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# IN-SITU RECOVERY – PROGRESS OVER THE LAST FIVE YEARS

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## ABSTRACT

In-situ recovery (ISR) transfers hydrometallurgical processing of mineralised bodies to the subsurface to directly obtain solutions of commodities. As a result, there is little surface disturbance. For ISR to be successful, however, deposits need to be permeable. Furthermore, commodities need to be readily amenable to dissolution by leaching solutions over a reasonable period of time, with an acceptable consumption of leaching reagents.

CSA Global presented an overview of ISR for non-uranium metals at the ALTA-2019 conference. The ISR industry rapidly changes and material updates are now available for presentation.

Uranium. ISR accounts for more than 50% of world uranium production. The main uranium ISR regions are Kazakhstan, Uzbekistan, USA (Wyoming, Nebraska) and South Australia. Ukraine, a pioneer of the ISR industry, returned to applying this technology through pressure air/oxygen gas uranium leaching, initially developed in Uzbekistan. This technology is most suitable in the Kalahari Desert (Namibia) where new uranium deposits were discovered.

Copper. Copper is extracted by sulfuric acid, however, ammonium-base lixiviants may be used if sulphuric acid is not suitable due to a high carbonate content. Florence Mine and Gunnison Mine in Arizona started ISR copper production in 2019-2020. Moonta and Kapunda deposits in South Australia have been extensively investigated and are close to pilot plant ISR operation.

Gold and Silver. These commodities are extracted by chlorine or sodium hypochlorite. The Gagarskoe and Dolgy Mys deposits in the Urals are currently subject to the successful application of ISR. Several projects in the weathering crust and deep placers in Russia are nearing production, and some projects in Australia and the USA are currently being assessed for ISR potential.

Nickel, Cobalt, Manganese. The most significant recent progress has been made regarding the development of ISR for nickel and cobalt laterite projects in Kazakhstan. Pilot operation from 2019 to 2020 was performed on the Gornostay deposit. Four field cluster tests have been completed to assist with the preparation of a program to achieve a PFS level investigation. Sulphurous acid is used as a lixiviant for leaching with the production of pure metals. Sulphuric acid was not economical for the ISR of nickel and cobalt. Manganese is also a commodity which can be mined by a similar lixiviant, as has been demonstrated in field tests.

A successful push-pull test for tungsten using a complex lixiviant with hydrochloric and ethanedioic acids was completed in Kazakhstan. This technology was patented by Dala Mining company.

Forty Cady project (California) started ISR pilot operation at a boron deposit at the end of 2020. The aim was to produce boric acid using hydrochloric acid as the lixiviant.

Scandium is extracted as a by-product from pregnant uranium solutions at Dalur in Russia. ISR of Rare Earth Elements from ionic clays is used in China, however environmental issues exist which could potentially be resolved through adequate planning and organising of the ISR process.

*Keywords: in-situ recovery, copper, gold, silver, nickel, cobalt, manganese, tungsten, scandium, rare earth, yttrium, boric acid*