Winning paper: Optimization of a raiseline at Mponeng Mine

by N. Ragoonanthun* **Paper written on project work carried out in partial fulfilment of B.Sc. (Mining Engineering) degree**

Synopsis

This report investigates the optimization of a raiseline in order to open up the ore reserve quicker. The project was carried out at Mponeng Mine (an Anglogold shaft formerly known as Western Deep Levels 1 Shaft and South Mine, in Carletonville). The project was divided into two focus areas namely:

- ➤ **To design an optimum layout of a raiseline, which includes the scheduling of all activities for the establishment of the infrastructure. Consideration was given to the blasting practice, mining cycle, orepass placement and slusher positioning. Two designs were carried out on the above basis.**
- ➤ **The design of a ledging operation/practice to match the optimized layout of the raiseline. The ledging cycle design involved a thorough investigation into the possible use of drill rigs, Electronic Delay Detonators (EDD) blasting technology, longer drilled holes, Threshold Blasting (THROB), and waterjet cleaning.**

Introduction

One of the key elements to any engineer's design capability is the ability to optimize. Through optimization, one can significantly reduce a company's cost on a certain task by shortening the period of time for which it was planned. In a mine where optimization has reduced the time for tunnel development, it would be a definite plus. By having a raise that is completely developed in a shorter period of time, earlier ledging and stoping activities can occur. A raise is considered to be one of the most important tunnels in mining since it is through this tunnel that the orebody is accessed.

Optimization of a raiseline has many advantages. If the primary goal is time saving, then the achievements would be an ore reserve which is available for exploitation sooner then planned. Any additional costs picked up while optimizing the layout of a raiseline would be covered by the extraction of the orebody over the period of time that was saved.

There can be alternative layouts of a raiseline since a raiseline layout depends on several parameters. The approach taken in this project was to look at two different designs of raiselines. From these designs, a decision could be made as to which one is most suitable for Mponeng Mine.

An efficient ledging operation can complement an optimized raiseline. A thorough investigation was carried out to determine a suitable ledging operation. The investigation was focused on downdip ledging and implementing the possible use of drill rigs, EDD Blasting Technology, longer drilled holes, Threshold Blasting (THROB) and waterjet cleaning.

Objectives of study

The main objectives of this investigation were as follows:

- ➤ To determine a probable raiseline layout that is practical and cost saving
- ➤ To determine a raiseline layout that will result in quicker production
- ➤ To determine a practical ledging operation
- ➤ To hand over the completed ledged raise to the stoping crew in a shorter period of time
- ➤ To increase safety by having more control over people
- ➤ To reduce labour costs
- ➤ To have a better flexibility to mine.

Operational review of Mponeng Mine

Locality and background

Mponeng Mine is located on the West Wits line of the Witwatersrand Basin. It lies on the Gauteng/North West Province boundary, some 70 km south-west of Johannesburg and 8 km south of Carletonville (see Figure 1).

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Figure 1—The location of Mponeng relative to the major centres and within RSA

Mponeng shares boundaries with Anglogold's Tautona and Savuka Mines to the north, Driefontein to the east and Elandsrand to the west.

The mine currently produces gold from the Ventersdorp Contact Reef (VCR). Stoping takes place at a mean depth of 2,750 metres below surface. Twin shaft sinking from surface commenced in 1981 and the shafts were commissioned along with the gold plant complex in 1986. The mine operates two vertical hoisting shafts and two ventilation shafts. The hoisted ore is milled and smelted at the Mponeng Plant. The capacity for the shaft is 2.6 Mtpa and that for milling is 1.9 Mtpa. The mine has reserves of 35.3 million tonnes @ 9.02 g/t for 10.3 million ounces and resources of 115.9 million tonnes @ 11.34 g/t for 42.3 million ounces.

Geology

Mponeng is located on the north-western rim of the Witwatersrand Basin. There are seven gold-bearing conglomerates within the lease area, of which only two are currently economically viable. The first is the VCR, which is a gold-bearing quartz/pebble conglomerate of intermediate grade capping the last known angular Witwatersrand unconformity. A characteristic of this orebody is the pronounced palaeomorphology where thick reef has been preserved in the form of terraces separated strategically by thin inter-terrace slope reef. Mponeng currently mines only the VCR above 109 level. Early in 2004 additional VCR will be mined between 109 and 120 Level in the deepened area of the sub-shaft.

