Work package 3

Bioprocessing of Cobalt: Abiotic and Biotic Leaching and Production of New Biomineral Products

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This WP will focus on modified and novel environmentally-benign biological strategies **for extracting cobalt** from primary ores**, recovering cobalt** from the process liquors, and **biomineralization** of cobalt to synthesise targeted products. These biological strategies for metal recovery will be compared with existing technologies which to date have focused on abiotic leaching for recovery of metals of interest including cobalt. Further **abiotic chemical leaching** experiments using both organic and inorganic solvents using the batch and column facilities will be conducted.

Bioprocessing will involve using microorganisms (bacteria, archaea and fungi) to bioleach Co-containing ores and mineral concentrates and to selectively remove Co from pregnant leach solutions (PLS). The bio-leaching experiments will be conducted by the Bangor Acidophile Research Team and Dundee Geomicrobiology Group. By combining these two components, novel integrated approaches will be devised to facilitate the recovery of Co from primary ores. Both reduced (sulfidic; Co(II)) and oxidized (lateritic oxide deposits and marine nodules; Co(III)) reserves will be bioleached. Reduced ores will be subjected to oxidative dissolution catalysed by defined consortia of acidophilic sulfide mineral-oxidizing prokaryotes in pH-, temperature- and redox potential-controlled bioreactors, operated under different conditions in order to optimize Co extraction.

Biomineralization options used to selectively capture Co from PLS will include:

- Precipitation as a **sulfide phase**, using H_2S generated by sulfidogenic bacteria either in-line or off-line.
- Precipitation by fungal metabolites, to form **oxalates**. Oxalates are very important industrial substances used in e.g. nuclear reprocessing, nanotechnology, catalysis, superconductor and laser technology. Cobalt oxalate is already known as an important component in cobalt hydrometallurgy. It is possible that oxalate formation can be manipulated to nanoscale dimensions, providing further applications in biomineral technology
- Nutritional manipulation of geoactive cultures in bioreactors to produce supernatants laden with carbonate or phosphate to effect Co precipitation as the **carbonate** (high purity and can be of nanoscale dimensions) or **phosphate**

Finally, direct **bioconversions** of oxidized Co-rich lateritic Fe(III) minerals to potentially **useful bio-nanomaterials**, will also be explored in the Manchester laboratory. This approach has been shown to work on synthetic Fe(III) minerals, with fine grained **biomagnetite nanoparticles** formed with tuneable magnetic and catalytic properties. The Manchester Geomicrobiology group will investigate if such approaches can also be used for the bioconversion of naturally occurring Co-rich Fe(III) minerals.