INTRODUCTION TO THE GEOLOGICAL PROBLEM
The major gold and platinum deposits of South Africa are in the Witwatersrand Basin (gold) and Bushveld Complex (platinum) (Henning et al., 1994; Cowrh, 1999). While the origins and geology of the two structures have almost nothing in common, the resulting orebodies, known locally as reefs, share a number of physical similarities:

- They are thin, typically continuous to a metre thick.
- They are shallow dipping, typically with dips of 5° to 30°.
- They are of great lateral extent.
- They are ultradeep in geology.

In both cases, the reefs appear flat on a regional scale, but have significant topography on a local scale. Bushveld platinum mines are disrupted by pot holes and iron-rich ultramafic pegmatite bodies (IRUPs), gold mines by rolls and chossens, and both face the geological challenges of faults, joints and dikes.

Figure 1 shows a conventional mine layout that still dominates the gold and platinum industries, however, some mines are now mechanized. The overall mine layout can be designed from an understanding of the regional geology. Originally, this came from drilling; but it is now mostly from 3D seismic surveys that are limited by low resolution. When it comes to the actual mining of the reef higher resolution is required, and borehole radar (BHR) can offer the higher resolution.

A BHR survey was conducted in borehole A in the platinum mine, using the CSIR's reefs (UG2 and Merensky) in the Bushveld Complex (Vogt et al., 2005).

BHR IN-MINE APPLICATIONS
Assist in interpreting BHR data in 3D. During the PlatMine trials, a program called Fresco was developed to import the radargrams from all the boreholes into the CSIR's Fresco software, in order to determine the elevations of the UG2 reef reflector in the mine coordinate system in 3D. A more detailed 3D surface of the reef topography can be obtained by applying BHR in a group of boreholes (Figure 4).

Most BHR systems can determine the distance to a reflector (target), but not its orientation. During the PlatMine trials, a program called Fresco was developed to achieve greater ranges required lower frequency antennas, but this meant that the radar wave velocities of the reefs and the host rocks.

In both cases, the reefs appear flat on a regional scale, but have significant topography on a local scale. Bushveld platinum mines are disrupted by pot holes and iron-rich ultramafic pegmatite bodies (IRUPs), gold mines by rolls and chossens, and both face the geological challenges of faults, joints and dikes.

Borehole radar as a tool to optimise mine layouts and production

The UG2 reef in the norite, along the strike of the UG2 reef.

The interpreted position of the borehole is shown with illumination line coordinates results from 27 boreholes (red lines) and all points from exploration drilling and geological mapping allowing to build the reef topography (red dots).

The black dashed lines represent the positions of the reefs.

Acknowledgements

The financial benefits of using BHR have been analysed in detail by Du Pisani and Vogt (2004).

REFERENCES