Mining

Mponeng commenced operations utilizing the longwall method of mining. In 1995, a decision was taken to convert to the more efficient and inherently safer sequential grid method. This allows for the selective mining of VCR, with its inherent high-grade variability. Current production levels are between 22,000 m^2 and 23,000 m^2 per month.

Part A

Designing an optimum layout for a raiseline

It is a challenge to produce an optimum layout for a gold mine since every gold mine has unique parameters. A common parameter that varies at each mine is the geology of the area, which is considered to be the most critical parameter. Inter-level spacing is also as nearly critical. Inter-level spacing, which is the perpendicular distance between two consecutive stations underground.

The approach taken in this investigation was to study two different raiseline designs. The raiseline designs studied were:

- A raise with a slusher
- Direct boxholes to the raise (no slusher).

The layouts were first hand-drawn to scale and then later drawn on computer. After completion of the layouts, the scheduling of all activities for the establishment of the infrastructure for the layouts was carried out on a project scheduling software package. Each of the design layouts is discussed in brief in the following sections.

The designs were based on the raiselines between levels 109, 113, 116, and 120. The inter-level spacing between 109 and 113 levels is 125 m whereas the spacing between 113, 116 and 120 levels is 100 m (see Figure 2). With the reduced inter-level spacing for the deeper levels, the raises have become shorter. The raises between 109 and 113 levels are on average 347 m in length whereas raises between 113, 116, and 120 levels are on average 267 m in length. The raise length between 109 and 113 is still significant and thus a slusher would prove to be most suitable. For long raiselines without a slusher, the boxholes that are required are considerably longer. By introducing a slusher, the development of excessively long boxholes would be eliminated.

A raise with a slusher

The raise with a slusher layout is currently in use in most of the raiselines at Mponeng Mine. The combination of a raise and slusher is suitable for longer raises such as those that are currently being mined, which are on average 350 m to 400 m in length. When designing the layouts, it was more appropriate to study raiselines that are of future development in the deeper project areas of the mine.

Problem encountered

When developing the raise, the development is stopped four metres past the holing position of boxhole 1a (see Figure 3). Boxhole 1a is holed and a grizzly is installed. Thereafter, the slusher and the raise commence with development. The broken rock from the raise development is scraped into boxhole 1a and into the slusher. More rock collects in this location from the slusher development. Thus the region where the breakaway meets the slusher becomes a bottleneck and ventilation pipes incur damage. There is also difficulty in cleaning this rock due to the lack of space for the movement of the scraper.

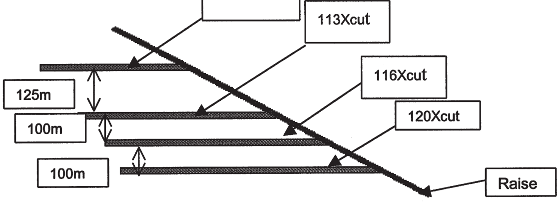

Figure 2—Interlevel spacing between respective cross cuts

Proposed solution

The solution would be to develop boxholes 2 and 3 simultaneously (see Figure 3); therefore both boxholes are holed together. This will provide a dedicated orepass for both the development of the slusher gully and the raise respectively. This will prevent the congestion of using one boxhole only and allows for quicker and easier cleaning. Access for the development end of the slusher gully can be through a travelling way from the raise. Ventilation columns through the travelling way can provide the slusher development end with forced ventilation.

Direct boxholes to the raise (no slusher)

This raiseline layout was designed for the raises between levels 113, 116, and 120 where the inter-level spacing is 100 m. With a shorter raise length of 267 m, there is no need for a slusher (see Figure 4). The longer boxholes can be developed by blind hole boring so as to aid in quicker and safer development.

The crosscuts from levels 113 to 120 are in the footwall and thus blindbored holes can developed effectively, since the reef is known from geology bore holes (GBH) drilled previously. The development of the bored holes for boxhole 4 and boxhole 5 takes place in a minor crosscut of 20 m–30 m in length off the main crosscut. Thus the development does not interfere with development in the main crosscut. The additional crosscut length is great enough to accommodate all necessary equipment required for the boring machine, i.e. drill rod storage and hoppers for the rock chips produced.

