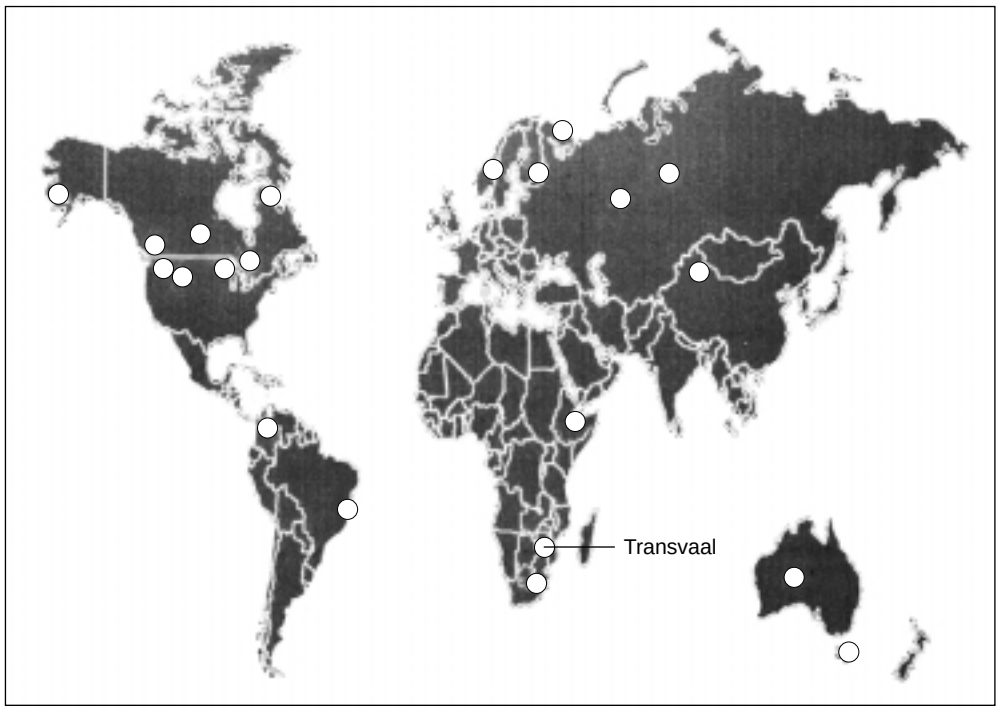
Information sheets – the platinum story

The platinum story

Platinum has been valued as a jewellery metal since ancient times. It was used by the Egyptians over 2000 years ago. It was thought the metal was a form of silver and the name platina means little silver.

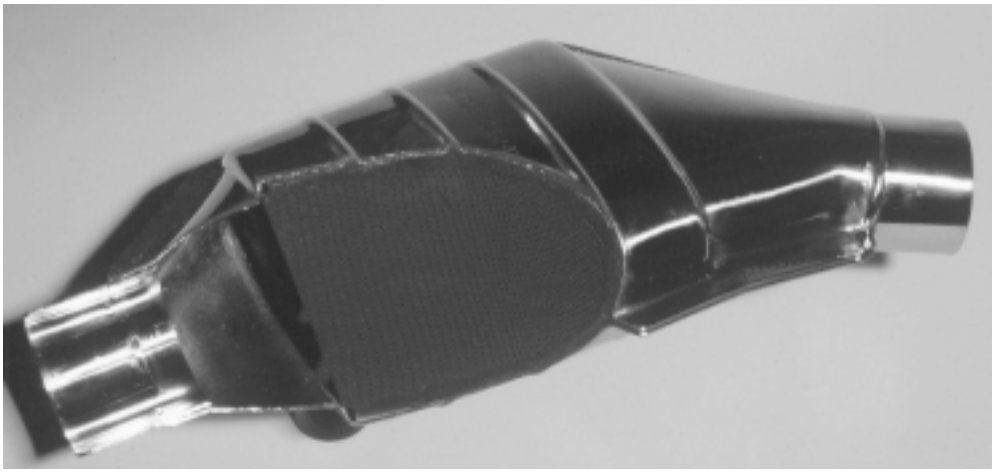
Platinum is a rare metal and its ores are found only in a few places around the world mainly in igneous rock deposits formed some two thousand million years ago. South Africa produces the largest amount of platinum in the world. The Merensky Reef deposits in the Transvaal (see Map) cover a wide area and are some of the richest in the world. Even so the deposits produce only 10 grams of platinum for every three tonnes of rock that are mined.



The location of platinum deposits

Platinum is found in ores containing other metals, often base metals - copper, nickel and cobalt – but also other very rare metals. **Iridium, osmium, palladium, platinum, rhodium and ruthenium** are called the platinum group metals (PGM). Gold and silver are also sometimes present in smaller quantities, so the ore is very precious.

Platinum and the other rare metals are very unreactive and have high melting points. Their many uses (apart from jewellery) include applications in electronics, chemotherapy, glass fibres (where platinum is used to make the spinneret through which molten glass is drawn) and in fuel cell technology as catalysts. They are useful as catalysts in many processes. Platinum is part of the catalyst system in the catalytic converters of car exhausts.



