A New Route to Precious Metal Recovery from Ore and Subsequent Electrodeposition using Ionic Liquids

Jacqueline A. Whitehead, Geoffrey A. Lawrance, Michael P. Owen and Adam McCluskey

Discipline of Chemistry, School of Environmental and Life Sciences, The University of Newcastle, University Drive, Callaghan, NSW, 2308, Australia

Ionic liquids have been shown to enhance the yield and selectivity of organic reactions and have also been employed in electrochemistry (1). Recently, we have established a role for them in the extraction of metals from ores (2), and have now extended this to recovery of the metal from the ionic liquid by electrodeposition. Early work in the application of ionic liquids to metallurgical processing has focused primarily on the electrodepostion of metals from the air and water sensitive chloroaluminate ionic liquids and not on the preliminary extraction of metals from ores. This study represents the first example of a total ore-to-metal process in an ionic liquid.

The cyanide-free extraction of precious metals from a synthetic ore sample and also from a gold-bearing sulphidic ore (of dominantly chalcopyrite / pyrite / pyrrhotite/ sphalerite mineralogy) using 1-butyl-3-methylimidazolium hydrogen sulphate ($bmimHSO_4$) and the subsequent electrochemical deposition of precious metals recovered from an ore in the ionic liquid is reported.

The extraction of gold and silver was achieved by oxidative leaching of the powdered ore using a solution containing $bmimHSO_4$ and thiourea with iron(III)sulphate as the oxidant (Figure 1). The extraction of gold using the $bmimHSO_4$ was as effective as the commercial aqueous cyanide extraction, and silver showed significantly enhanced extraction in the ionic liquid in comparison to the aqueous thiourea system. The high selectivity of the $bmimHSO_4$/thiourea system for gold and silver extraction is demonstrated with other metals in the ore extracted to only small percentages. Recyclability of the ionic liquid was also demonstrated.

To provide a complete ore-to-metal process in the ionic liquid (Figure 2), electrodeposition offers the most direct option. This study also examined the deposition of precious metal from the air and water stable $bmimHSO_4$ ionic liquid onto platinum electrodes (Figure 3). Electrochemical deposition in a model system was carried out with both synthetic and ore-extracted ionic liquid solutions, with current efficiency, quality of deposit and rate of deposition at differing current densities and ionic liquid concentrations probed. This model study may be amended for more practical application.

References
(1) R. D. Rogers and K. R. Seddon (eds), *Ionic Liquids: Industrial Applications to Green Chemsitry*, American Chemical Society, Washington DC, 2002
(2) J. A. Whitehead, G. A.Lawrance and A. McCluskey, submitted for publication in *Green Chemistry* (April 2004).

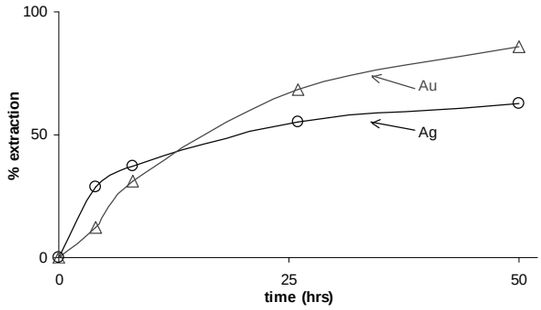

Figure 1.

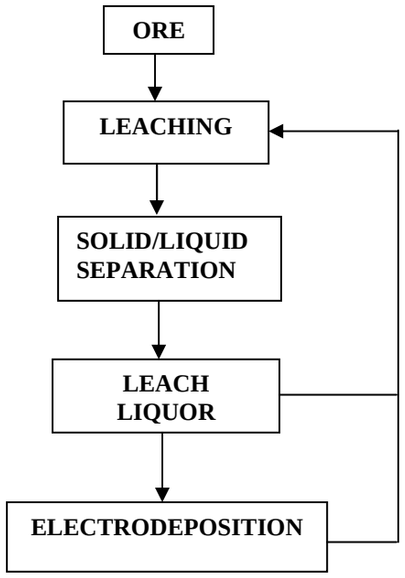

Figure 2.

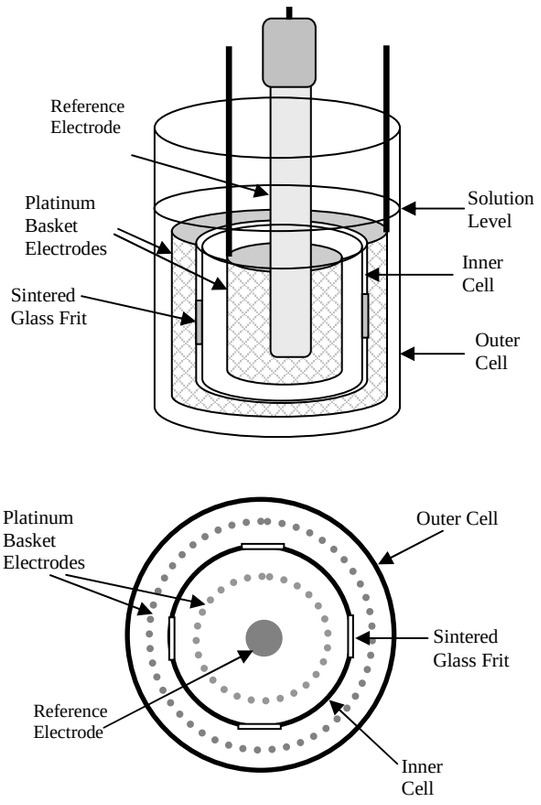

Figure 3.