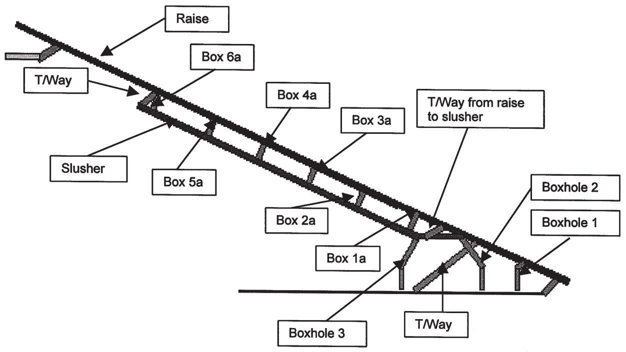

Figure 3—Cross-sectional raiseline layout with raise length of 347 m

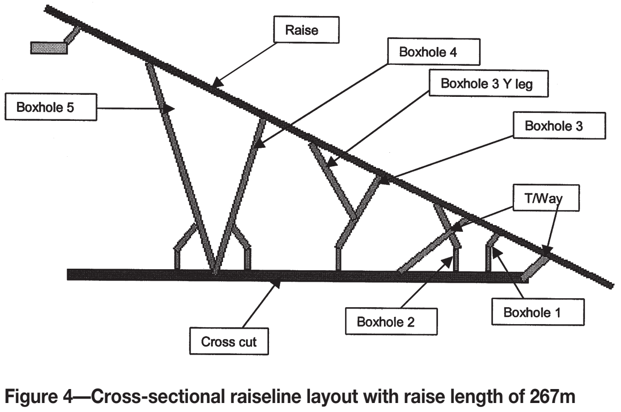

Figure 4—Cross-sectional raiseline layout with raise length of 267m

During the ledging and stoping phases of this raiseline layout, boxholes 4 and 5 require more hoppers when they are to be emptied of ore since they have a higher storage capacity due to their length. The design does consider this requirement since boxholes 4 and 5 are the initial boxholes to be intercepted by the hoppers. The span of hoppers is easily accommodated in the remaining length of the crosscut thus allowing for ease of tramming.

Scheduling of the raiselines

The following advances per month were used in determining the total time required for the completion of a raise (Smit, 2001):

- Raise development: 90 m (in multiblast)
- Slusher development: 65 m (in multiblast—shift cycle: 2 blasts, 1 clean)
- Conventional boxhole development: 15 m (shift cycle—single blast per day)
- Blind boring boxhole development: ±190 m (12 hour shift with advance per shift of 8 m–14 m)
- Travelling-way development: 20 m (shift cycle—single blast per day).

When scheduling, a 20% loss in efficiency was taken into account for each type of development.

Part B

Ledging

Ledging is the term used to describe the process where 15 m (depending on the standard of the shaft) of the reef is stoped out on each side of the raise so as to create a starting point for the stoping crew to commence with the mining operation. Moreover, the extent of which ledging occurs depends on the overstoping requirements for the underlying cross cut or slusher. Generally, there are two ways in which ledging is done, namely:

- breast ledging and
- downdip ledging.

Both types of ledging have their distinct advantages and disadvantages.

Advantages of breast ledging:

- Breast ledging can give a large number of centares on a single face in a single blast
- Several panels can be developed at once along the raise
- Gullies are established immediately.

Disadvantages of breast ledging:

- Sidewall damage to the raise
- A face winch is required for every face
- After blasting a panel, a shift may be lost due to supporting the panel
- It is difficult to equip the raise since different panels are blasted in different areas.

In comparison, the advantages of downdip ledging are as follows:

- There is better control of the sidewalls in the raise
- Support is installed every day as the face advances

- The winch remains in one place
- The back areas remain clean
- Equipping can commence while the ledge face advances
- Easier control of ventilation.

The disadvantages of downdip ledging are:

- There are no gullies established
- Footwall ripping is done when ledging is complete.

Breast ledging does prove to be a faster ledging process, but downdip ledging was chosen for the project because of its advantages and suitability to the mine.

An investigation was carried out in the possible use of EDD Blasting Technology, drill rigs, longer drilled holes, Threshold Blasting (THROB) and waterjet cleaning. A brief study into each of the above was taken into how it could be used in downdip ledging.

EDD blasting technology

EDD blasting technology incorporates the use of an electronic detonator (called the Electrodet). The Electrodet blasting system, with associated blast control systems such as Detnet 2000 and MiMine, was developed by African Explosives Limited (AEL) in response to the mining industry's need for increasing safety and productivity. (AEL, 1999).

