

Chocolate Chip Mining

Contents: A practical activity linked to analysis of data about copper mining.

Time: 2 to 3 periods.

Intended use: GCSE Chemistry and Science. Links with work on metal extraction with special reference to the environmental problems associated with the recovery of minerals.

Aims:

- To show the economic importance of the fact that mineral resources are not evenly distributed in the Earth's crust
- To develop awareness of the environmental impact of mining and the difficulty of reclaiming mined areas
- To provide an opportunity for open-ended problem solving
- To provide an opportunity to practise the skill of interpreting data.

Requirements: Students' worksheets No.1001. Suggested equipment for Part 1 is listed below.

Author: Andrew Hunt

Suggested use

This unit is in two parts. Each part is self-contained.

Part 1 Mineral processing

This is a practical activity which should have a wide appeal. It uses the problem of 'mining' chocolate chips in a biscuit as an analogy for the difficulties involved in developing mineral resources.

Part 2 Copper mining

This is a data-analysis exercise which is designed to show the real-life importance of the analogy used in Part 1. With some pupils it may be more appropriate to give Part 1 more meaning by showing a film, slides or a video (see below under 'Further resources').

Notes on Part 1

Safety

There is little doubt that some students will be tempted to eat the results of their 'mining' and so this activity should not take place in a laboratory if at all possible. In any case normal laboratory equipment should not be used unless it can be guaranteed that no one will eat the output of their processing operations. One way round the practical problems is to set this activity for homework but students will then miss the benefits of discussing the results with others. Alternatively students can be asked to bring their own 'mining equipment' from home.

Requirements

Each group of students will need:

2 chocolate chip biscuits (which should be stored in a refrigerator or other cool place before use)
clean containers, e.g. margarine tubs, or yoghurt pots

access to a variety of equipment and materials such as:

- knife
- spatula
- sieve or strainer
- water bath
- a balance
- measuring cylinder
- oven

This exercise could be used as an opportunity to introduce some simple statistical ideas. Students could be asked to plot a histogram to show the range and variation of the quantities of chocolate 'mined' from biscuits by the groups in the class.

Answers to questions in Part 2

Q.1 80 times more concentrated

Q.2 (a) 500 kg
(b) 8 kg
(c) 2 kg

Q.3 (a) 25%
(b) 0.4%
(c) 0.2%

Q.4 0.2%

Further resources

Background reading for the teacher is included in:

- Science in Society, Book G, *Mineral Resources*, Heinemann Educational Books, 1981.
- Revised Nuffield Advanced Chemistry, *Mineral Process Chemistry*, Longman, 1984.

Information on films or videos about the extraction and uses of metals is available from:

- Viscom Limited (for British Steel and RTZ Group films), Audio Visual Library, Unit B11, Park Hall Road Trading Estate, London SE21 8EL. (Tel: 01-761-3035)

TV broadcasts for schools also include programmes about the extraction and uses of metals.

Booklets, wall charts and other printed information about metal extraction are available from:

- British Steel Corporation, 9 Albert Embankment, London SE1 7SN (Tel: 01-735-7654)
- Institute of Metals, 1 Carlton House Terrace, London SW1Y 5DB (Tel: 01-839-4071)
- RTZ Services Limited, Intermail Ltd, Unit 2, Fleming Road, Newbury, Berkshire RG13 2DE

CHOCOLATE CHIP MINING

This unit is in two parts. Part 1 is practical. You have to try and extract a useful 'mineral' from a 'rock' sample. Part 2 describes some of the problems of copper mining.

Part 1 Mineral processing

You are a research scientist for a mining company. You work in a laboratory which investigates methods for getting useful minerals from rocks. You have just been sent a sample of rock which seems to have small pieces of a valuable mineral mixed up with unwanted waste material. The mineral is dark brown. The waste is paler.

Research brief

- Find a method for separating the valuable mineral from the rock sample.
- Measure the amount of mineral and the amount of waste. Compare your results with those obtained by other working groups. Does the amount of the valuable mineral seem to be about the same in each rock sample?
- Compare the volume of waste rock with the volume of your original sample. Is it likely to be possible to put the waste back into the hole made during mining?
- If a second rock sample is available, try to see if you can extract the mineral more efficiently.
- Carry out any further investigations which you think may be helpful and then write a report for the directors of your company.

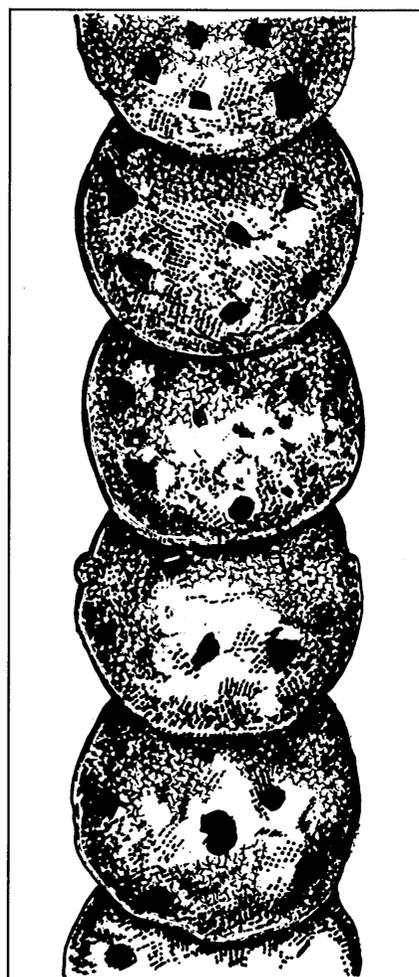


Figure 1 A typical 'rock' sample

Part 2 Copper mining

There is very little of some metals in the crust of the Earth. Look at the table below — the centre column gives the average percentage of five metals, including copper. Fortunately minerals are not spread evenly through the Earth's crust. There are places where valuable minerals are concentrated as ores.

