

## **1. Background**

The Bushveld Igneous Complex of South Africa hosts the world's largest reserves of platinum-group elements (PGEs). The Merensky reef was the first PGE-bearing reef to be exploited due to its relative ease of processing given the fairly large quantities of sulphides hosting the well-associated platinum-group minerals (PGMs) (Jones, 1999). Recent developments in flotation technology have led to the exploitation of the more difficult to process chromite-bearing UG-2 reef. New expansions are focused on exploiting the UG-2 reef on the Eastern Limb of the Bushveld Igneous Complex. Deep-level mining and difficulties encountered with mechanised mining due to the inadequate thickness of the reef, have contributed to consideration of the Platreef and the Great Dyke of Zimbabwe as possible sources of PGEs. The Great Dyke of Zimbabwe is commonly believed to host the second largest reserves of PGEs after the Bushveld Igneous Complex of South Africa. However, the exploitation of this reef has been slow, which can be partly attributed to the lack of infrastructure, political instability and complexity of the ore. The Platreef in South Africa has recently been classified as an economically viable reef; it can be accessed by conventional open-pit mining (Merkle *et al.*, 2002). Both the Platreef and the reef from the Great Dyke of Zimbabwe host very complex ores and require innovative design to process these altered ores. In addition to this, these ores contain appreciable quantities of exotic platinum group minerals (such as [Pt,Pd]-bismuthotellurides, PGE sulpharsenides), which are believed to contribute to the low PGE recoveries, especially from ores of the Great Dyke.

Research on platinum flotation in the past was mainly focused on the flotation of base metal sulphides because of the association of the PGMs with these minerals. However, the assumption that all PGMs remain associated with the base metal sulphides was challenged by the findings of Penberthy *et al.* (2000) who conducted a comprehensive study on the recovery of platinum-group elements from UG-2 chromite from the Bushveld Igneous Complex. The platinum-group mineral assemblage of the UG-2 chromite consists mainly of PGE-sulphides (predominantly, cooperite, braggite, malanite and laurite) and a significant component of alloys (such as Pt-Fe alloy) and various tellurides. The PGMs identified in the ore sample were

indeed mainly associated with the base metal sulphides (>74 %), occurring either within or at the sulphide-gangue grain boundary. However, Penberthy *et al.* (2000) found that up to fifty percent of the PGMs were liberated during milling. This clearly emphasises the importance of studying the flotation behaviour of the liberated PGMs themselves with the main aim to optimise their flotation response. Most of the PGMs associated with the sulphides reported to the concentrate during flotation, while PGMs associated with the silicates were not recovered. The response of the liberated PGMs to the flotation stimulus was difficult to investigate due to their small size (< 10  $\mu\text{m}$ ). Most of the liberated grains did float, albeit with a slower response than the base metal sulphides. In general the rate of PGM flotation was, in decreasing order, braggite, cooperite, malanite, ferroplatinum and laurite. No indication was given on the rate at which sperrylite and (Pt,Pd)-bismuthotellurides float. Nevertheless, it is expected that the PGE-sulphides will float at a higher rate than sperrylite and (Pt,Pd)-bismuthotellurides, especially the latter which are possibly prone to chemical attack, as discussed below.

Elvy *et al.* (1996) reported the incongruent oxidation of minerals in the Pd-Te-Bi system leading to the formation of a layer of tellurium and/or bismuth oxide covering the palladium-rich substrate. Both Te and Bi oxidise from the bismuth-telluride minerals despite the fact that these elements do not oxidise readily, in their pure state, in air. The reactivity of the minerals increased in the order of: PdTe < PdTeBi < PdBi. This is in the same order as the reactivities of Pd, Te and Bi in the pure form. This implies that merenskyite (ideal formula: PdTe<sub>2</sub>) should be more resistant to oxidation than michenerite (ideal formula: PdBiTe).

The next section on the platinum-group mineralization of the platinum reefs of Southern Africa will highlight the importance of studying the flotation characteristics of sperrylite and (Pt,Pd)-bismuthotellurides.