Inside the catalytic converter is a ceramic honeycomb coated with small quantities of platinum group metals

From ore to platinum

The seams of the ore-bearing rock are mined underground and large lumps of rock are brought to the surface.

Platinum ore is mined up to 1.5 km below the surface

These lumps of rocks are first crushed between steel jaws and then mixed with water and put into ball mills, which are rotating steel drums partly filled with steel balls. These grind the ore to a wet slurry.

Ball mills – giant rotating drums

The slurry is mixed with a special detergent which produces a froth. The metal compounds contained in the rocks are attracted to the surface of the foam and can be removed. This is called froth flotation.

Froth flotation

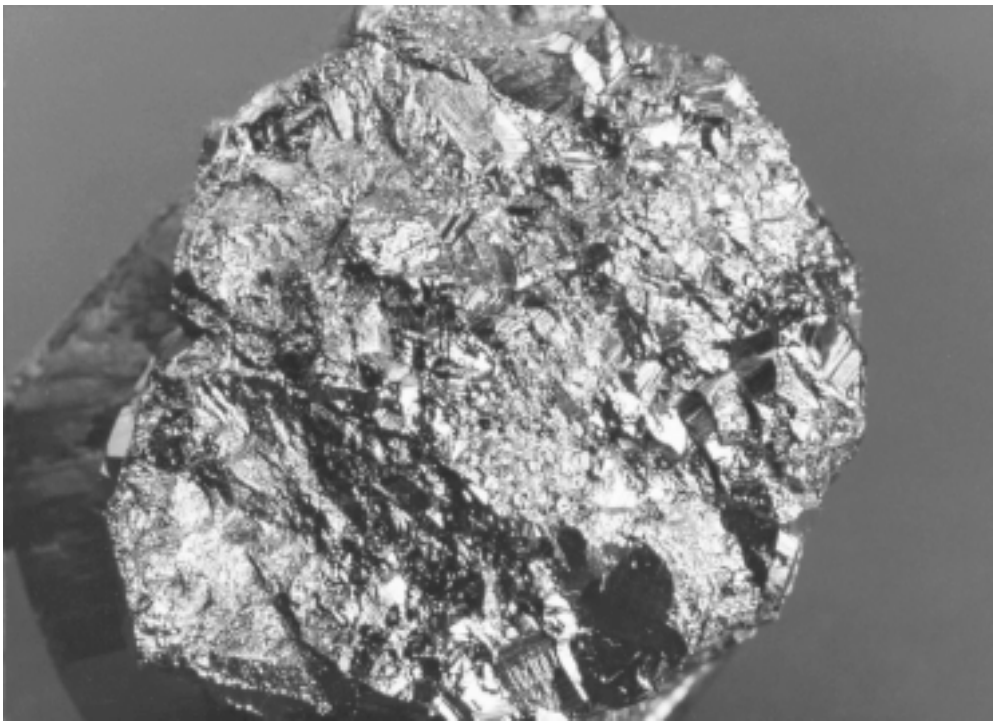
The next step is smelting. The metal compounds are put in an electric furnace at a temperature of 1400 °C and processed to drive off some of the sulfur from the sulfide ores as sulfur dioxide.

Smelting

Any sulfur dioxide produced from the sulfides is converted to sulfuric acid leaving a liquid called a **matte** which is cooled to a solid. The solid is a mixture of:

- nickel and copper sulfides; and
- a metallic alloy (a mixture of metals) consisting of the PGM enriched with metallic nickel.

This solid is crushed to a powder. Then it is separated into the parts described above by using a magnetic drum. This works because nickel is a magnetic metal so the alloy part of the powder, which contains the PGM and nickel, sticks to the drum and is separated from the non-magnetic sulfides.



Solidified matte

The non-magnetic sulfides are next dissolved in sulfuric acid. This leaves behind a valuable slurry consisting of any precious metals not picked out by the magnetic drum. The base metals such as copper and nickel are recovered from the solution by electrolysis.

The magnetic mixture, containing most of the PGM, is dissolved in hydrochloric acid ready for the final stage.

The PGM, now present as chlorides, are separated from each other using some rather complex processes. For example, a solution can be added which causes one of the metals to form an insoluble solid salt which can be filtered off (this is called precipitation), and separates this one from the others. Alternatively, some can be separated by a process called solvent extraction where the metal compounds dissolve to different extents in different solvents and are separated from each other one after another.

Platinum question sheet

Part A

Extraction

1. a) Where in the world are the largest deposits of platinum found?

   b) Why is platinum so expensive?

   c) How much ore do you need to extract 10 g of platinum?

2. a) List the main stages used in extracting platinum.
   Outline what happens at each stage (a flow diagram may help).

   b) The platinum ore contains large amounts of sulfur. This could result in large amounts of sulfur dioxide being released into the atmosphere.
   What is done to prevent this?

3. Other metals are produced at the same time as platinum. Give the name and the chemical symbol of each of these metals.

