INTRODUCTION TO THE GEOLOGICAL PROBLEM
The major gold and platinum deposits in South Africa are in the Witwatersrand Basin (gold) and Bushveld Complex (platinum) (Meyers et al., 1994; Carr et al., 1994; Cowhorn, 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 centimeters to a metre thick.
- They are shallow dipping, typically with dips of 5° to 30°.
- They are of great lateral extent.
- They are tabular in geometry.

In both cases, the reef appears flat on a regional scale, but have significant topography on a local scale. Bushveld platinum mines are disrupted by potholes and iron-rich ultramafic pegmatite bodies (IRUP), gold mines by rolls and channels, and both face the geological challenges of faults, joints and dykes.

Figure 1 shows a conventional mine layout that still dominates the gold and platinum industries, however, some mines are now mechanised. The overall mine layout can be described 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.

**BHR (Trickett et al., 1994; Carr et al., 1994)**

Most BHR systems can determine the distance to a reflector (target), but not its thickness. To achieve greater distances required lower frequency antennas, which are impractical to use underground due to large size. BHR was proposed to overcome the problems with handling large antennas. From 1998 to 2000, the DEEPMINE collaborative research programme funded investigations of BHR (Trickett et al., 1994; Carr et al., 1994). In 2001, the CSIR embarked on development of the Aardwolf BR40 (Vogt, 2006). The DEEPMINE work showed that BHR for the gold industry worked very well for the VCR.

Initially the Surface Penetrating Radar (SPR) was used for reef imaging but was limited in range. To achieve greater ranges required lower frequency antennas, which are impractical to use underground due to large size. BHR was proposed to overcome this problem. During the PlatMine trials, a program called Fresco was developed to assist in interpreting BHR data in 3D (Du Pinani and Vogt, 2004).

**DIRECTIONAL AMBIGUITY**

Most BHR systems can determine the distance to a reflector (target), but not its direction. During the PlatMine trials, a program called Fresco was developed to assist in interpreting BHR data in 3D. The directional survey information as well as radargrams from five boreholes (borehole A was drilled approximately 20 m below the UG2 reef in the north, along the strike of the UG2 reef. Figure 3 shows the radargrams from borehole A and Figure 4 shows the radargrams from borehole 3). The radargrams from borehole A were imported 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).

**Borehole radar as a tool to optimise mine layouts and production**

The directional survey information as well as the radargrams for borehole A were imported 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).

**REFERENCES**

- Vogt, D., van Schoor, M., and Du Pisani, P., 2007. The financial benefits of using BHR have been analysed in detail by Du Pisani and Vogt (2004). The directional survey information as well as radargrams from five boreholes. The radargrams from borehole A were imported 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.