Gold Cyanidation

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Ground Truth Trekking

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CYANIDE VAT LEACHING — View of the cyanide leach vats in use at Alaska's Fort Knox Mine (/Issues/MetalsMining/FortKnoxMine.html). — Get Photo (/photos/cyanide-vat-leaching/)

Summary

Cyanide (CN), a single carbon atom triple-bonded to a nitrogen atom, has proved extremely useful in extracting gold from ore. However, with a toxic reputation dating back to the Holocaust, its use in mining has been very controversial. Through a

process called " **gold cyanidation** “,” **the cyanide process** “, or” **cyanide leach mining** ", cyanide is used to extract gold from the surrounding rock. While cyanide is both effective and economical, its use and transportation present significant environmental risks.

Process

Cyanide can be used to extract gold, either in a controlled mill environment, or more crudely on rock piles in the open. Cyanide “vat leaching” mixes finely crushed ore with a cyanide salt in water. The cyanide binds to the gold ions, and makes them soluble in water, thereby allowing separation from the rock. This process usually takes place inside a mill or other mining facility.

Mine Tailings

READ ARTICLE (/Issues/MetalsMining/MineTailings.html)

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Mine tailings are materials left over after extraction of valuable minerals from ore….

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Cyanide “heap leaching” is used for very low-quality ore, or sometimes to reprocess waste material from other extraction methods (e.g. leftover mine “tailings” (/Issues/MetalsMining/MineTailings.html)). A large outdoors mound of ore is sprayed with a cyanide solution that drips through the rock over time. The resulting liquid is collected at the bottom, and the gold is chemically extracted. Heap leaching extracts less of the gold than processing the ore in a mill, but is much cheaper.

There are a few alternatives to cyanide for processing low-quality ores but none are employed very widely to date (1). These alternatives are either expensive, also toxic, less efficient, or inadequately studied. However, in 2013 researchers published some work (http://www.popsci.com/science/article/2013-05/cornstarch-replaces-cyanide-clean-new-gold-extraction-method) on the possibility of using cornstarch instead of cyanide, a process that has great potential but has not been tested in a commercial setting.

Environmental Concerns

Both the use and disposal of cyanide present significant safety and environmental risks. Cyanide and cyanide gas are both extremely toxic and great care has to be taken during ore processing to avoid exposure for workers. Solutions containing cyanide have to be carefully managed to prevent the formation of cyanide gas. In addition, there are significant problems with the disposal of cyanide-containing waste. Pure cyanide in open air breaks down into other compounds relatively quickly, however the exact composition and toxicity of these products is

not well understood (http://www.earthworksaction.org/files/publications/cyanideuncertainties.pdf). One of the common breakdown products is nitrate (http://en.wikipedia.org/wiki/Nitrate), which itself can cause both environmental and human health problems. Lastly, cyanide can form complexes with certain metals, such as cobalt (http://pubs.acs.org/doi/abs/10.1021/es702334n), and these can persists for many years in groundwater.

Many old mines, and some current mines, simply place cyanide waste into the mine tailings (/Issues/MetalsMining/MineTailings.html) ponds along with other mining waste. Failure of a tailings dam containing cyanide can be a massive environmental problem, resulting in the sterilization of large areas downstream. In 2000, a tailings dam failure in Romania (http://en.wikipedia.org/wiki/2000_Baia_Mare_cyanide_spill) dumped an estimated 100 tons of cyanide into a river system, contaminating drinking water and killing fish up to 250 miles downstream, with effects purportedly lasting for years.

In comparison to acid mine drainage (/Issues/MetalsMining/AcidMineDrainage.html), cyanide has a higher toxicity, but is shorter lived. Acid mine drainage can last for thousands of years, whereas cyanide will break down within a few years at most. However, its high toxicity means that even a relatively small spill can have major consequences.

Many modern mines now use a “de-toxification” process that converts cyanide into the less toxic cyanate before combining it with the mine tailings waste. In addition, the majority of

cyanide gold mines use “impermeable” liners in their tailings ponds and underneath their heap leaching operations. However, leaks and tears in these liners have been a continual problem at many mines. Mining companies often argue that the combination of de-toxification and the use of liners makes the use of cyanide an acceptable risk, but there have been numerous accidents over the last decade.

As a result of these environmental concerns, a few countries and US states (http://en.wikipedia.org/wiki/Gold_cyanidation#Legislation) have banned the used of gold cyanidation. In response, the gold mining industry has promoted adherence to a voluntary “cyanide management code (http://www.cyanidecode.org/)” with strict independent audits of signatory companies. Some environmental organizations have applauded the code (http://www.mineweb.com/mineweb/view/mineweb/en/page68?oid=56820&sn=Detail) for increasing transparency and others have condemned it (http://www.earthworksaction.org/files/publications/DecodingCyanide.PDF) as “greenwashing (http://en.wikipedia.org/wiki/Greenwash)”.

Gold Cyanidation in Alaska

While cyanide is not used at the recently-opened Kensington Mine (/Issues/MetalsMining/KensingtonGoldMine.html), it would be used at the proposed Donlin Creek Mine (/Issues/MetalsMining/DonlinCreek.html), and most likely as well at the proposed Pebble Mine (/Issues/MetalsMining/PebbleMine.html). Cyanide is already in use at the large mines of Greens Creek (/

Issues/MetalsMining/GreensCreekMine.html), Fort Knox (/Issues/MetalsMining/FortKnoxMine.html), Nixon Fork (/Issues/MetalsMining/NixonForkMine.html), and Pogo (/Issues/MetalsMining/PogoMine.html), in addition to the majority of smaller operations throughout the state. In May 2010, Fort Knox (/Issues/MetalsMining/FortKnoxMine.html) had a spill releasing 300,000 gallons (http://www.ktuu.com/global/story.asp?s=12443773) of cyanide-containing water, although the majority was contained within a building with no appreciable environmental damage. To date Alaska has not had a major cyanide spill at any gold mine, however the risk increases as the number of new mines continues to rise.

References (These sources are behind pay walls (http://en.wikipedia.org/wiki/Pay_wall).)

1. Hilson, G. and A.J. Monhemius. 2006. Alternatives to cyanide in the gold mining industry: what prospects for the future? J. Clean. Prod. 14(12-13): 1158-1167.

Further Reading

> "Cyanide Leach Mining Packet" by the Mineral Policy Center (2000) (http://www.earthworksaction.org/pubs/Cyanide_Leach_Packet.pdf)

> Wikipedia article on gold cyanidation (http://en.wikipedia.org/wiki/Gold_cyanidation)