The potential of deep eutectic solvent ionic liquids for recovery of Te, Bi and Sb from gold ores (BRIO)

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Associated metals in gold ores
Gold ores, and concentrates from them, often contain high enrichments of scarce or critical elements such as Te, Bi and Sb, but these elements are not always recovered, as they can incur smelter penalties and so are not prioritized for recovery. Tellurides can passivate traditional cyanidation and lead to poor gold recoveries. Recovery of these elements with the gold would add value and secure supply. Recovery would also avoid sending environmentally sensitive elements to tailings, reducing remediation costs.

Deep Eutectic Solvent Ionic Liquids
These provide a new approach to recovering gold and associated elements from ores. Ionic liquids are anhydrous salts that are liquid at low temperature. They are powerful solvents and electrolytes with potential for high selectivity in both dissolution and recovery. Deep eutectic solvents (DES) are a form of ionic liquid that are mixtures of salts such as choline chloride with hydrogen-bond donors such as urea. DESs are environmentally benign, yet chemically stable and, furthermore, the components are already produced in large quantities at low cost.

Dissolution and recovery in DES
Gold, as electrum, dissolves rapidly by oxidation in DES at 50°C (Jenkin et al. 2015) and recovery of the gold by electrodeposition has been demonstrated (Abbott et al. 2015). In itself this is a potential environmentally-benign alternative to cyanidation for gold recovery. However, hessite (Ag₇Te) dissolves as rapidly as electrum, and tellurobismithalite (Bi₂Te₃), altaite (PbTe) and stibnite (Sb₂S₃) also dissolve. Base metal sulphides such as galena and chalcopyrite dissolve relatively slowly, whereas pyrite and sphalerite are insoluble. Thus there is good discrimination in dissolution behaviour between the base metal sulphides/pyrite gangue and the Au, Ag, Te, Bi and Sb minerals, suggesting the potential to recover all these elements from gold ores.

Top: Optical profiler image of hessite dissolution at 0, 5, 10 minutes (= 9 µm).
Bottom: Dissolution rates of ore minerals at 45/50°C in Ethaline DES with iodine oxidising agent (Jenkin et al. 2015). Unpublished data suggests electrum rate is >80x faster than maximum cyanidation rate at 25°C.

Proposal to SC5-13b – BRIO - By-product Recovery by Ionometallurgy of Ore
We aim to develop our technology to TRL5 through bench scale testing and pilot validation. Our project will also involve:

• Assessment of associated element endowment in our target ores in the EU.
• Process optimisation
• Environmental, economic and technical assessment
• Preliminary business planning

Project coordination and process design and optimisation will be by Idener. We have a number of industrial partners on-board who will provide suitable material for testing (Scotgold Resources, Mandalay Resources) and academic partners including TU Freiberg.

Your chance to be involved!
We would welcome expressions of interest from other industrial and academic partners.

The list of elements and ore types is still open to refinement and we are keen to broaden these to investigate what we can do, e.g. Co and PGE from Kupferschiefer ores.

Our processes can also be applied to ore concentrates, smelter intermediates and secondary recycled materials and we are interested in exploring opportunities in these fields to be able to demonstrate wide application of our work.

TeaSe
This work has developed from our Te and Se project TeaSe a ~€3M research project funded by the UK NERC as part of the Security of Supply of Minerals (SoS) programme. Please see the poster by Dan Smith for more details. Twitter @TeaSe_SoS

References (copies available below)