A rock-engineering monitoring programme at West Driefontein gold mine

by R.G. Gürtunca and D.J. Adams*

CONTRIBUTION BY J.F. CURTIS†

The paper, which in an exemplary manner records the monitoring of backfill behaviour, falls short in the 'rock-engineering' stated in the title. Just what the objective of the rock engineering was is obscure.

The introduction refers to the original use of backfill support at West Driefontein 'with the objective of reducing seismicity and rockburst damage'. However, no records of seismicity other than the nine events in Tables I and II are given. There is no evidence of its reduction or increase.

COMRO's involvement is noted as 'firstly, to measure the *in situ* performance of these backfill materials and the surrounding rockmass; and, secondly, to assess the effectiveness of the backfill in reducing rockburst damage'. The '*in situ* performance of these backfill materials' has been comprehensively observed and recorded; of 'the surrounding rockmass', by implication only by virtue of its causative relationship to the behaviour of the backfill materials. When the paper goes outside this narrow objective and claims that backfilling has reduced rockburst damage, it produces no evidence to support this claim.

The claim is made in two places:

(1) in the synopsis, 'underground observations also showed less rockburst damage in backfilled panels than in unfilled panels', and

(2) under the Summary and Conclusions, '(5) The seismically induced rockburst damage in backfilled panels is less than that in unfilled panels'.

To substantiate these claims, it would be necessary, first of all, to define in detail how 'damage' is measured. In a mining operation, the following parameters are relevant:

Personnel :	Fatalities	
	Injuries:	Permanent disabilities Shifts lost
Equipment :	Unrecoverable	
	Recoverable:	Cost of repairs Shifts lost
Support :	Mechanical:	Written off Cost of repairs
	Non-mechanical:	Replacement cost
Production :	Permanent:	Loss of ore due to abandonment of stope face
	Temporary:	Due to interruption in productive operations.

All of these are quantifiable in monetary terms, although the 'damage' in the case of personnel, in terms of morale, far exceeds the compensation paid and the cost of medical and recuperative treatment.

The only attempt to quantify damage is made in Table II, which is headed 'Rockbursts in backfilled and unfilled stopes'. There is no comparison with unfilled stopes; descriptions of damage are limited to rock movements; the extent of damage is described in such unspecific terms as 'relatively minor', 'little', and 'significant'.

The authors apparently consider that their claim that 'rockburst damage in backfilled panels is less than in unfilled panels' needs corroboration and, under *Control of Rockburst Damage*, quote: 'Gay *et al.*[1] also concluded that, in general, stopes that had been backfilled survive rockbursts better than do conventionally [what is conventionally?] supported stopes' [p. 433]. There is no evidence in this paper to support such a conclusion.

The introduction of the concept of 'conventionally supported' is of interest. Under the same heading, they noted that 'underground observations (Table II) showed that rockburst damage was minimal in the backfilled panels provided the fill-to-face distances were about 5 to 6 m and the face area was supported adequately'. Since the authors give no description of what they consider to be 'supported adequately', one is left to conjecture what part in the prevention of rockburst damage is played by the face support, and what part, if any, is played by the backfill.

The paper as an academic exercise in monitoring backfill behaviour is competent; it has no value in showing how to reduce rockburst damage at the stope face.

REPLY BY R.G. GÜRTUNCA AND D.J. ADAMS

The authors thank Mr Curtis for his interest in their paper and for his comments.

One of Mr Curtis's criticisms is that the influence of backfilling on seismicity is not dealt with. In this he is confused between the objectives of the mine for introducing backfill in the first place, and the objectives of the paper.

Although backfilling was introduced by the mine with the express purpose of reducing seismicity at West Driefontein, the authors clearly state that their objectives in the paper are only determination of *in situ* behaviour of backfills and the surrounding rockmass, and assessment of the effectiveness of backfilling in reducing rockburst damage. Therefore, this paper was not intended to address the seismicity issue at all. This aspect of the influence of backfill has been dealt with by other researchers[1] at COMRO.

Regarding the influence of backfill on the behaviour of the surrounding rockmass, the authors strongly believe that the behaviour of backfill is probably the most effective way of determining the rockmass behaviour around a stope in three dimensions.

