9.1 Gold prospecting

Science understanding

Verbal/Linguistic

Prospecting for gold can be fun and if prospectors discover gold then they will make a lot of money. Many gold mines that are still producing gold today were found by individual prospectors who discovered the gold there by chance.

Locating the gold

About 3.5 billion years ago, gold was deposited in the igneous rocks that formed the continents. Since then the original rocks have undergone metamorphosis, have been eroded and the gold has been moved around by hydrothermal fluids. This means the gold has been concentrated in some places in the rocks to form large nuggets, and has also been washed away and carried by surface waters to other locations.

Gold is often deposited close to fault lines because it is moved around by hydrothermal fluids deep underground. These fluids can flow through the cracks in the rocks and deposit the gold in veins. A geological map of a known gold-producing area is a good place to start the search for gold. This is how the prospectors of the 1800s searched for gold and the process is not much different today.

Early prospectors found gold nuggets on the surface of the ground. However, as the surface nuggets ran out, prospectors soon learned to dig to search out the rock the nuggets came from.

Methods and equipment

For modern-day prospectors, the methods, laws and equipment used are similar in all Australian states. However, prospectors have to check the prospecting laws in each state before they start digging.

Crushing the ore

A dolly pot is a simple crushing device used by individual prospectors. Ore is placed in the dolly pot and crushed into small granules and powder.

Panning

Crushed ore can be mixed with water and the gold separated out by panning. Panning uses a shallow, wide bowl and water is swirled around to wash the rock grains away from the gold. The heavier gold sinks to the bottom of the pan. Panning is only possible in places where there is enough water present.

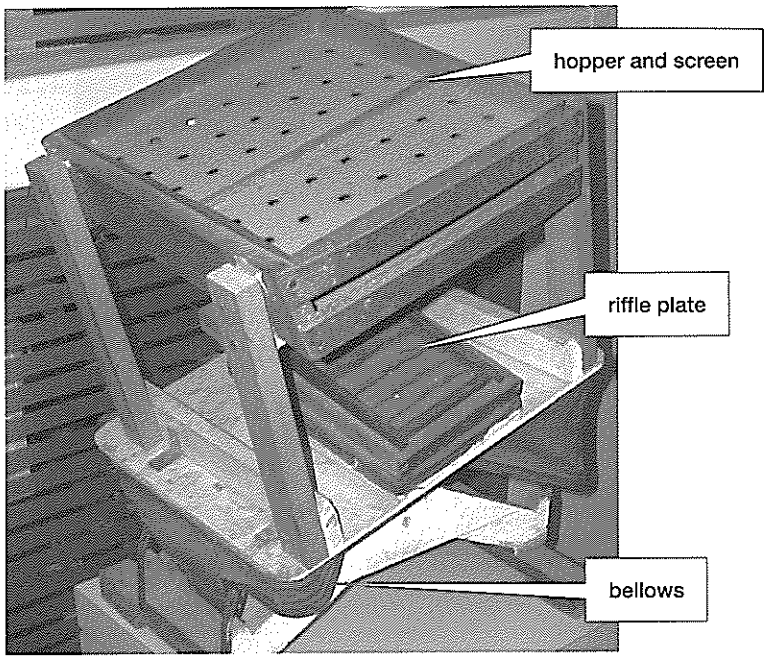
Dry blowers

In much of Australia, there is not enough water available for panning, so 'dry blowers' are used instead. Dry blowers use air to separate the gold from the crushed rock and soil. In the past, prospectors used a bellows. A bellows is a bag-like structure with a valve that allows air in one end and blows air out the other end when the bellows is pumped. Modern dry blowers have engines that blow air through crushed rock and soil. The crushed rock drops into a narrow box that has a series of horizontal bars called riffles across the bottom. You can see these in Figures 9.1.1 and 9.1.2. The air is blown through the riffle box and blows much of the crushed rock away. The gold collects behind the riffles because it is heavier than the rock powder.

If water is available, it can be used with a riffle box of a different design, called a sluice. A sluice is more efficient and cheaper than dry-blowing using a petrol engine.

Figure 9.1.1

An early 20th century dry blower from the Kalgoorlie goldfields in Western Australia. Rocking from side to side pumped air through the riffle plate.



