2c Represent proportional relationships by equations.

Background Information

What is copper ore?

Once a concentration of copper bearing minerals are discovered in Earth's crust and it is determined to be profitable to extract the copper, the rock material to be mined from the copper deposit is referred to as copper ore. There are two basic methods of mining the copper ore: surface or open-pit mining and underground mining. Open-pit mining is the predominant mining method used throughout the world. Determining the mining method depends on many factors such as the depth of copper deposit from the surface. A shallow deposit is more likely to be mined by open-pit methods and a deeper deposit is more likely to be mined by underground methods.

Where can you find copper ore?

Thousands of years ago, copper could easily be found on Earth's surface and was abundant enough in quantities to meet the demands of society. Prospecting and mining for copper then was very laborious using relatively simple methods.

The industrial revolution in the late 1800's and early 1900's increased demand for copper. The quantity of easily found copper on the surface was not sufficient to keep up with the increasing demand. As a result, prospecting and mining technology evolved allowing profitable extraction of copper from beneath the surface in large enough quantities to meet the future demand.

How is copper produced?

Pure copper metal is generally produced from a multistage process, beginning with mining of the copper ore, followed by concentrating the copper minerals, smelting (melting the copper minerals) and electrolytic refining (copper plating) to produce pure copper in a form called a cathode. Another method of copper metal production begins with mining of the copper ore followed by acid leaching (dissolving the copper minerals) and then electrolytic refining. Copper is one of the oldest metals ever used and has been one of the important materials in the development of civilization.

How do we use copper?

Building construction is the single largest market, followed by electronics and electronic products, transportation, industrial machinery, and consumer products.

Key Vocabulary

Copper- an element that is a ductile metal with very high thermal and electrical conductivity
Mining- a method to extract minerals or other useful materials from Earth
Natural Resources- materials that come from the environment that are put to beneficial use

Materials

- Copies of copper mining sites

Steps for Activity

1. Ask students the following questions:
   - What types of materials are used to make cell phones?
   - Where do you think we find these materials?
   - Do cell phones have anything in common with minerals?

   Explain to students that cell phones help us stay connected and have features that allow us to access the internet, play games, message, and take pictures. All of the components to make these features work come from mined minerals extracted from the earth. Share the breakdown of some minerals and elements found in cell phones.

Arsenic
Copper
Gallium
Gold
Indium
Platinum
Silver
Tin
Silica (glass)
Plastic (oil)

   Explain to students that potential mining sites are evaluated economically to meet a production volume that matches human demand. Currently mining companies worldwide produce 20 million tons per year of the most profitable copper metal to meet the demand. Current demand is growing at about 5% per year. This means that next year the mining companies will need to produce 21 million tons.

2. Say: Geologists look for signs and/or anomalies that would indicate the presence of a mineral deposit. Three sites of copper ore deposits have been discovered in Arizona. You have been asked to identify which mine site will be the most economically feasible from which to extract copper. It is very important to be accurate in locating copper ore, because the exploration step is a very costly process.

3. Explain that according to the Arizona Mining Association, the average mine produces 10 pounds of copper from one ton of copper ore. Ask: if one ton equals 2,000 pounds, how many pounds of copper will be found in 2 tons of copper ore? *That means the mine will produce 20 pounds of copper.* Students can record this information on their capture sheet. As a reference, share with students that the electronics in cars require 50 pounds of copper. A cell phone includes a half an ounce of copper, which is about 12% of the phone's total weight.

4. Distribute the mining sites. Explain to students that they need to identify the current market price for copper using *http://www.nasdaq.com/markets/copper.aspx* or they can see prices over time at *http://minerals.usgs.gov/minerals/pubs/commodity/copper/*. Automobile, appliance, and electronic manufacturers are the most interested in buying copper to use for everyday objects like cell phones, cars, and washing machines. Explain to students that they are looking at the three sites to find the more profitable mine.