Part B

Uses

1. List as many items as you can that are made of platinum. For each item say why platinum is suitable.

2. Imagine that you are asked to forecast whether platinum will still be as valuable in 20 years time as it is today.
   What factors might make it more expensive?
   What factors might make it cheaper?
   Try to make a reasoned case to back up your forecast.

3. Write a report on the properties and uses of one of the other metals extracted at the same time as platinum.

4. Find out about catalytic converters in cars.
   What is their purpose?
   Why must they be used with lead-free petrol?
   What happens to the catalyst when a car is scrapped?

Platinum comprehension

We are all familiar with metals such as iron and aluminium which we see and use every day. Enormous amounts of these metals are extracted from their ores which generally contain quite a lot of the metal.

Platinum, on the other hand, is found in tiny amounts in deposits of ore mixed up with even smaller amounts of other similar metals, such as rhodium and palladium.

The ore is found only in a few places in the world, mainly in igneous rock deposits which are approximately two thousand million years old. The Merensky Reef deposits in the Transvaal, South Africa cover a wide area but produce only 10 g of platinum for every three tonnes of rock that is mined.

Separating the platinum out is a very complicated process with lots of stages, using unusual methods such as solvent extraction.

Platinum has always been valued as jewellery since ancient times and was known for example in Egypt over 2000 years ago.

Recently demand for platinum and other similar metals has increased due to their use as catalysts in the exhaust systems of cars.

Questions

1. Copy and complete the passage below using the list of words provided.

   catalyst gold metals ore Periodic solvent

   Platinum belongs to a set of _ _ _ _ _ _ _ in the _ _ _ _ _ _ _ Table known as the platinum group metals (PGM). It is found in tiny amounts in deposits of _ _ _ _ _ _ _ _, in which it is mixed up with even smaller amounts of other similar metals such as rhodium. Getting the metal out is a very difficult process, using methods such as _ _ _ _ _ _ _ extraction. Platinum is a rare and expensive metal which is even more valuable than _ _ _ _ _ _ _. It is widely used in the exhaust systems of motor cars as a _ _ _ _ _ _ _.

2. Where is the Merensky Reef?

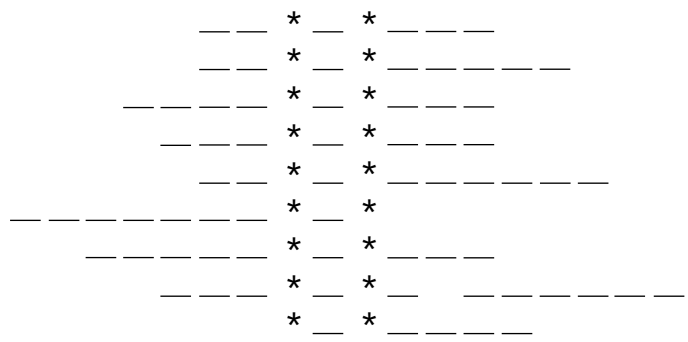
3. How long ago were the platinum deposits formed?

4. Why do you think platinum is so valuable?

5. What does a catalyst in a car exhaust do?

Precious metal puzzle

Complete the puzzle by filling in the blanks 1–9. When you have finished, you will find the word between the stars. It reveals what many transition metals are used for. You may find a Periodic Table useful.



1. A metal with 28 protons per atom extracted at the same time as platinum.
2. An expensive metal used in jewellery.
3. Means heating an ore so it reacts and melts, giving free metal.
4. Pt and Pd are used to ‘clean up’ gases from a car ..... pipe.
5. A useful metal with catalytic power which has the same name as a theatre in London. [Hint – its symbol is Pd].
6. Name of ‘reef’ where most of the world’s platinum is found..
7. An oxidation problem affecting most metals but not platinum!
8. A country rich in several deposits of minerals which contain precious metals.
9. A commonly used alloy of element with atomic number 26.

Wordsearch

Platinum is the most important metal in the set of metals which are called the platinum group metals (PGM). (Note that the word group is not being used in the strict sense in which we use it in the Periodic Table.) They are usually found together in rocks where they are present as minerals. Find the six metals **PLATINUM, PALLADIUM, RHODIUM, IRIDIUM, RUTHENIUM, OSMIUM,** in the word search below .

R	E	B	H	C	A	R	U	Y	T
M	U	I	D	A	L	L	A	P	S
P	V	T	E	C	F	H	I	R	X
I	L	B	H	O	X	A	L	H	E
O	Y	A	B	E	J	D	L	O	G
R	S	T	T	V	N	O	P	D	A
E	A	M	U	I	D	I	R	I	S
W	O	K	I	J	N	H	U	U	F
C	O	N	E	U	D	U	S	M	T
R	P	A	E	W	M	I	M	L	A

When you have found them, look them up in the Periodic Table. Draw a block of these elements as they appear in the Periodic Table.

a) These metals are often found with nickel. Use the Periodic Table to predict which other metal or metals might be present. Add these to your blocks.

b) Gold is also found in the ore. Name another precious metal that you might expect to be present.