The system consists of an integrated electronic system, which controls the precise timing at which an explosive element within the detonator unit is initiated. The system so far has shown some benefits for Mponeng Mine. Face advance has been improved by up to 25% per blast, and stoping widths have been decreased by as much as 18%. Fragmentation of rock is far more uniform than before. Misfires at Mponeng have been reduced dramatically since cut-offs are eliminated as all detonators are already charged when the first shot is initiated. A higher degree of control is achieved, eliminating blast damage to the footwall and the hangingwall caused by out-of-sequence shots. (AEL, 1999)

The Electrodet system consists of four components namely the detonator, facebox, Crosscut Control Unit (CCU) and a management information system.

To activate the detonator, a coded input signal is first sent to the detonator. On receiving a valid signal, the control circuit starts the timers. The detonator has a 125-millisecond delay. The facebox is first and foremost a diagnostic device, which tests the integrity of the detonator installation once charging up operations have been completed. The facebox also acts as an interface between the detonators and the Crosscut Control Unit (CCU), which issues the blast command. The CCU is positioned in the crosscut and is able to service up to six face boxes delivering a total blasting capacity of up to 2400 shots, based on a maximum of 400 shots per facebox. The CCU controls the issuing of the final blast command to the faceboxes and acts as a charging bay for the faceboxes.

The features of this system are:

- Precise inter-hole delays
- Adaptable for selective centralized blasting
- Delay remote blasting
- Real time testability of each detonator connected
- Safety lockout keys and password-protected software.

Mponeng Mine has changed over to the Electrodet system and has since had excellent improvements in safety and misfire reductions. It is also evident that with the use of electronic blasting, there has been an improved control of seismic activity. Electronic blasting allows blasting for the entire mine to be controlled from surface. Since the time of the EDD implementation at Mponeng Mine, the seismic window has been narrowed from 9 hours to 5 hours (Hamman, 2002).

The use of EDDs allows for perfectly timed holes and for breaking the rock sequentially, which is especially critical in Threshold Blasting.

Threshold Blasting (THROB)

Threshold Blasting involves the use of small amounts of high explosive to break and fragment hard rock without having to evacuate mining personnel. This allows for a continuous operation and no time loss due to the evacuation period required for poisonous gases and dust to dissipate after blasting. This concept was developed by AEL in 1995 and branded recently as 'Threshold Blasting'.

The following information on Threshold Blasting was extracted from a paper on Threshold Blasting by Cunningham and Zaniewski (2001).

The technical problems that have to be addressed if people are to remain at hand when blasting takes place are:

- minimization, and dilution, of asphyxiant and toxic fumes so that the ventilation system can deliver healthy air to workers
- rock particles to be retained at the face and not allowed to fly into refuge areas or to knock out support
- minimization of damage to hangingwall.
- complete breaking to depth so that full tonnage is achieved with each hole
- rapid operation to deliver the required flow rate of broken ore, ensuring short re-entry times.

These objectives are all realizable with Threshold Blasting, which has the following key elements.

- Use of the minimum amount of explosive required to fragment the rock. This directly reduces the gas volume produced, and prevents problems caused by high velocity throw rocks.
- Use of a rigidly controlled explosive that primes easily, produces minimal toxic fumes, and which delivers consistent performance in small quantities.
- Effective stemming which prevents any gas from exiting through the collar of the hole. This enables all the available energy to work effectively in rock breaking, and forces the gases towards more complete combustion, hence removing toxic components.
- A fluid-coupling medium against the explosive to improve transmission of energy and cleaning of released gases.
- Disciplined drill teams, preferably using an appropriately engineered drilling rig, to ensure that holes are drilled parallel, are correctly burdened and are within the stoping limits. This ensures consistent and economic breaking without dilution.
- Blasting as many holes as makes sense within the capabilities of the stope system to accommodate the rock in each blast and the volumes of gas and dust created. This promotes productivity, as the process of withdrawing, firing and re-starting takes about the same length of time irrespective of how many holes are fired. Tons per cycle increase with larger batches.

- Use of electronic delay detonators for initiation. This eliminates the fumes from pyrotechnic methods, enables complete checking of the system prior to firing and gives certainty of sequential firing. With Threshold Blasting, out of sequence firing is fatal to success, as there is no insurance of excess energy.
- Properly trained and motivated work teams who can underwrite the Basis of Safety of the system and know what to do to solve problems.