5. Ask students to use the information they captured in step 3 and the site information on the map to determine the profit margin at each site. The capture sheet guides students through the steps to evaluate each mining site. Clarify that the reclamation cost includes costs associated with restoring the land that has been mined or disturbed. This cost ensures the land will return to a condition that is compatible with the natural environment and minimizes impacts to undisturbed land, natural water, and air quality. Sometimes the reclaimed land can be used for other purposes such as farming and cattle grazing. This cost is determined before the mining process begins. There also may be costs associated with land use, including fees to provide environmental protection.

   Teacher Note: Additional information about environmental protection of specific species is available at *http://www.fws.gov/*

6. Guide students to rank each site from most to least profitable based on the available ore and cost of mining.

   Teacher note: The correct order of profitability is site 2, 3, and 1.

Extension Activity

Challenge students to calculate how many car electronics or cell phones could be outfitted with copper based on the data in step 3.

Additional Resources

http://www.usgs.gov/energy_minerals/
http://mineralsciences.si.edu/

Mining Sites Activity Sheet

Background Information

- 2,000 pounds = _____tons
- In each ton of copper ore, approximately _____ pounds will include copper that can be used for manufacturing.
- Current market price of copper _____/lb.

Step I - Fill in the numbers from the Mining Sites below

	Site 1	Site 2	Site 3
Tons of Ore			
Mine per Ton Cost			
Environmental Protection Cost			
Reclamation Cost			

Step II - Calculate the *pounds* of copper at each site

Solve for **Z** in the equation

$$\frac{1 \text{ ton of ore}}{\#\text{ of tons of ore at Site}} \times \frac{10 \text{ pounds of copper}}{Z \text{ pounds of copper at site}} = \text{pounds of copper at site}$$

	Site 1	Site 2	Site 3
Pounds of copper at site			

Step III - Calculate the price of copper at each site

pounds of copper at site x market price for copper = price of copper

	Site 1	Site 2	Site 3
Price of copper at site			

Step IV - Calculate the mining cost at each site (you do not need to convert to pounds for this step)

of **tons** of ore at Site x $25.00 per ton = mining cost

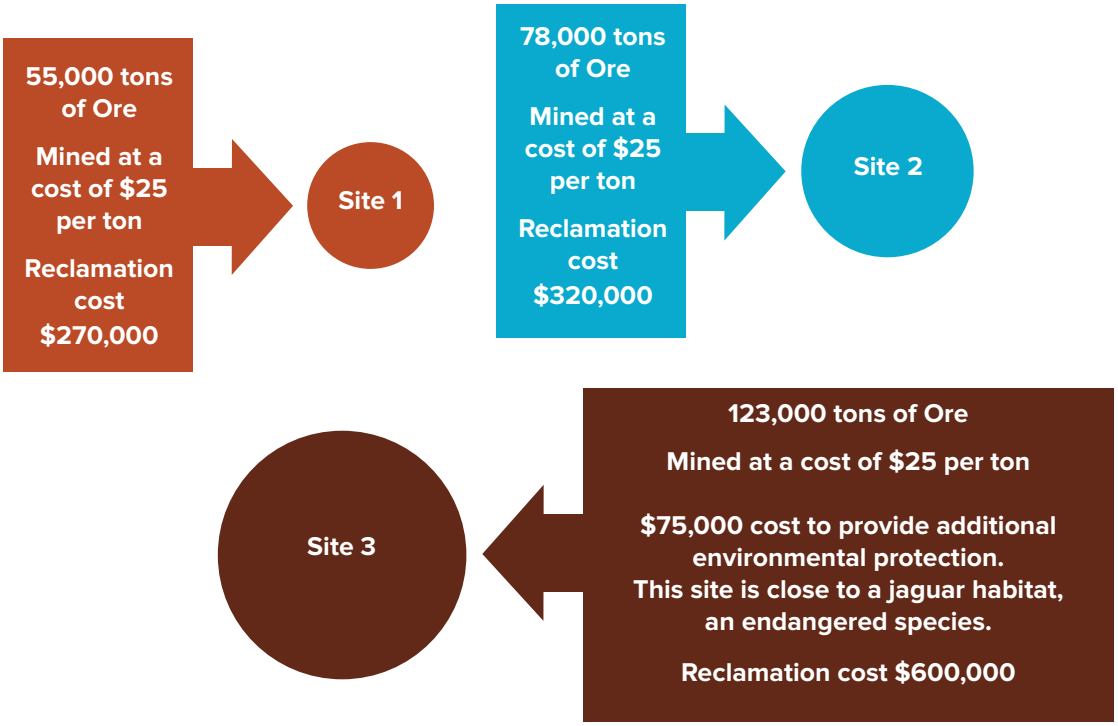
	Site 1	Site 2	Site 3
Mining cost at site			