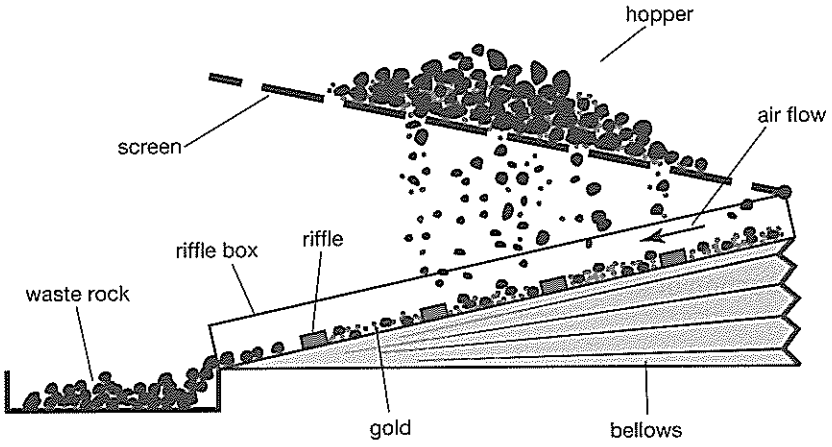


Figure 9.1.2 The general parts of a dry blower

Metal detectors

Many modern prospectors don't crush rock or use a dry blower or sluice. They use metal detectors, which can cover a large area of ground very quickly. A metal detector is shown in Figure 9.1.3 on page 120. Metal detectors are especially good for searching soil for larger gold nuggets. These can be dug up with a pick and shovel, or earthmoving equipment. Modern metal detectors can search much deeper in the ground than earlier models. Many prospectors are now locating nuggets in areas previously thought to be exhausted of gold.

9.1

Figure 9.1.3

A metal detector uses magnetism to detect metals buried in the ground.

1 **Discuss** whether all gold nuggets were formed at the sites where prospectors find them.

2 **Justify** the argument that it is a good idea to consult a geological map when prospecting for gold.

3 **Describe** what you have to check first before deciding to prospect in an area.

4 **Explain** the function of the dolly pot.

5 **Describe** how a dry blower works.

6 **Propose** why prospectors would use a metal detector rather than a dry blower.

9.2 Golden bacteria

Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on page 322 of your student book to answer the following questions.

1 **State** the observation that made scientist Frank Reith curious about bacteria and gold.

2 **State** a hypothesis that Reith wanted to test by conducting further research on the bacteria.

3 **Propose** why he organised a team of several scientists from around the world to help him with the research.

4 **Describe** what the scientists discovered the bacteria could do when placed in a solution that contained gold.

5 **Explain** how the response of the bacteria to gold was of use to the scientists.

6 **Name** the technique used to image the bacteria and the metal particles they were accumulating.

7 **Discuss** whether the group's research could be of use to the mining industry.

9.3 Finding mine sites

Science inquiry

Logical/Mathematical **Visual/Spatial**

Geochemists searching for new nickel deposits decided to take soil samples from the area shown in the diagram. This diagram shows a map of the magnetic anomalies in the area. There is a stream flowing through the site.

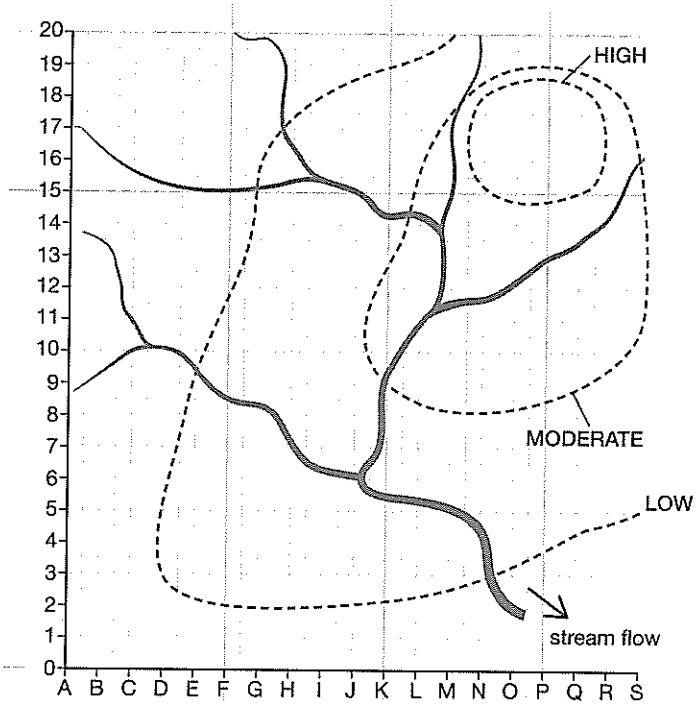


Figure 9.3.1

Locations of sites where soil samples were taken.

