Selective recovery of green technology metals from acid mine drainage

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Project Highlights:

- Development of a new technology for the selective extraction of metals from acid mine drainage
- Through our CASE partner there will be opportunity to test the real-world application of the technology at Wheal Jane
- The research has potential to be globally transformative, given the widespread occurrence of AMD

Overview:

Acid mine drainage (AMD) is amongst the most problematic issues currently facing the mining industry and yet also poses a significant opportunity for the recovery of green technology metals which are reliant upon to tackle the Climate Emergency. The current industry-standard approach for AMD treatment is High Density Sludge (HDS) neutralisation. While highly effective for water quality remediation, this HDS-derived product is a complex mixture of co-precipitated metals in a chemically stable but difficult-to-process form, limiting downstream metal recovery opportunities.

This PhD project will explore new horizons in the geochemical, electrochemical and/or hydrometallurgy manipulation of this critical treatment step – to selectively recover critical metals from AMD – to also produce a 'clean' ochre which can be valorised. The candidate will be hosted at the Camborne School of Mines, University of Exeter but also benefit from collaborations with the UK Mining Remediation Authority (project design, site access and industrial synergy).

Figure 1: Acid mine drainage (AMD) at Wheal Maid, a legacy Cu-Sn mine in West Cornwall. Photo credit: Rich Crane.

Methodology:

Representative AMD samples will be collected in collaboration with our project partners and characterised using a range of analytical methods including ICP-MS/OES, IC and via titration. The student will then design and undertake systematic laboratory experiments to evaluate candidate sorbent and/or ion exchange technologies, as well as relevant chemical engineering approaches (e.g., precise pH control), to enable selective recovery of critical metals while producing a 'clean' ochre suitable for valorisation. Experimental products will be characterised using a range of analytical techniques including QEMSCAN, FTIR, Raman Spectroscopy, XRD, BET surface area and zeta potential.

This project will benefit from access to world-leading laboratory facilities located at the Camborne School of Mines, University of Exeter, and fieldwork at a range of different high-profile legacy and active mine sites.

Possible Timeline

Year 1: Collection and characterisation of representative AMD samples; completion of a comprehensive literature review on AMD valorisation; initiation of the first phase of selective metal extraction experiments.

Year 2: Optimisation of extraction approaches and development of an industrially scalable process flowsheet integrating target metal recovery with ochre valorisation.

Year 3: Upscaled experiments under optimised conditions, potentially at Wheal Jane (an active AMD treatment facility), to deliver proof of concept for the proposed AMD valorisation flowsheet.

Training and skills:

TARGET researchers will participate in a minimum of 40 days training over the 3.5 years of study composed of:

- an annual one-week workshop dedicated to their year group, and tailored to that cohort's needs in terms of skills development – *for the first three years of their study*;
- an annual all-TARGET workshop with cross-year interactions, advanced training and opportunities to specialise in particular areas – *all years of study*;
- a number of one-day workshops;
- additional online events and in-person workshops attached to relevant conferences.

Partners and collaboration (including CASE):

CASE support for this project will be provided by the UK Mining Remediation Authority and the UK Environment Agency. In-kind support (totalling £30,000) will include attendance at regular project steering meetings, sharing existing water quality data held by the Environment Agency and the Mining Remediation Authority, technical support for co-development of the project to ensure maximum alignment with the Mining Remediation Authority and Environment Agency strategic aims and for new policy development. Financial support (£1587) for a 3 month placement at the Wheal

Jane water treatment facility will also be provided for the student to conduct on-site upscaled experiments to support the aims of their project.

Further reading:

Crane, R.A. and Stewart, J., 2021. Selective leaching of ecotoxic metals from lime dosing plant metalliferous ochre using acid mine drainage and organic acids. *Minerals Engineering*, *160*, p.106687.

Crane, R.A. and Sapsford, D.J., 2018. Selective formation of copper nanoparticles from acid mine drainage using nanoscale zerovalent iron particles. *Journal of hazardous materials*, *347*, pp.252-265.

Further details:

Please visit https://target.le.ac.uk/ for additional details on how to apply. Please contact r.crane@exeter.ac.uk with any questions.