

24: Thiosulphate leaching – 1970s research in Canada

Thiosulphate leaching has the potential to replace cyanide leaching, being relatively cheap, environmentally less hazardous and capable of leaching gold from difficult refractory hardrock ores such as carbonaceous or Carlin types. In contrast, cyanide cannot leach gold from refractory ores without a preliminary step [69].

Thiosulphate leaching is by sodium thiosulphate $Na_2S_2O_3$, an essentially non-toxic colourless crystalline compound that is more familiar as the pentahydrate, $Na_2S_2O_3 \cdot 5H_2O$ known as sodium hyposulphite or 'hypo' as used with silver in traditional photography.

Although hypo had been known since the early 1900s to be useful in leaching gold, it was only in the 1970s that it was subjected to detailed study, leading to a patent being awarded to Roman N. Genik-Sas-Berezowsky, Verner Sefton and Lynton Gormely of Canada in 1978 (US #4,070,182) assigned to Sherritt Gordon Mines Ltd.

For three decades thiosulphate leaching has been heralded as being close to challenging cyanide leaching [69]. It has been the subject of four to five US patents every year since the late 1970s and the focus of hundreds of research papers. In spite of this, thiosulphate leaching has not yet been properly commercialised. A breakthrough seems tantalisingly close as shown by the patent awarded to Jinxing Ji, Christopher Fleming, Paul West-Sells and Ralph Hackl of Canada and patented in 2006 (US #7,066,983) assigned to Placer Dome Inc.

The thiosulphate method uses a solution of hypo $Na_2S_2O_3 \cdot 5H_2O$ in the presence of an oxidising agent to dissolve ('leach') fine gold as a strong complex $[Au(S_2O_3)_2]^{3-}$, and then to precipitate easy-to-recover gold. The preferred oxidising agent is copper ions. In contrast, thiourea leaching uses ferric iron (Fe^{3+}) whereas cyanide leaching uses oxygen direct from the air.

Adding more oxidising agent is unnecessary for a Cu-bearing ore.

Operation

1st stage – leaching gold into solution

Sodium thiosulphate pentahydrate $Na_2S_2O_3 \cdot 5H_2O$ ('hypo') is usually supplied in powder form sourced from specialised manufacturers. A solution of hypo is prepared, and then ammonia added to make the leachate strongly alkaline (10 to 10.5pH). Copper ions must also be present as essential oxidising agent. The ammonia and copper are catalyst-like for they are neither produced nor consumed but recycled. In practice, copper may precipitate cupric sulphide that inhibits leaching, while ammonia may escape

Hypo tends to be unstable, avoidable by adding sulphite ions to regenerate the thiosulphate and prevent silver precipitating too early as insoluble silver sulphide.

The milled ore is added to the thiosulphate leach with a pulp density of 40 to 45% solids. Hypo consumption may be as much as 30 kilos per ton of ore, but can be cut to 13 kilos/ton by adding reducing agents as chelates.

2nd stage – recovering gold from solution

The pregnant thiosulphate leach solution contains dissolved gold in the form of gold-thiosulphate complex, and the pregnant solution is removed for further processing to recover the dissolved gold.

Activated carbon or resins are ineffective for recovering the gold from the pregnant leach solution.

Instead gold is recovered by cementation method using zinc, iron or copper. Under controlled conditions, gold recovery from suitable ores can exceed 90%.

Adoption by placer gold miners

The author is unaware of thiosulphate leaching being used at large-scale placer gold mines, large or small. The main deterrent is the uncertain technology, variable results and difficulty of controlling the process efficiently.

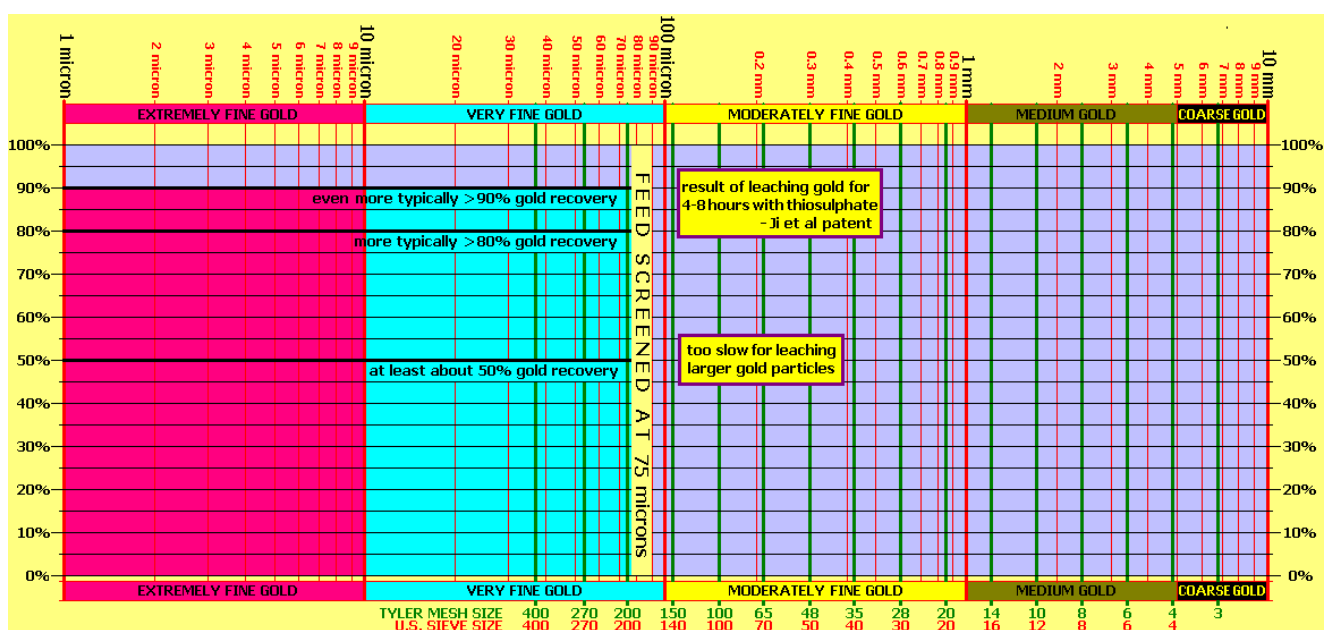


Figure 54. GOLD RECOVERY BY THIOSULPHATE LEACHING
Thiosulphate can leach >90% of gold smaller than about 75µ, but is too slow for leaching larger gold. (compiler: Robin Grayson)