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Seismic exploration of the world's deepest gold and platinum orebodies in South Africa – Overview of the past, present and a look into the future

Minerals keynote paper

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SUMMARY

Without doubt, the geologically complex Witwatersrand Basin in South Africa is by far the most important known gold-producing province. It has produced about one-third of the gold ever mined, worldwide. Gold mining in the goldfields takes place at depths ranging from 500 to 4200 m below surface. Many call the underground workings the 'devil's workplace'. This means that there are an increasing number of technical challenges in exploration and optimizing new resources, with rising costs and reduced effective mine designs. There are about 20 or more gold ore bodies (quartz pebble conglomerates) that have been mined, or are currently in production. Furthermore, the Bushveld Complex of South Africa is estimated to contain about 70% of the world's reserves of platinum group elements. The most important platinum ore bodies are the Merensky Reef and the UG2.

This paper presents the past and current research activities on the use and implementations of seismic methods for gold and platinum exploration and deep mine planning and designs. It, particularly, presents a state-of-the-art in seismic design and acquisition, processing, interpretation of the seismic data as well as modelling of strato-structural complexies of the basin using advance techniques. The current challenges and possible future solutions are further discussed with special emphasis on the reflection seismic imaging limitations. For example, reflection seismic data acquired on the surface in the Witwatersrand Basin and Bushveld Complex have wavelengths of approximately 60–100 m, providing vertical seismic resolution of approx. 20 m. Consequently, it is difficult to resolve the top and bottom of thin reefs (~ 1m in thickness) due to seismic wave interference as well as to detect faults with throws less than 20 m. However, gold reefs as thin as 20 cm to 1m are currently the main targets for deep mining and faults that crosscut these reefs with throws as small two meters may present difficulties to deep future mining operations. Recent research work has further demonstrated that some of these minor faults may act as conduits for ingress of water and flammable gas into underground workings.

There has been more of hard-rock reflection seismics undertaken in South Africa than anywhere else in the world. Therefore, this paper attempts to answer the following trickier question: Will seismic application in the mining industry in South Africa accelerate or decline in the coming years?