Current Constraints

The outstanding feature of Threshold Blasting is that, when applied correctly, it breaks rock safely and effectively. However, the following vital constraints need to be taken into consideration.

- The system requires independent ventilation districts.
- A high quality and efficient local ventilation system must be in place.
- Personnel need good knowledge of explosives and blasting so as to be able to introduce changes and modification; if blasting efficiency drops.
- There is a lack of suitable narrow reef equipment for mechanized and automatic drilling, charging up and blasting. This is true for all blasting operations and not just Threshold Blasting.
- Legal constraints:
  - re-entry time: DME permission
  - multi-blast conditions permission
  - explosives cutting permission if this is necessary during trials
  - permission to charge up, while drilling operation is in progress
  - safe distance from blast to which crew can be evacuated
  - requirements for design of the temporary waiting place
  - alarms and warnings to ensure the zone is cleared.

To resolve the above constraints and requirements will be time-consuming work and will possibly require some changes in current mining legislation.

Threshold Blasting is currently being carried out at Kopanang Mine in Klerksdorp. A visit to the shaft has proven to be of value since the Threshold Blasting project being carried out is done on a downdip basis. This can help sustain confidence for the possibility of Threshold Blasting in a downdip ledging face.

Envisaged labour allocation is for 8 personnel working in pairs: drilling; charging up and blasting; cleaning; and support and logistics. In 3 minutes the drill rig should drill a set of 2 holes, index to the next position and begin collaring (see Figure 5). If this is sustained, it should be possible to drill, charge, and initiate a batch of 30 holes every hour, giving 5 m^2 for an advance of 1.0 m and a burden of 33 cm. In reality, the blasting rate will be slower than 1 hour, at least during system development and with the normal unpredictability of mining operations. If 4 to 5 blasts could be taken in a six-hour shift, there would be 18 blasts per day for a 24-hour operation. If the blasting efficiency is only 75%, ±70 m^2/man can be obtained. Three blasts per six-hour shift are frequently achieved.

Can Threshold Blasting work at Mponeng?

An investigation into applying Threshold Blasting on the ledging faces where a slusher is not used was carried out. A suggestion for the possible use of this concept would be to narrow down the length of the current 15 m ledging panel to 5 m.

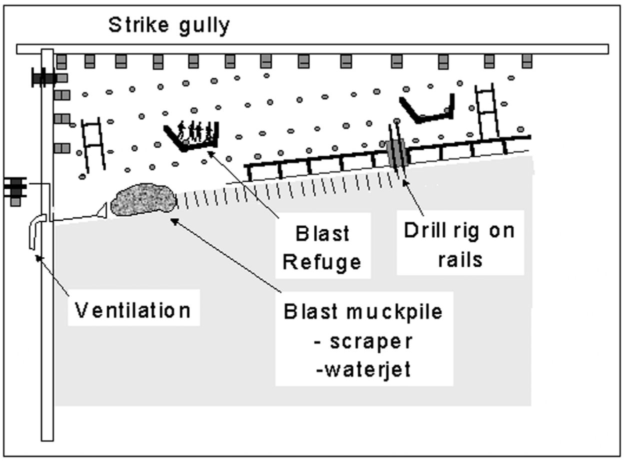

Figure 5—Threshold Blasting layout for a downdip panel (Cunningham and Zaniewski, 2001)

A theoretical outlook for the use of Threshold Blasting would be to blast a 5 m panel 3 times per shift. The use of a drill rig would give holes of 1.5 m in depth. Therefore 25.0 tons can be achieved per blast and this can be cleaned in 1.5 hours. It takes a scraper to clean at a rate of 15 tons per hour. If assisted by a waterjet, the rate is increased to 20 tons per hour. If a waterjet is used, there might be no need for a scraper. Thus the advance per day is 13.5 m at the face considering that there are three shifts per day. The requirements for this extreme advance per day can be overcome by having a dedicated drilling, cleaning and support crew since Threshold Blasting allows people to be present at the face continuously. Thus theoretically, a 267 m raise can be completely ledged in 20 days.

With the above system, only two ledging faces can be done at one position in the raiseline, i.e. at the top of the raiseline. If more faces were to be established along the raiseline, then separate ventilation for those faces would be required since contaminated air from each working face would degrade the air quality required for other faces along that raise. Threshold Blasting conditions would therefore not be achieved.