1 **Describe** the method probably used by geophysicists that helped them decide that this area was worth sampling.

2 **Explain** why the geochemists would not have sampled the water in the stream to detect minerals in the area.

3 **Predict** where the geochemists would have decided to take soil samples. **Explain** why you chose that area.

After studying the map, the geochemists took their soil samples. The samples returned the results for nickel shown in the table below. The values are parts per million (ppm). Anything under 30 ppm was recorded as zero.

Grid reference	8	9	10	11	12	13	14	15	16	17
M	0	0	30	0	0	0	0	0	0	0
N	0	35	37	59	71	74	78	109	77	35
O	0	35	37	78	87	100	140	150	135	80
P	0	35	61	66	69	85	137	100	76	55
Q	0	0	0	31	33	30	31	30	0	0

4 **Classify** these values for nickel grade as low (L) if they are in the range 30–50 ppm, moderate (M) if they are 51–100 ppm or high (H) if they are over 101 ppm. Write the letters L, M or H in the table below. Leave zeroes blank.

Grid reference	8	9	10	11	12	13	14	15	16	17
M										
N										
O										
P										
Q										

5 On the map in Figure 9.3.1, colour the three grades of nickel (low, moderate and high) with a different colour to **identify** high concentrations of nickel.

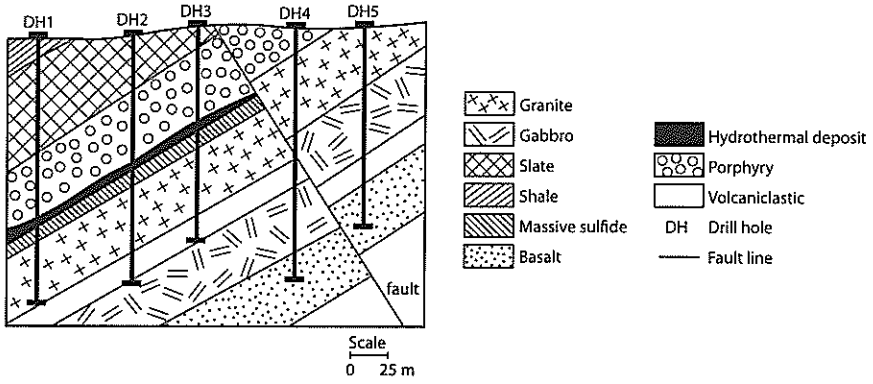
6 **Explain** the next step that geochemists would probably take.

9.4 Geological maps

Science understanding, Science inquiry

Visual/Spatial

This is a geological cross-section of an area that a company is mining.



1 The sulfide deposit shown in the cross-section was the layer of interest to the mining company. **Identify** how many of the drill holes would have cut through the sulfide deposit.

2 **Describe** how the geologists at the mining company probably created this cross-section.

3 The rock layers at the surface all run parallel to each other for several hundred metres. In the space below, **construct** a diagram showing a 50-metre deep strip at the surface that runs across the diagram from left to right. Use a key (legend) to indicate the type of rock in each layer.

9.5 Super pit

Science understanding

Verbal/Linguistic

The mining process

Open-cut mining operates in a sequence of steps. All the mine workers in every job must cooperate fully or the process may fail. The Super Pit is a huge gold mine near Kalgoorlie in Western Australia. It is a good model of how an open-cut mine is designed and operated.

1 Designing the mining layout

Mining proceeds on a series of levels, called benches. The benches gradually go deeper into the ground as each layer of rock is cleared away. The explosive blasting of the benches must be carefully designed in a cooperative effort between planning engineers, geologists, drill and blast engineers and voids officers design the size and shape of the blasts on these benches.

2 Marking old mine shafts

The Super Pit is built over many old underground mines. The location of old shafts in the pit must be marked for safety. This is the job of the voids officer (*void* is another word for a hole). The old workings are marked with different types of flags. Special drills called probe drills search for these old workings.

3 Grade control drilling

Geologists locate the ore blocks on the bench by drilling holes and checking the quality of the ore. A sample is taken every 2 metres down the hole and sent to the laboratory to find out how much gold is in each sample.

4 Production drilling and charging

The rock is very hard, so it must be blasted apart with explosives. Holes are drilled in a pattern about 5 metres apart. The drill holes are filled with ANFO (ammonium nitrate and diesel) explosive at the bottom. The hole is filled with several metres of gravel. This forces the explosion to go into the rock, rather than back out the hole. The explosives in all holes are connected together to go off in a certain sequence. Then the blast is ready for firing by a worker known as a shot firer.

