IMAGING GAS-BEARING STRUCTURES IN AN IGNEOUS DEPOSIT

SUMMARY

We deployed Borehole radar (BHR) in order to map the character of a reef in a platinum mine. BHR was used to detect and map the reef and surrounding features, allowing us to identify both lateral and vertical changes in the platinum reef. The results obtained from BHR were then used to accurately map the characteristics of the reef and surrounding structures. These findings played a crucial role in modifying the geologic model of the reef.

PROBLEM

To address the client's requirement of accurately detecting and locating methane-bearing structures in platinum mining, we deployed borehole radar (BHR). The presence of methane is a significant safety concern due to its potential for causing explosions during mining operations. Gas conduits such as fractures, voids, and faulting are among the structures that could facilitate the movement of methane.

SOLUTION

BHR is an electromagnetic technique used for imaging or detecting discontinuities in resistive hard rock formations. It was deployed through a borehole drilled subparallel to a platinum reef.

BHR reflections are normally caused by sharp changes in the electrical properties of the rock and can yield information on geological features such as lithology contacts, fractures, faults, voids, dykes, and ore body geometry.

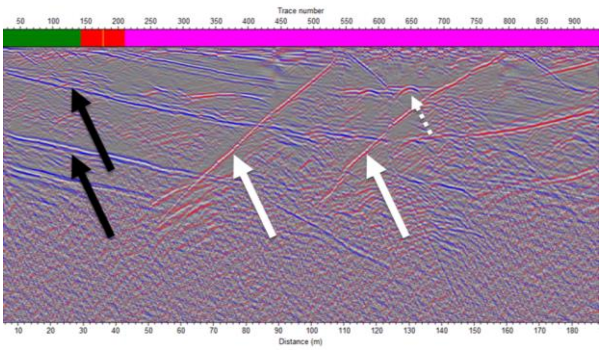
The figure below illustrates the results of the BHR, with the geology overlaid on top of the radar section.

The range represents the radial distance from the borehole, here imaged to approx. 50m – we observe anomalous responses to ranges of approximately 30m.

Using BHR, we were able to detect several features, such as platinum-bearing chromitite reefs, fractures, and voids. Interestingly, the fractures that were imaged showed the presence of methane gas at their intersection.

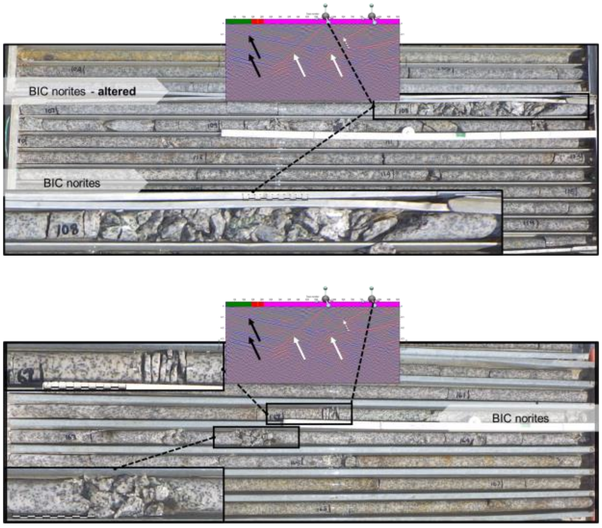
IMPACT

BHR successfully detected and imaged gas-bearing fractures and voids in relation to the platinum reef. These results were used for mining safely by informing the mining team in advance of the intersection of these structures by mining activity. Conventional interventions involve destressing or depressurizing the volume ahead of mining by de-stress blasting, thus avoiding rock bursts and blowouts.

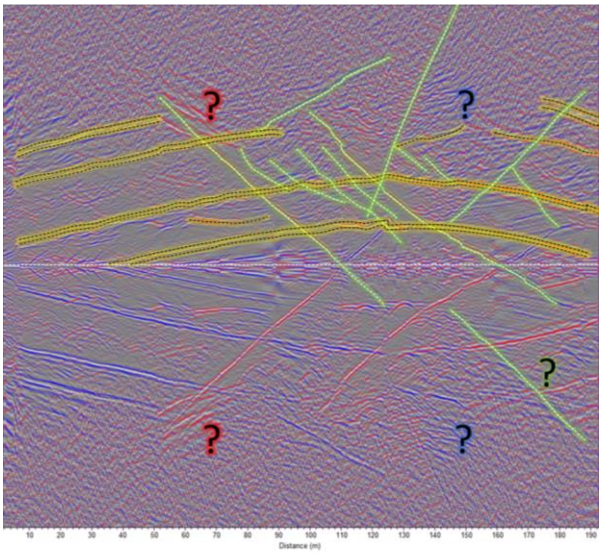


Borehole radar results showcasing how methane-bearing structures (white arrows) can be detected cross-cutting the Bushveld Igneous Complex chromitite reefs (black arrows).

TECHNOLOGY



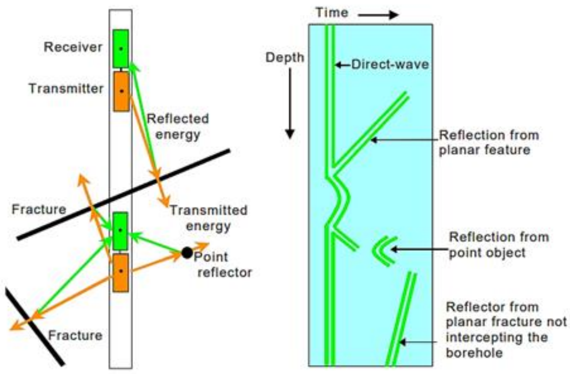
Diamond core from intersections at depths associated with the radar reflections, showing brittle deformation / structures resulting in reduced competent core recovery / RQD and discing. Little visible manifestation of alteration is visible at the intersection depths.



Vertical section illustrating interpretation of lithological contacts as well as brittle structures cross-cutting the lithological units. With a-priori information on the predominant structural orientations one can confidently interpret in 3D.

Borehole Radar (BHR) electromagnetic reflection methods can provide information about the extent and orientation of faults, fracture zones, and geological contacts intersected by the borehole as well parallel to subparallel off-hole features not intersected by the hole. The BHR system consists of an omnidirectional transmitter and receiver set orientated along the log axis of the borehole. A high-frequency electromagnetic pulse is generated by the transmitter and propagates radially into the formation surrounding the borehole. Some of the propagated energy is reflected to the receiver, where it encounters rapid spatial variation in the physical properties of the surrounding formation, specifically the dielectric permittivity.

These physical property changes can be due to lithological contacts as well as faults or fractures within the formation. The resultant 2D radargram is a composite image of the omnidirectional reflection events compressed into a two-dimensional image.



Transmitter and receiver antenna arrangement for borehole radar reflection logging and the typical patterns from planar and point reflectors (Lane et al, 2001).