



Figure 1. Alford East drill rig.

SUSTAINABLE SOURCING TO MEET DEMAND

Nicole Galloway Warland,
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considers how in-situ recovery
can be used for the sustainable
mining of copper and gold.

With the world shifting to a cleaner future to meet low carbon emission ambitions, the demand for renewable technology and electrification is increasing. To support the development of its infrastructure, the production of copper is vital. The slowing rate of new significant copper discoveries, the increasing cost of such discoveries and the lowering of copper grade in producing mines, however, continues to drive the global demand for quicker and more economic processes to produce the metal.

Thor Mining, a diversified resource company listed on the AIM Market of the London Stock Exchange, the ASX in Australia and the OTCQB Market in the US, is at the forefront of the extractive industry through its assessment of the in-situ recovery (ISR) technique at its copper-gold project in Australia. The company believes this technique offers a more attractive method for extracting metals.

Alford East Project, Australia

The Alford East Project, located approximately 150 km north-west of Adelaide, is a copper-gold project covering the northern extension of the Alford Copper Belt on the Yorke Peninsula, South Australia. Thor is currently earning in to an 80% interest of the project, which benefits from significant local infrastructure, including mains electricity, sealed highways and local towns to provide a workforce. Historic drilling over several decades has unveiled copper oxide mineralisation, providing encouragement to the company's management team for the recovery of copper as a primary target, but also for gold, which could significantly enhance the fundamentals of the project.

In January 2021, Thor completed an inferred mineral resource estimate at Alford East which estimated 125.6 million t at 0.14% copper (Cu) containing 177 000 t of contained Cu and 71 500 oz of contained gold (Au). To further explore the project, during 3Q21, the company completed the first phase of its diamond drilling programme, consisting of nine diamond drillholes totalling 878 m, with results reporting significant intercepts, including drill hole 21AED005, which returned 73 m at 1% Cu and 0.19 g/t Au from 6.3 m, defining a new structurally controlled, broad zone of high copper and gold grades, from near surface.

In September 2021, initial pump testing was completed at the project, with preliminary results showing favourable water parameters and permeability for potential ISR of copper and gold. Thor subsequently engaged Mining Processing Solutions (MPS), trialling its alkaline Glycine Leaching Technology (GLT), branded as its GlyCat™ and GlyLeach™ processes, that has the capability to selectively leach base and precious metals using glycine as the principal, eco-friendly, reagent. A preliminary 'discovery' metallurgical test programme determined the amenability of the Alford East mineralisation to metal recovery using GLT. This work is co-funded by the South Australian government Accelerated Discovery Grant (ADI) of AUS\$300 000, demonstrating local governmental support for the project and highlighting a more environmentally friendly method of extracting copper and gold.

Based on the results of the first phase of diamond drilling, a new robust 3D geological model was generated using a combination of weathering, lithology, assay and structural data from logging, and regional geology, structural and geophysics (magnetics and gravity) data. The second phase of the programme, designed for 2Q22, includes continuing hydrogeology and hydrometallurgical studies. The company's

objective is to investigate and optimise both copper and gold metal extraction using environmentally friendly lixiviants.

In-situ recovery

Notable projects around the world utilising the ISR-copper technique include Excelsior's Gunnison project, Copper Fox Metals' Van Dyke project, and Taseko Mines' Florence Project, all located in Arizona, USA. ISR has also been used commercially in South Australia for over 15 years in the uranium sector and, as such, Thor benefits from significant local expertise. This local expertise also includes the South Australian government regulators who are familiar with ISR and the required approval process.

Rather than developing an expensive mining operation, the ISR process captures copper and gold in-solution and brings it to the surface where it can be easily processed with no ground disturbance. It seeks to extract the material from the ground in the most environmentally friendly way possible, making it a favourable alternative to traditional mining. With no large pits, crushing, grinding or waste dumps, which are commonly associated with traditional mining, the ISR procedure is sometimes known as the 'invisible mine'. Furthermore, thanks to its minimal impact on the environment around the site, the land adjacent to projects can remain active and continue to provide alternative uses, such as farming.

To confirm that an ore body has the correct geology for ISR, trials, comprising tracer and 'push-pull' tests, must be completed. The trials are undertaken in two stages. The first stage involves injecting and extracting a tracer solution (sodium bromide [NaBr]) from the same well to demonstrate hydraulic connectivity between wells and the environmental monitor well network. This is followed by injecting and extracting a 'lixiviant' from the same well to test copper and gold solubility from the mineralisation. The lixiviant is a 100% non-toxic, biodegradable solution with a pH suitable to the existing surrounding water conditions, developed through research by the CSIRO and Curtin University. At Alford East, the underground water is hypersaline and hence has no agricultural use.

