

## Extraction of gold using cyanide

Gold is found in very low concentrations in the ore from which it is mined. To collect the gold from the ore it needs to be separated from the other minerals in the ore. To do this the gold needs to be made into a soluble form so that it can be separated from the other minerals as gold is insoluble. To make gold soluble sodium cyanide (NaCN) is added and the cyanide ion forms a complex ion with the gold. This complex ion,  $[\text{Au}(\text{CN})_2]^-$ , is readily soluble.

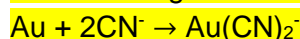
### Issues of gold extraction using cyanide:

Cyanide is toxic to animal and plant life and may cause death if exposed to high enough doses. Free cyanide is cyanide ion ( $\text{CN}^-$ ) and hydrogen cyanide (HCN) which is often gaseous as it is volatile. Free cyanide causes cellular asphyxiation.

### The process:

The ore is ground and crushed to make a slurry

The treated gold then has sodium cyanide added to it and the following reaction:



1 In this form the gold is now soluble. This process is known as leaching. This reaction is normally carried out at a pH of 10-11 as this prevents cyanide ion being converted to hydrogen cyanide which would occur if the pH was lower.

Because gold is soluble in this form it can now be separated from the rest of the ore that is insoluble. This process of dissolving the gold using cyanide is known as leaching.

Sometimes some other precious metals can also be leached along with the gold, for example silver. This process of leaching is done in leaching tanks or by heap leaching where sodium cyanide is dripped onto a heap of gold ore and left to percolate its way through the heap of gold ore.

The dissolved gold in the form of the complex now needs to be separated out and recovered. This can be done by a process called absorption. Absorption is when gaseous or dissolved species attach to a solid surface. A substance called activated carbon is used to absorb the gold. Activated carbon is formed from wood, peat, coal, etc. It is treated so that gold will absorb to its surface. The majority of the gold will absorb onto this activated carbon. The activated carbon is then washed with water or air on screen, and the gold can be further purified by electro winning which use electricity. It is then further refined until the final product is obtained

The remaining cyanide in the slurry now needs to be disposed of or recycled in some way.

As mentioned above cyanide is toxic and cannot be allowed into the local environment.

There are a number of natural processes that get rid of cyanide. Included in this list are:

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- Volitisation – when  $\text{CN}^-$  turns into HCN at low pH's and then this becomes gaseous.
  - Absorption – when  $\text{CN}^-$  naturally absorbs onto solid surfaces, e.g. soil particles.
  - Microbial degradation – some bacteria naturally break down cyanide.

These processes can all occur in holding pools in which the slurry after gold extraction is put into. Some chemical processes can also be used. One of these is the Cyanisorb process which is used at a mine near Waihi. This takes the slurry and reacts it at low pH forming hydrogen cyanide which can be converted back to cyanide ion for reuse later. The use of air mixed in helps this process. All of the above processes lowers the cyanide levels to within NZ safety levels and so there is no dangerous cyanide levels entering the environment.