Clean Earth™ Technologies

IN-FIELD TESTING AND VALIDATION OF THIOSULPHATE:

A REPLACEMENT FOR CYANIDE IN GOLD RECOVERY AND CLEAN GOLD PRODUCTION

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REFERENCING CSIRO RESEARCH AND DOCUMENTATION: http://bit.ly/2IYIMHZ

SITE: MENZIES GOLD HUB (WESTERN AUSTRALIA), JULY 2018

OVERVIEW:

"The aim of the project was to demonstrate the CSIRO IP in the field at scale in order for the technology to be commercialised and adopted by miners. Until this point, the technology had only been (successfully) developed and tested at laboratory scale."

The project itself aimed at several things:

- To design, build, and transport the plant to Menzies from Perth (a 730km distance)
- Commissioning said plant, carrying out optimised procedures for its deployment
- Processing ore (untreated battery sands)
- Using the CSIRO IP (acquired by Clean Mining Limited, a subsidiary of Clean Earth Technologies) for an innovative, new leaching process *(a non-toxic leach reagent)*
- Elimination of cyanide use in the gold recovery and production process
- Smelting and forming gold into bars
- Additionally, this leach process design also intended to demonstrate how a small mobile plant could operate in the field, "to unlock small/high grade stranded deposits"

One of the primary key performance indicators in this project was to reach a benchmark of >80% recovery of leachable gold, taking into account the economics of longer leach residency time vs. diminishing gold recovery returns.

This KPI in particular has been met with resounding success—the thiosulphate leaching solution led to an **85% gold recovery rate.**

Note: This project was initiated using vat leaching tanks in the process. Continued analysis and the associated learnings has led us to introduce the use of agitated tanks into the process. This has resulted in even greater recovery rates. As such, this new approach has now been incorporated into all projects currently in planning.

ADDITIONAL IN-FIELD VALIDATION:

The above validation came on the heels of Barrick Mining's 2015 adoption of CSIRO's thiosulphate-based solution and process, which targeted a specific ore characteristic. They successfully integrated this approach with production at their Goldstrike mine in Nevada.

CSIRO / Barrick prove thiosulphate alternative to cyanide commercially

"At full capacity, 13,400 t/d of ore can be processed daily, with leaching taking place simultaneously in two sets of seven tanks... The new process will contribute an average of 350,000 to 450,000 oz/y of gold to the operation." http://bit.ly/2ks5EPO

ORE TYPES AND CLEAN GOLD RESULTS USING THE THIOSULFATE-BASED LIXIVIANT SYSTEM

Description	Size (µm)	Head (g t-1)	NaCN leach recovery	CSIRO product leach recovery	Thiosulfate consumption (kg t-1)
Low sulfide ore	P90-74	0.9	90% @ 24 hrs	90% @ 24 hrs	2.2
Carbonaceous ore (gold partially encapsulated)	P80-75	1.9	51% @ 24 hrs	70% @ 24 hrs	1.6
Aged sulfide ore gravity tails	< 2000	1.2	73% @ 24 hrs	67% @ 24 hrs	1.1
Oxide ore	< 10000	1.4	59% @ 24 hrs	56% @ 2 days	1.5
Oxide ore gravity tails	< 1000	2.1	80% (intense cyanidation with LeachWell)	76% @ 7 days	< 0.2
Oxide ore (potential ISR candidate)	< 4000	~5	38% @ 24 hrs; 81% @ 7 days	79% @ 2 days	1.3

Note: The above tests and subsequent results were conducted separately from the Menzies Demonstration Project, and used bottle roll leach tests, which simulate tank leach conditions.

ADDITIONAL INFORMATION ON OUR CLEAN GOLD SOLUTION

What is thiosulphate?

Thiosulphate is an inorganic compound, a salt, which is non-flammable and water soluble. While others have identified similar compounds previously, the Clean Mining technology, developed by CSIRO, is applicable to a range of ores for mining operators.

Clean Mining technology is particularly attractive to socially and environmentally responsible junior producers who don't want the compliance and rehabilitation costs associated with cyanide. Clean Mining, for example, offers a mobile/transportable and scalable plant design that is ideally suited to small, high-grade deposits that might otherwise be stranded.

ABOUT CLEAN EARTH TECHNOLOGIES:

Clean Earth Technologies identifies technologies for commercialisation. With the launch of the Clean Mining initiative, the group is looking to transform gold mining by eliminating the use of toxic chemicals to recover gold. We will deliver more environmentally and socially responsible mining to the world while creating a Clean Gold consumer brand.

info@cleanmining.co

SINGAPORE 52a Club Street, 069429
AUSTRALIA Suite 1, 96 Royal Street, WA 6004

www.cleanearth.tech www.cleanmining.co

Clean Earth™
Technologies

SINGAPORE 52a Club Street, Singapore S.069429
AUSTRALIA Suite 1, 96 Royal Street, East Perth, WA 6004
T +65 9382 6401 E info@cleanearth.tech **cleanearth.tech**
CLEAN EARTH TECHNOLOGIES PTE LTD UEN 201909921K

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