Journal Comment

International Rock Mechanics Symposium

"Rock of Ages cleft for me
Let me hide myself in thee"
Augustus Toplady 1772

In the papers in this issue we are exposed to some of the expertise that has evolved over the decades in rock mechanics - the basic science involved in rock breakage, whether accidently or intentionally.

It is no great admission for me to say that in reading the papers there is much beyond my detailed comprehension. Indeed, I would need a course in computer-based mathematical modelling before being in a position to pass any scientific judgement or comment on the monumental paper by E. Sellers, J. Furtney, I. Onederra, and G. Chitombo on the hybrid stress blasting model. I have studied the computer-generated colour diagrams more in awe rather than with detailed comprehension. But these are for the specialists, not the commentators. As such, I can only attempt to give a broad indication as to where this work might contribute in future, and of course this means yet another look at the past and indulging in reminiscing, even at the cost of some repetition from past comments.

Perhaps, to start, I should explain that the quotation from a hymn was retrieved from that portion of my memory bank that goes back some 75 years when I was a chorister in the parish church. It has no religious significance whatever and intruded into my thinking only because of two words, 'rock' and 'cleft', which according to the Oxford Dictionary is derived from the word 'cleave' meaning to 'split or sever along a natural grain or line'. This meaning is particularly topical in my future analyses.

In the last century, the mighty gold-mining industry in South Africa has depended on the use of explosives to mine the rock, and a million detonators went off every day to deliver of the order of 100 million tons of ore, from which 600 tons of gold were produced every year. Bonuses were paid on the basis of the tonnage of broken rock sent to the surface, so brute force from high-energy explosives characterized this boom-for-bonuses era.

Inevitably, seismicity triggered by such blasting gave rise to increased rockbursts, which is the topic of several papers in this issue.

I was privileged to witness and discuss the mid-century work on rock cutting by the Chamber of Mines as an alternative to blasting. I was intrigued by two features. The first was the ease with which the rock could be 'cleaved' by what was a conventional milling tool design. Secondly, the ease with which the reef material, having been relieved of the rock pressure at depth by cutting just above and below the tabular reef, could be removed from the face by, for example, a crowbar, as it was full of pressure-relief micro-cracks. Rock cutting was abandoned by the Chamber as being too costly and dangerous.

My particular pilgrimage started some 58 years ago, when I was commanded by the consulting metallurgist of Anglo American to solve the problem of the 'unassayable' (missing) gold, believed to be the reason for the low Mine Call Factors. Half a century later, I have come to the conclusion that the most probable explanation is that the missing gold is carried away as fine dust in the vast volume of explosion gases tearing apart the components of the narrow reefs. My theory has never been proved nor disproved, despite several attempts to sample and analyse for gold the vast volumes of the explosion gases. This is not surprising, considering the specific gravity of the gold in relation to the density of the gangue material. It is like looking for one gold particle among millions of others in the rapidly expanding dust cloud. It is like 'looking for a fly in a cathedral', to quote Lord Rutherford in his quest to be the first to split the nucleus in the large atom. Whether my conclusion regarding the loss of gold in the explosion gases is exactly correct, it is certain that, in a bulk stope explosion, the mineralization is spread over a good proportion of the underground workings.

The paper by Sellers is highly relevant. Although it refers specifically to open-pit kimberlite mining, it is the latest chapter in the work on hybrid stress blasting models. Complete understanding for me as a non-specialist is impossible. I have gleaned from this and a previous publication that the model identifies two main types of breakage—that caused by the buildup of high-pressure gas phase causing displacement of fragments of the matrix, and the shock wave fracture caused by the interaction of the shock wave on the different crystal phases in the rock structure.

It is the shock fracture that I relate to cleavage. This is what is wanted in the gold reefs. Fragmentation is the term commonly used in the world of blasting in an open pit, and this is much desired. But according to Sellers, fracture is undesirable and can result in weakening of the supporting wall, and the HSB model can identify and characterize such effects.

However, in deep-level lateral reefs fracture with no gas displacement is the ideal for the reef, and fragmentation, if operated on a sequential millisecond blasting pattern, can be confined to the roof and hangingwall regions, producing a cast blast hurling the waste to the back of the stope.

This was envisaged some 20 years ago, and I was involved in considerable test work at the Kopaneng mine and Impala platinum mines. The concept was to separate the reef material from the waste in one sequential blast. The concept came close to working, but was never implemented because of unreliable detonation equipment.

I come to the point of this comment, with apologies for the lengthy reminiscing.

I believe that there is a good probability that selective blasting, in which the reef material can be separated from the waste, can be achieved on an economical basis. The science of rock mechanics has advanced to the point where there are a number of options worthy of detailed investigation. Undoubtedly the work to date on the HSBM approach is the leading critical path, particularly as regards the advances in blasting mechanisms in the form of shock-tube and electronic detonators.

The benefits of a successful selective blast are great, apart from the additional gold recovery in many mines and the savings in hoisting less than half of the total broken amount of rock to the surface. There are many additional economic advantages, and a host of options for further R&D work that could have great impact on deep-level mining, sustainability, employment, and AMD elimination, leading to a total zero waste philosophy. But this would demand several issues of the Journal to describe all the ramifications of a national portfolio to justify its impact on the industries around gold and platinum.

There are many other papers of specialized and general interest, but one in particular shows that even the down-to-earth mining industry can bring science fiction to reality. This is the paper by D. van Rensburg, of Anglo American Platinum, which describes a gigantic rotary broom that has been automated to sweep boulders off the top edges and walls of open-pit mines to avoid them rolling into the pit and causing great damage. This device is a world first, and remarkably it can handle boulders of 600 kilograms on a horizontal surface. ◆

R.E. Robinson