Step V - Calculate the profitability

Price of copper – mining cost – reclamation cost – any other noted expenses = profit at mining site

	Site 1	Site 2	Site 3
Profit at each site			

Mining Sites



Analysis

How much would each site Profit?

Site 1	Profit	# of car electronics that can be produced	# of cell phone components that can be produced
		(Extension)	(Extension)
1			
2			
3			

If you could only mine at one site, which would you choose? Why?

What if the price of copper dropped to $2.25? Would that influence your choice from #2?

Mining Sites Activity Sheet *(Answer Key)*

Background Information

- 2,000 pounds = *1* tons
- In each ton of copper ore, approximately *10* pounds will include copper that can be used for manufacturing.
- Current market price of copper *3.25*/lb.

Step I - Fill in the numbers from the Mining Sites below

	Site 1	Site 2	Site 3
Tons of Ore	*55,000 tons*	*78,000 tons*	*123,000 tons*
Mine per Ton Cost	*$25*	*$25*	*$25*
Environmental Protection Cost	*0*	*0*	*$75,000*
Reclamation Cost	*$270,000*	*$320,000*	*$600,000*

Step II - Calculate the *pounds* of copper at each site

Solve for **Z** in the equation

$$\frac{\text{1 ton of ore}}{\text{\# of tons of ore at Site}} \times \frac{\text{10 pounds of copper}}{\text{Z pounds of copper at site}} = \text{pounds of copper at site}$$

	Site 1	Site 2	Site 3
Pounds of copper at site	*550,000 lbs*	*780,000 lbs*	*1,230,000 lbs*

Step III - Calculate the price of copper at each site

\# pounds of copper at site x market price for copper = price of copper

	Site 1	Site 2	Site 3
Price of copper at site	*$1,787,500*	*$2,535,000*	*$3,997,500*

Step IV - Calculate the mining cost at each site (you do not need to convert to pounds for this step)

of **tons** of ore at Site x $25.00 per ton = mining cost

	Site 1	Site 2	Site 3
Mining cost at site	*$1,375,000*	*$1,950,000*	*$3,075,000*

Step V - Calculate the profitability

Price of copper – mining cost – reclamation cost – any other noted expenses = profit at mining site

Site 1	Site 2	Site 3
$1,787,500-$1,375,000-$270,000=	*$2,535,000-$1,950,000-$320,000=*	*$3,997,500-$3,075,000-$75,000-$600,000=*

	Site 1	Site 2	Site 3
Profit at each site	*$142,500*	*$265,000*	*$247,500*

Analysis

How much would each site Profit?

Site 1	Profit	# of car electronics that can be produced	# of cell phone components that can be produced
		(Extension)	(Extension)
1	*$142,500*	*550,000lbs/50lbs=11,000 car electronics*	*550,000lbs/.03125ounces= 17,600,000 cell phone components*
2	*$265,000*	*780,000lbs/50lbs=15,600 car electronics*	*780,000lbs/.03125ounces= 24,960,000 cell phone components*
3	*$247,500*	*1,230,000lbs/50lbs=24,600 car electronics*	*1,230,000lbs/.03125ounces = 39,360,000 cell phone components*

If you could only mine at one site, which would you choose? Why?

It is anticipated students that will choose site 2.

What if the price of copper dropped to $2.25? Would that influence your choice from #2?

Responses will vary.