The key outcomes anticipated from lixiviant trials are establishing:

- Hydraulic connectivity between wells.
- Copper and gold solubility and recovery.
- Lixiviant and time parameters for design of the site environmental lixiviant trials (SELT).

The lixiviants dissolve the copper-gold ore and recovery wells pump the solution that carries the copper and gold to the surface. These tests are the final hydrometallurgical assessments before the commencement of SELT, which form part of the project's feasibility study required to progress the project.

During each of these steps, monitoring wells are installed to ensure that no solution leaches away from the mining area. This guarantees that impact on the

surrounding environment is as minimal as possible. Following mining, the wells are removed and rehabilitated with minimal impact to the surface, leaving it almost unchanged.

Subject to the success of the feasibility study, the well field pattern can be scaled up for copper production, with the addition of injection and extraction wells.

With initial drilling and test work at Alford East appearing conducive to utilisation of the ISR technique, and with SELT anticipated at Alford East as early as 2022/2023, Thor has a clear pathway to copper and gold development, production, and commercialisation.

The company recognises that social awareness and continued dialogue, to ensure the support of all necessary parties, is critical to any extractive operation. ISR assessment is no different. Stakeholder and community engagement commenced shortly after Thor signed the joint venture/earn-in agreement in November 2020. This covered the Alford East Project, with an initial focus on landholders and pertinent stakeholders, before shifting to the wider community. All of Thor's stakeholder engagement focuses on developing lasting relationships with the local community and key regional and business partners that are built on respect, transparency, and shared goals.

South Australia's other ISR copper-gold projects

While Thor's Alford East project is poised to become a contributor to Thor's growth and value creation for shareholders, the ISR technique is also being trialled across the company's other copper projects in South Australia; Kapunda and Alford West, via Thor's 30% equity interest in EnviroCopper Ltd. EnviroCopper is a private Australian company that, from 2018 to 2021, undertook extensive research into solving existing knowledge gaps in the ISR industry. The study was funded by a Cooperative Research Centres (CRC) Program Grant from the Commonwealth Department of Industry, Innovation, and Science to the total value of AUS\$6 million and partnerships with CSIRO and the University of Adelaide. Thor and EnviroCopper are the first companies to focus on the potential extraction of oxide copper-gold mineralisation in the South Australia region.

EnviroCopper is earning up to a 75% interest in Kapunda and Alford West, which lie adjacent to Alford East. Thor acquired Alford East believing that the project represents a continuation of the favourable geology at Alford West. Based on substantial historic drilling, a mineral resource estimate was completed in 2019 on several of the deposits at Alford West, totalling 66.1 million t grading 0.17% Cu, containing 114 000 t of contained Cu, using a cut-off grade of 0.05% Cu.

At Kapunda, in December 2021, Thor announced that it had completed the installation of test well arrays and commenced ISR trials to assess the solubility of copper and gold mineralisation, and therefore recovery. The next step at Kapunda is the SELT, funded by the Australian government grant. It is the final technical feasibility demonstration of ISR technology at Kapunda for copper and gold recovery, prior to the completion of a commercial feasibility study.

Conclusion

With copper experiencing heightened demand for use in developing infrastructure associated with the renewable energy and electric vehicle sectors, countries worldwide are aggressively progressing means to source copper and play an essential role in the supply chain. In developing a more sustainable future, the world is also calling out for copper supply to more closely reflect global demand. The ISR technique offers a more attractive, safer, and more economic option of mineral extraction that could, over time, have a significant influence over how companies source commodities globally. **GMR**

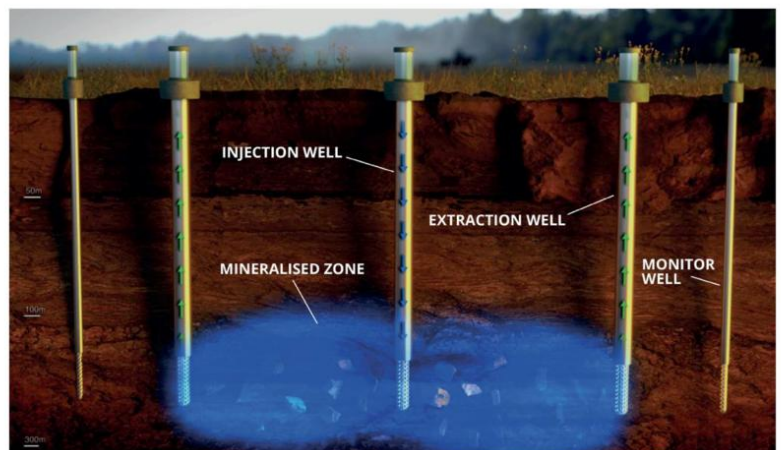


Figure 2. ISR well field design showing injection, extraction, and monitoring wells with lixiviant in the mineralised zone.



Figure 3. Hydrogeologist carrying out pump test.