The right-hand column in the table shows you the percentage of the metals in ores which are economical to mine. Below these percentages the ore is not worth mining because it costs more to get the metal out than the metal is worth.

Look at the table and answer question 1.

Table 1

<i>Metal</i>	<i>Average percentage in the Earth's crust</i>	<i>Percentage of the metal in ores which can now be mined economically</i>
Aluminium	8	30
Iron	5	17
Copper	0.005	0.4
Lead	0.001	2
Gold	0.000 000 4	0.000 8

You can see from the table that some ores contain very little of the metal. This means that a huge amount of waste has to be mined to get at the valuable metal. The mining company has the problem of getting rid of the waste.

There is a big open-pit copper mine on the island of Bougainville in Papua New Guinea (see Figures 2 and 3). About 220 000 tonnes of ore and waste rock are mined each day. The ore from the mine is used to produce about 500 tonnes of copper metal a day.

Question

- 1 How much more concentrated is the copper in an ore than the average concentration of the metal in the crust of the Earth? (See table.)

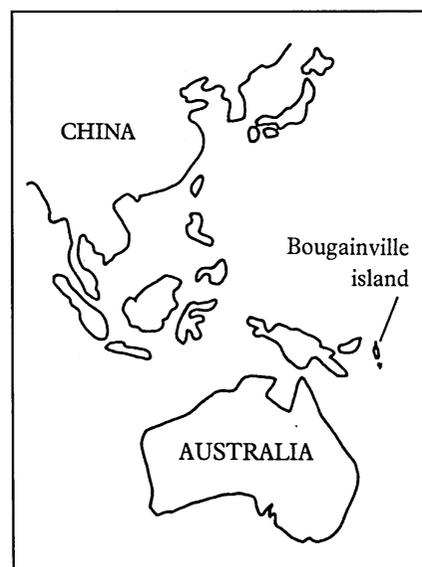


Figure 2 The position of the island of Bougainville



Figure 3 Mining copper ore at Bougainville

Waste rock with no ore in it is dumped. The ore with the copper in it is crushed and ground to a powder. Then the valuable mineral which contains the copper can be separated from the rest of the waste.

Powdered wastes from the separating plant are washed into the Kawerong river. Some of the waste ends up along 35km of the river system. The rest is making a delta where the river flows into the sea. In the future it is planned to take these wastes out to sea, via a pipeline.

The Bougainville mine is only economic because the ore also contains traces of gold and silver. There is about 0.6g of gold and 1.6g of silver in each **tonne** of the ore. Even with such tiny amounts, for every £1.00 earned by the mine in 1984, 45p was from sales of gold, 2p from silver and 53p from copper.

Study Figure 4 and then answer questions 2 to 4.

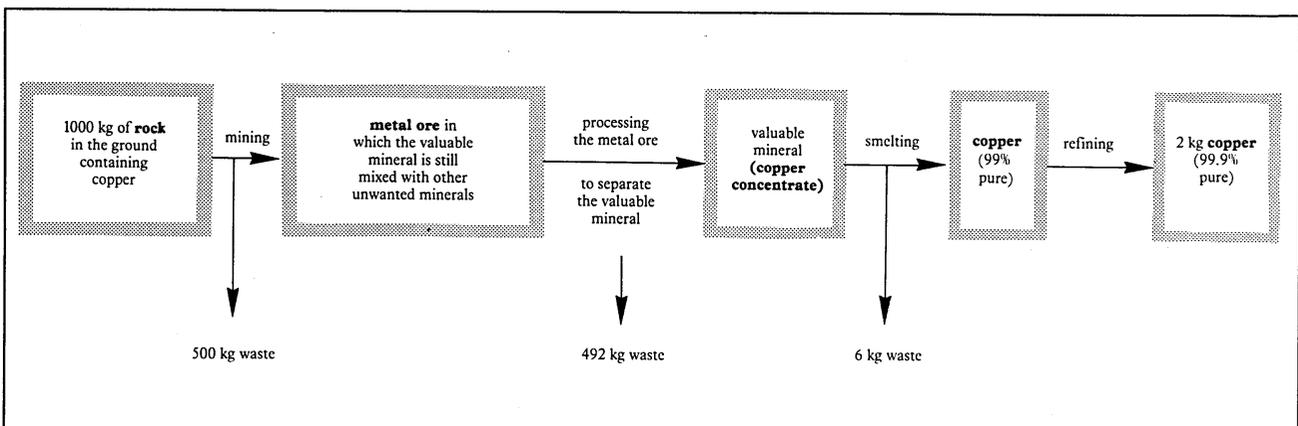


Figure 4 The main stages in the mining and processing of a copper ore

Questions

- 2 This question is based on Figure 4.
 - (a) How much metal ore is obtained for each tonne (1000 kilograms) of rock dug from the mine?
 - (b) How much of the valuable copper concentrate is obtained from 1000 kilograms of rock dug from the mine?
 - (c) How much copper metal is obtained from 1000 kilograms of rock (ore and waste) dug from the mine?
- 3 Work out the answers to this question with the help of Figure 4 and your answers to question 2.
 - (a) What is the percentage of copper in the copper concentrate?
 - (b) What is the percentage of copper in the metal ore?
 - (c) What is the average percentage of copper in the rock in the ground?
- 4 Compare your answers to question 3 to the information given about the Bougainville mine. What is the percentage of copper in the 220 000 tonnes of rock which are mined each day?