

2: Cyanide – chemical leaching of gold



Figure 15. CYANIDE LEACHING
A Chinese operation near Zuunkharaa in north Mongolia, leaching fine gold from mercury-laden tailings of edge mills. (photo: Jørgen Hartwig of Projekt-Consult)

Cyanide leaching has been used to recover gold since the 1890s but only since the 1960s with the advent of heap leaching has cyanide become the method-of-choice for leaching gold from milled hardrock, and has potential for leaching gold from placer concentrates.

Cyanidation uses a very weak cyanide solution to dissolve ('leach') fine gold into solution, and then precipitates it as easy-to-recover gold. It leaches gold that – due to flatness, small size or attached quartz – is lost by simple gravitational devices or mercury.

Cyanide has risks if handled carelessly or gains access to streams or wells. The cyanide solution must be kept strongly alkaline to prevent the generation of highly toxic hydrogen cyanide gas. A problem is cyanide vapour rising from ponds. Such concerns have triggered the gold industry to seek cost-effective alternatives [32]

Coarse gold typical of most placers takes too long to leach. Marcello Veiga noted that for a 0.21mm gold particle to dissolve in cyanide took over 60 hours!

Operation

The sodium cyanide (NaCN) is either in a dry solid or liquid form, sourced from specialised manufacturers.

1st stage – leaching gold into solution

A weak cyanide solution is prepared, usually 0.02-0.05%, and must be kept strongly alkaline (pH 10-11).

Cyanide leaching can be by different methods:

- ✘ percolation leaching – very weak cyanide solution percolates down through a vat of concentrate. Commonly used for ground hardrock ore, but also successful in tests on placer gold concentrates in Alaska by Cleland Conwell [33];
- ✘ agitated leaching – very weak cyanide solution is added to vats that are agitated by paddles or by blowing in compressed air to keep the material in suspension; and
- ✘ heap leaching – very weak cyanide solution percolates down through crushed/milled ore heaped in a 'heap basin' lined with leach-proof materials e.g. clay, asphalt or tarpaulin.

2nd stage – recovering gold from solution

Having leached the gold and dissolved it into solution as gold cyanide complex_{AQUEOUS}, the solid gold is recovered by a choice of methods, such as traditional methods tested on placer gold concentrates in Alaska [33]:

- ✘ absorption by activated carbon – 99.85% Au recovery;
- ✘ absorption by ion-exchange resin – 96.31% Au recovery; or
- ✘ precipitation by zinc dust – 99% recovery.

The zinc dust method, as typified by the Merrill-Crowe process, first removes oxygen from the cyanide solution and then mixes in a fine zinc powder and recovers the fine gold precipitate (<50µ) on a precoat filter.

Adoption by placer gold miners

The author is unaware of the cyanide leaching being used at large-scale placer gold mines. Yet for small-scale and artisanal mining, cyanide leaching is now widespread for hardrock ores and 'difficult' lateritic ores in Peru, Ecuador, Columbia, Brazil, Philippines and China.

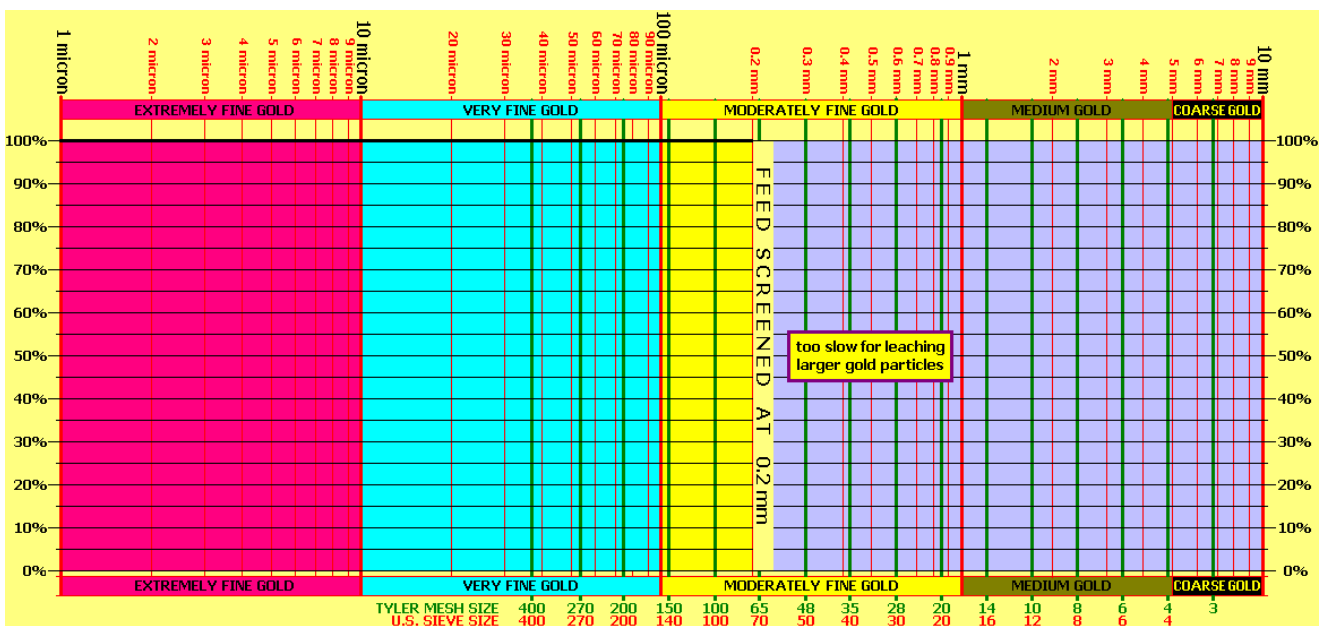


Figure 16. GOLD RECOVERY BY CYANIDE LEACHING
Cyanide can dissolve (leach) >90% of very fine gold, but is too slow for leaching larger gold. [22] (compiler: Robin Grayson)