Biomining Electronic Waste for Rare Earth Elements and Critical Metals

Project ID: 3678

Supervisory team

Main supervisor: Dr James Byrne (University of Bristol)
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Host institution: University of Bristol



Project description: A legacy of electronic waste (e-waste) is accumulating faster than almost any other waste stream in the UK and globally. E-waste contains a combination of precious metals, rare earth elements (REEs) and critical metals, with concentrations depending upon the feedstock which ranges from neodymium magnets in hard drives or speakers, to gold and copper in printed circuit boards (PCBs). Often the concentrations of these metals exceed those available in virgin ores, meaning that recycling offers a viable option. Conventional recovery often relies on energy-intensive smelting or aggressive chemical leaching, both with a heavy environmental footprint. This project will instead focus on the application of acidophilic, iron- and sulphur-oxidising bacteria (e.g. Acidithiobacillus ferrooxidans etc.), and testing their suitability for biologically mobilising REEs and associated metals from shredded e-waste components, including PCBs and permanent magnets. These organisms naturally generate sulphuric acid and ferric iron as they oxidise sulphidic minerals, and this project will adapt that geochemistry, already well understood in an acid mine drainage context, to solubilise metals from an anthropogenic waste stream instead of a geological one. The student will characterise leaching efficiency and selectivity across metal types, track the iron redox cycling that drives the process using Mössbauer spectroscopy and synchrotron techniques, and assess residual solid mineralogy by XRD and electron microscopy. The project combines geomicrobiology, geochemistry and environmental mineralogy, and offers training across microbial cultivation, analytical chemistry (ICP-MS/OES) and critical metals characterisation. This project aligns with the SWBio DTP's mission to address environmental challenges through innovative bioscience, and contributes to the UK's circular economy and critical minerals security agendas.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.