

Non-explosive mining: An untapped potential for the South African gold-mining industry

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Mechanical extraction of rock has been a goal sought after for some decades in the South African gold-mining industry. There are factors distinct from the mode of mechanical extraction that may have considerable influence on its prospects for extensive adoption; the rockburst factor is one of these.

When rock is extracted by conventional blasting, it is well established^{1,2} that most rockbursts occur in a relatively short period after a blast. This is not a consequence of the energy of the explosives: it is the near-elastic response of the rockmass to the enlargement of the excavation. The significance of this temporal distribution of rockbursts is that most rockbursts occur when the work places are cleared of workers (and expensive equipment).

If the same amount of seismic energy is released during continuous enlargement (i.e. with mechanical mining) as with step-wise enlargement (i.e. blasting), the frequency of rockbursts can be expected to be uniform across the day, and, therefore, higher during on-shift time than at present. The consequence will be that the stope workers are exposed to a higher level of rockburst risk than at present.

Also material is the rockburst risk to exposed mechanical mining equipment: if equipment is damaged, or the working place rendered unmineable by rockburst activity, too frequently the economic viability of the system will be affected adversely.

These factors should be included in the research and evaluation of mechanical mining viability. In particular, the effects (if any) of continuous extraction on the total release of seismic energy, the magnitude-frequency relationship, and the location of rockbursts with respect to stope workings need elucidation.

References

1. HEUNIS, R. The development of rock-burst control strategies for South African gold mines. *J. S. Afr. Inst. Min. Metall.*, vol. 80, no. 4, Apr. 1980, pp. 139-150.
2. Chamber of Mines of South Africa. *An industry guide to the amelioration of the hazards of rock bursts and rock falls*. 1988, p. 78.

* *J. S. Afr. Inst. Min. Metall.*, vol. 91, no. 11, Nov. 1991, pp. 381-388.

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REPLY BY H.H. HAASE AND R.G.B. PICKERING

We agree with Professor O'Connor that, in conventional gold-mining operations, a disproportionate number of seismic events occur in the period immediately following a blast; rockburst activity follows the same pattern, and it has been calculated that, if the rockburst peak were spread evenly across the day, the rockburst exposure of stope workers would nearly double.

Even if a mine made extensive use of impact rippers, a large percentage of rock would still be broken using explosives, since only 45 per cent of the known reserves are estimated to be suitable for impact ripping. Consequently, current non-explosive mining scenarios are based on three shifts of 6,5 to 7 hours, with a re-entry period of 3 to 4 hours, which would coincide with the blasting activity.

Further factors that should have a favourable effect on reducing the exposure of stope workers to rockbursts are as follows.

- The stope support shown in the paper consists of three rows of hydraulic props, positioned between 0,3 and 2,4 m of the face, with the majority of stoping activities taking place between the second and third rows of props.

- Impact ripping is designed for waste sorting and packing, and permits the installation of high-quality backfill within 2,5 m of the face.

- At this early stage in the development, impact ripping has demonstrated twice the productivity of conventional mining, which, for a given tonnage mined, will result in substantially fewer workers at risk.

COMRO has used non-explosive mining methods to mine over 100 000 m² with no fatalities. In a rockburst that occurred when working the Carbon Leader stope at a depth of 2700 m, an event of magnitude 3,3 occurred during the morning shift, approximately 50 m behind the impact-ripper face. The conventionally mined panels below the impact ripper were subjected to major damage, and four fatalities were recorded; some workers in the impact-ripper face suffered minor injuries from rockfalls, but the equipment was not damaged and was in operation the following day.

In summary, we believe that there are substantial potential benefits from impact ripping in terms of increased safety and profitability, and it is expected that these will be demonstrated in the major production trial currently being planned.