Safety in Mines Research Advisory Committee
Project Summary: GAP 821

Project Title:	Further assessment of seismic hazard/risk in the Bushveld Complex platinum mines and the implication for regional and local support design.

Authors:	A.v.Z Brink, M.K.C. Roberts, S.M Spottiswoode	**Agency:**	CSIR Miningtek

Report Date:	31/03/2002	**Related Projects:**	GAP 711

Category:	Gold & Platinum	Applied research	Rock engineering

Summary

The objective of this project was to assess the seismic risk in the Bushveld Complex platinum mines and to provide guidelines for regional and local support in areas where the seismic risk is considered to be high. In order to achieve this objective, seismic data from some recently installed seismic networks were analysed.

A significantly increased risk is observed with mining at depth (down to 2000 m below surface), and with larger mined-out areas. Potholes, a feature unique to the Bushveld Complex, do not show as increasing the potential for larger seismicity. The deteriorated ground condition experienced when approaching potholes, however, enhances the likelihood of 'shakedown' damage and therefore increases the probability of an undesirable consequence (an increased risk of experiencing seismic related damage/injuries).

Comparable mining areas were selected in the Bushveld and on the Far West Rand. Based on the analyses of the seismicity, and in particular the peak ground motion that an excavation is subjected to, the seismic risk associated with mining in the deepest areas of the Bushveld is about 6 times less than a similar area on the VCR.

An industry workshop on local support requirements in areas of higher seismic risk resulted in the specification of support requirements. A maximum design parameter for yielding support in terms of the ground motion velocity is 1 m/s. Subsequent seismic monitoring provided the confirmation of this specification. A stope support design methodology and parameters are given.

A single example of the need for better regional support was demonstrated. An abutment pillar greatly reduced the convergence rate and seismicity in an area of mining down-dip from an extensively mined-out area.

The following conclusions were reached in this project:

- The vast majority of the mining areas in the Bushveld do not experience seismicity that poses a significant risk to the safety of underground workers.
- Seismicity is assumed by a significant portion of the industry to only occur in or around highly stressed pillars/remnants. The project experienced this to be true in the majority of areas that can be described as shallow to medium depth mining.
- Accepting the above observation, seismic risk in the Bushveld is due to being close to the source (for example in the case of strain bursting) and also the apparent inability of the support units to yield while maintaining a stable hangingwall.
- No seismicity was found that could uniquely be attributed to the existence of potholes, except where potholes were left as small remnants.
- The researchers found clear evidence of dynamic failure on a geological structure. The deeper operations are experiencing normal (as in gold mining) seismicity ahead of the working face.
- The amount of seismic energy released in the selected area in the Bushveld mines at comparable mining depths is in the same order (within an order of magnitude) as the selected and similar area on the Far West Rand.
- There are strong indications that the daily blasting has a less concentrating effect in terms of temporal distribution of seismicity. A larger percentage of the seismicity occurs during shift times. In general terms it can be stated that the underground worker in the deeper sections of the Bushveld is experiencing 100% more events of Mag > 0 during normal shift time than his counterpart working on the VCR at a similar depth.
- Again this is an observation that requires a larger data set for validation. It furthermore requires an understanding of why the time dependant behaviour of the Bushveld exhibits such a different response to the daily blasting.
- The risk posed by ground motion resulting from seismicity at Northam, is approximately 17% of the risk posed by ground motion at comparable mining on the VCR and 8% of the ground motion risk at depth on the Carbon Leader reef in the Far West Rand.
- This aspect is the most significant observation in this report and requires to be confirmed by comparing more areas and the inclusion of data on seismic damage in these areas
- The project found substantially different behaviour in the interpreted seismological behaviour between the familiar gold (Wits) environment and the Bushveld. In particular, in

terms of time of day distribution, peak ground motion, influence of depth. The project did not succeed in quantifying the possible contributing factors, such as k-ratio or higher horizon stress. This aspect requires addition research and monitoring.

- The design parameters for the support system provides for a relatively easy achievable energy absorption requirement (9,6 kJ/m2).