Currently at Mponeng, the dedicated ventilation return for Threshold Blasting prevents its implementation. In order for the Threshold Blasting concept to be a success at Mponeng Mine, this method of mining must be risk assessed by all the relevant disciplines in order to resolve all constraints.

Drill rigs

Any new technology that can take away the backbreaking drudgery of a job must be an advantage. If it can also add other benefits, then it must be worthwhile. After a brief study on the various drilling systems available for in-stope drilling, the Novatek Mk 1 drill rig was chosen as the most suitable drill rig to operate at Mponeng Mine.

Novatek instope drill rig

The choice of the Novatek Mk 1 drill rig was based on the drill rig's simplicity and relatively easy manoeuvrability compared with other drilling systems. The drill rig is of a simple structure that uses a conventional drill without the airleg (See Figure 6). The rigs are designed to mount onto temporary or permanent support using traverse beams on which the drill boom is able to slide. The drill rests on the rig structure. The rig provides the necessary guidance for the drill to achieve accurate drilling and positioning of blastholes.

In their paper 'Rollout of stope drilling systems in S.A. mines', Wills and Buyens (2002) indicate the achievements of the Novatek stope drilling system. Although the system is still evolving into a better and easier to-use system, it proved from the start that it was able to provide the benefits of accurate drilling, mining efficiency and safety in a simple, easy to operate package.

Novatek has tested the system in over 25 shafts in southern Africa, and over 350 units have been supplied. Of these, approximately 70% are in regular use or in the process of being implemented. The remaining 30% represent cases where trials and implementation have been ineffective.

Results on mines where the system has been in use has shown that the system provides the means to:

- Drill accurately
- Drill up to 50% faster due to the in-line thrusting
- Reduce drillers by up to 50%, dependent on mining conditions. This provides the opportunity to re-deploy drillers to increase raise line utilization, etc.
- Drastically reduce worker exposure to rockfalls and rockbursts by moving workers 1 to 3 m back from the face and under good support
- Greatly increase mining efficiency, reduce costs, and improve productivity. A study within an Anglogold mine showed that a 10% to 15% reduction in stoping costs was possible
- Face shape, stope width and hangingwall condition are greatly improved.

The design has the advantages of being modular with low mass, so that the components can be stored in the working area and rapidly assembled by hand. The drill rig depends on the stope support for its operation and thus the drilling crew must ensure that the support is up to standard. The simplicity of the drill rig allows for operator training at the shaft over a period of two days. The stope drilling system is summarized in Table I.

Rolling in reef does occur at Mponeng Mine. With the Novatek Mk 1 drill rig, roll in reef can be negotiated since the panels will be mined on downdip.

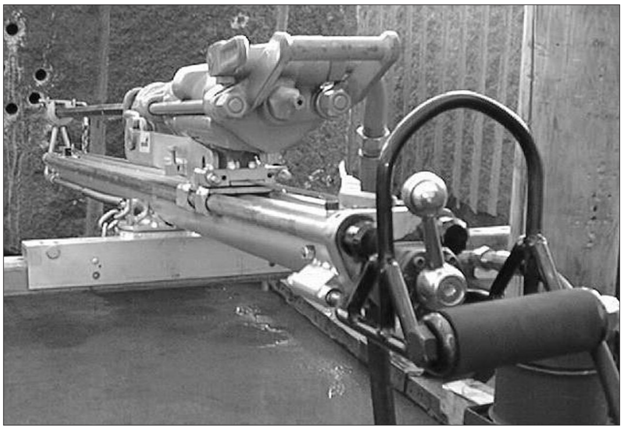

Figure 6—Novatek Mk 1 drill rig (Novatek Drills (Pty) Ltd, 2002)

Recommendation for the use of the Novatek drill rig at Mponeng Mine

A visit to Mponeng Mine on 30 May 2002 revealed that eight downdip faces are being prepared for ledging. Four faces are situated in the 44 Raiseline and two each in the 49 and 63 Raiselines. The current intention is to introduce the Novatek drill rig to these faces to achieve an advance per blast of 1.5 m.

For the drill rig to be accommodated, the support (whether it be elongates or temporary support) would have to be at a maximum distance of 1.2 m away from the face. The spacing between the elongates or temporary support units should be 1.5 m (Novatek Drills (Pty) Ltd, 2002).

