Abstract

A process that does not depend on water as a medium for reaction is beneficial in water-strapped regions such as South Africa. This thesis describes such a process. Gasphase extraction involves a volatile organic reagent that reacts with a metal of interest. In the process under investigation, a volatile organic ligand reacts with solid, native gold transforming it in a gas phase. Studies have shown that β-diketone ligands such as acetylacetone and its derivatives could be used as the volatile ligand in the process. This process is capable of extracting gold from low-grade ores and presents a lower environmental risk than the cyanide process. It also has the added advantage that the extractant can potentially be recycled.

The gold content in the material under investigation was 0.3 g/t Au and the average particle size of the sample was 9 µm. The material falls into 'Group C' of Geldart's classification and cannot be fluidized, owing to its cohesive nature and strong interparticle forces.

A density functional theory (DFT) study on the structure and properties of three Au(III)-β-diketonato complexes: Au(III)-acetylacetonate, Au(III)trifluoroacetylacetonate and Au(III)-hexafluoroacetylacetonate—is presented. The HOMO-LUMO gap of the Au(III)(□-diketonato)3 complexes have been calculated and were found to be very similar, showing similar stability of the three complexes. Thus, indicating that acetylacetone is as good as any of the two other, more expensive βdiketone ligands in extracting gold. Acetylacetone was therefore used as the extractant in this study. The extraction of gold was measured at temperatures of 190, 210, and 250°C and a bed mass of 20 g. The highest extraction of gold was obtained at 250°C with an extraction efficiency of 50%. SEM-EDS images and XRD of the tailings after the gas-phase extraction showed evidence that the acetylacetone ligand attacks and breaks down the pyrite and the implication is that in time the refractory gold will be extracted.