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 significant, 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. A fundamental issue, however, holding back this opportunity is that AMD contains a wide variety of metals which readily precipitate to form a mixed phase (and often environmentally toxic) ochre product which is difficult to subsequently treat to extract target metals.

This PhD project will explore new horizons in the geochemical, electrochemical and/or hydrometallurgy manipulation of this step – to selectively recover key target metals. The candidate will be hosted at the Camborne School of Mines, University of Exeter but also benefit from collaborations with the University of Bristol (project design and analytical expertise) and the Coal Authority (site access, project design and industrial synergy).

Figure 1: Acid mine drainage (AMD) at Wheal Maid, a legacy Cu-Sn mine in West Cornwall, colloquially known to locals as 'Cornish Mars.' 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 undertake a critical literature review to determine candidate sorbent, hybrid sorbent – electrochemical or hydrometallurgical processes to selectively extract target metals from the AMD. Once an approach has been validated then the student will focus on the development of methodologies for the selective oxidation of residual Fe and other major metals within the AMD – to form ochre precipitates for valorisation. Such 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 of a range of representative AMD samples and their characterisation, completion of a critical literature review on AMD valorisation and commence the first round of selective metal extraction experiments.

Year 2: The student will focus on optimising the approach and in determining methodologies for the selective oxidation of residual Fe and other major metals into ochre products.

Year 3: The student will undertake upscaled experiments at optimal conditions, potentially at Wheal Jane which is an active AMD treatment facility, to provide a proof of concept for their new 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 is substantive and will include attendance of representatives from the UK Coal Authority and Environment Agency at regular project steering meetings, sharing existing water quality data held by the Environment Agency and the Coal Authority, and technical support for co-development of the project to ensure maximum alignment with Coal Authority and Environment Agency strategic aims and for new policy development. They will also provide financial support for a 3 month placement at the Wheal Jane water treatment facility for the PhD 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.