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The issue of rockburst damage is dealt with in various sections of the paper, including Tables I and II. The results of observations of rockburst damage sites are summarized in the section entitled 'Control of Rockburst Damage'. It is indicated that, if the backfill is not placed 5 to 6 m from the face, rockburst damage may increase. The ability of backfill to absorb seismically generated energy compared with timber support is demonstrated to be considerable.

The authors believe that the factors listed above, which were possibly overlooked by Mr Curtis, reasonably explain the influence of backfill on rockburst damage.

Reference

1. HEMP, D.A., and GOLDBACH, O.D. The influence of backfill on seismicity. COMRO Reference report 39/90, 1990.

The impact of forward sales on the price of gold

by H.L. Monro*

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The thought-provoking paper by Monro deserves serious consideration. If he is correct, the practice of selling gold forward should cease forthwith. However, similar arguments may well be advanced against the selling forward of many other commodities, and this runs counter to the success of futures markets worldwide. If, indeed, the practice were basically flawed, then such markets should long since have failed.

I believe the flaw in Monro's argument arises when he says 'The accuracy of the... calculation depends on the data shown in Table I, which consist of tonnages and price elasticities. *The latter are exact or close estimates....*' [emphasis added].

For non-Communist mine supply, he argues that 'the current price of gold has no effect on the current production'. This goes totally counter to the whole spirit of South African gold-mining taxation, which forces mines to reduce the grade when the price increases. Because there is limited surplus milling capacity to increase the tonnage treated, the tonnage of gold produced drops as the price increases and the grade goes down.

Thus, far from the elasticity in respect of new production being zero, as Monro argues, in fact it should be negative. This was tested using the data he employed[1]. Mine production was correlated with the average annual gold price in constant 1990 rands. For the period 1980 to 1990, the unlagged price elasticity had a value of –1,02, not 0,00.

Lagged price elasticities were close to 1, depending on the lag assumed. This is what one would expect: as the gold price increases, so new producers are attracted into the market and contribute in due course to the gold production.

In a similar vein, Monro argues that 'Forward sales... have a price elasticity of supply of +1,0'; that is, the higher the gold price, the greater the volume of forward sales. However, it could well be argued that forward sales reflect hedging against downward price movements, so that the owner who perceives a risk of a downward movement is more likely to sell forward, giving a negative price elasticity, not a positive one.

Again this was tested on the available data. Unfortunately, supply from hedging transactions commenced only in 1984, and grew from 13 t in that year to a peak of 259 t in 1988. Thus, there are two components in the relationship between volume of hedging transactions and price: the growth of this vehicle as a feature of the supply, and the growth of the impact of the supply on the market.

Within the limited data available, these two effects cannot be satisfactorily deconvoluted, but the second effect seems to have the anticipated negative elasticity. In the absence of firmer data and to be fair to Monro, it is probably adequate to assume a forward sales elasticity of zero in place of his +1,0.

If these elasticities for mine production and forward selling are incorporated in Monro's equations [1] and [2], the result is

$$-14 + 441Q^{1,4} - 1986Q^{-0,6} + 1559Q^{-1} = 0, \qquad [1]$$

which still balances when $Q = 1$, and

$$-254 + 441Q^{1,4} - 1986Q^{-0,6} + 1559Q^{-1} = 0, \qquad [2]$$

for which the solution is found at $Q = 0,510047$.

Following Monro, this means a gold price *inflator* of $187,94/240, or an *increase* of $0,783/oz for every ton sold forward.

In summary, therefore, Monro is correct to draw attention to the possible effects of forward selling, but his model depends critically on the values he has assumed for the elasticities.

There are grounds for believing that his values for the elasticities, far from being 'exact or close estimates', are actually of the wrong sign. If this is so, his conclusion that 'every extra ton of gold sold [forward] per annum reduces the price by about $0,2/oz' could be seriously in error. Indeed, I have shown that some reasonable values for the elasticities lead to an *increase* in the price of gold if gold is sold forward.

Reference

1. *Gold 1991*. London, Gold Fields Mineral Services Ltd, 1991.

* *J. S. Afr. Inst. Min. Metall.*, vol. no. 2. Feb. 1992. pp. 49-52.

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