5 Blasting

People in nearby towns are informed of blast times, and can see the process from a viewing platform. Workers and equipment are not allowed into a blast site for at least 12 hours after the blast. This gives the ground time to settle. The shot firer inspects the blast for any explosives that may not have detonated. When safe, the shot firer opens the site for the geologists and production crew to begin work.

6 Digging

Geologists mark where the ore blocks are with wooden pegs and coloured tape, to identify them for the digging teams. Then geologists produce a 'dig plan'. An electronic copy of this is sent to the on-board navigation system of the shovels and other loading vehicles driven by the production crew.

9.5

Hydraulic shovels are huge digging machines that can move 60 tonnes of rock and ore per bucketful. They load the haul trucks, which can each carry 225 tonnes. Bulldozers keep the floor of the bench level and clear up any spillage.

Dust is controlled by water trucks that constantly spray the area. This reduces the overall dust levels that the mine produces and gives operators a clearer view of the operations.

Once a haul truck is full, it takes its load to be crushed. The truck dumps its load and returns to the loading area to collect another one. Generally a load is picked up every 20–40 minutes.

The mining cycle continues 24 hours a day, 365 days a year. At present, about 240 000 tonnes of rock and ore are moved every day. In one year, 800 000 ounces of gold are produced. An ounce is about 28.5 grams.

1 **List** ten different jobs involved in running the Super Pit.

2 **Explain** why a worker in this mine has to be careful and observant.

3 **Clarify** why old underground workings are a problem in the Super Pit.

4 **Explain** why the blasting holes are plugged at the top.

5 **Name** the explosive used for blasting.

6 **Describe** how the driver of a hydraulic shovel knows where to dig.

7 **Calculate** how many tonnes or kilograms of gold the Super Pit produces in a year. **Compare** it with the mass of rock and ore carried by a haul truck on one trip.

9.6 Environmental effects of mining

Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on pages 338 and 339 of your student book to answer the following questions.

1 **List** five types of environmental damage that have occurred through mining.

2 **Clarify** what is meant by *tailings*.

3 **Describe** how tailings are stored.

4 **Name** an example of an earth wall at a mine bursting and contaminating rivers and soil.

5 **Describe** how dust is controlled at mine sites.

6 **Compare** the impact on land use of mines operating underground and open-cut mines.

7 **Describe** how open-cut mines are rehabilitated.

9.7 Literacy review

Science understanding

Verbal/Linguistic

1 **Use** the clues to **identify** the jumbled words.

Jumbled word	Clue	Answer
lanemir	A naturally occurring inorganic liquid or solid in the Earth's crust	
mopetrule	Oil and gas occurring naturally in rocks	
terygocismeh	The use of chemistry to show what minerals are present in an area	
tamomgetneer	Device that measures magnetic field strength	
gredding	A process that uses a floating platform that mixes water and rocks or soil to separate minerals	
nope tuc	A large pit dug into the ground surface	
gratenitconnc	Removing unwanted material such as rock and increasing the concentration of the mineral	

2 **Recall** key terms by drawing a line between the correct definition from column 1 with the correct term in column 2.

Column 1	Draw your lines across here	Column 2
Superheated liquids in the crust		seismic survey
A survey that measures the effect of applying a magnetic field to the Earth		electromagnetic survey
Sending a shock wave into the ground surface and recording the reflected sound waves		decline
An underground shaft that is on a slope, allowing vehicles to drive up and down		hydrothermal fluids
Using chemical methods to get the metal from the concentrated ore		extracting

3 **Use** the clues to **identify** the missing words.

Clue	Word
Physical property based on ability to scratch particular minerals	h _ _ dn _ _ _
How shiny a mineral is	l _ _ _ r _
Rocks containing minerals, but not including oil	_ r _
The colour left behind on an unglazed white tile when the mineral is scratched across its surface	s _ _ _ _ k
Very sensitive instrument that measures small differences in the gravitational pull of the Earth in different places	g _ _ _ _ m _ _ _ r
Horizontal tunnel through a mountain	a _ _ _
When a solution is pumped into the ground to dissolve minerals in the rocks	l _ _ _ h
Large deposits of ore	_ r _ b _ _ _ _ _
A drilled sample of rock	_ o r _ s _ _ _ _ _