The equipment that is required for the operation of drill rigs on a 30 m downdip panel would be:

- 3 Feeds (two for use and the other for a spare)
- 20 Traverse bars (each of 1,5 m in length)
- 21 Elongate clamps
- 1 C Saddle (used when the stoping width increases to more than 1.2 m).

The drill rigs can be shared across the two faces in a leapfrog manner, i.e. when the one face is completely drilled, the second face can commence. One drill rig can effectively drill 140 holes in a 6-hour shift. The drilling layout per panel would be a block pattern with a burden spacing of 0.8 m and top and bottom hole spacing of 0.4 m.

The use of longer drilled holes in a ledging practice

At Mponeng, the Rock Mechanics Department requires that after a single blast, there may not be an unsupported span of more than 3.0 m. With temporary/elongate support being 1.0 m from the face before the blast, this leaves room for an advance of 1.5 m to 2.0 m. On a downdip ledging face, it is possible to achieve an advance of 1.5 m since the blast occurs from the free face at the raise to the end of the panel.

A 1.8 m length jumper will give an effective hole length of 1.5 m. These holes can be effectively drilled with a drill rig (i.e. Novatek Mk 1 drill rig). It is arguable whether conventional drilling can be done for these lengths of holes. It is, however, important to note that drilling accuracy is of utmost importance since a constant burden spacing throughout the face must be maintained. With the use of EDD blasting technology, effective breaking can be achieved. If burdens were incorrectly spaced, the result would be a face that is uneven. With the use of EDDs on longer drilled hole faces, it allows for Throw Blasting. Throw blasting has the potential of throwing up to 70% of the rock towards the raise thus allowing easier cleaning.

It is important to note that preconditioning holes must be drilled at 3 m intervals with a hole depth of 3.0 m (see Figure 7). The preconditioning holes remove the high stresses from the face thus making it safer to work at. A recommendation made by CSIR (Miningtek) was that a 3.0 m deep hole be drilled. The 1 m adjacent to the collar is stemmed with clay and the rest of the hole contains explosives. The detonator lies in the front portion of the hole. There are two important reasons why the detonator is positioned there.

- The burning front of the explosive heads towards the

Table I

Stope drilling system (Novatek Drills (Pty) Ltd, 2002)

Type	Attachment to temporary support	Attachment to preloaded elongate support
Stope width range	500 mm to 2600 mm	
Support type	Camlok or similar prop	Standard preloadable elongates of 140 – 200 mm diameter. Yielding types also suitable.
Support spacing intervals	Typically 1.5 m, 2.0 m	Typically 2.0 m, 2.5 m
Traverse beam lengths	Typically 1.5 m, 2.0 m nominal Telescoping ±150 mm	Typically 2.0 m nominal Telescoping ±150 mm
Traverse beam type	Interlocking beam sections to form continuous beam in panel	
Beam attachment to support	Clamp-on collars	Clamp-on collars with toggle and chain
Mounting of boom on traverse beam	Sliding saddle with adjustment for sideways drilling angle	
Movement of boom past supports	Rotate boom parallel to traverse beam, move past support, rotate boom to continue drilling	

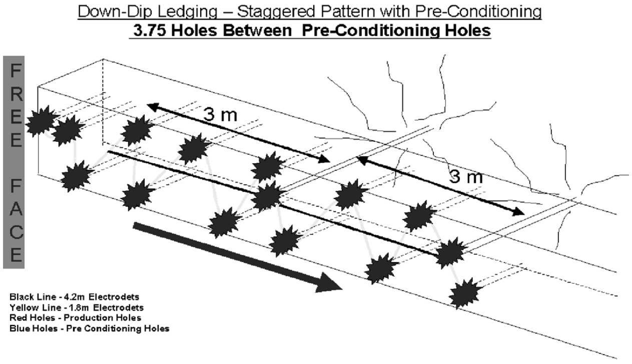

Figure 7—Three-dimensional face for 1.5 m drilled holes and 3.0 m pre-conditioning holes

rock and not towards the free face as would occur when the detonator is at the bottom of the hole. This allows for fracturing of the rock beyond the tamping.

- If for any reason the precondition hole misfires, the detonator can be removed safely from the hole and the hole made safe.

Conclusions

From the findings given for the raise and slusher layout, it is determined that the layout is most suitable for the 125 m inter-level spacing. The problem encountered at the breakaway and the slusher can be overcome by using Boxholes 2 and 3 for the raise and slusher development respectively.

From the layout in the next section, direct boxholes to the raise are most suitable for the 100 m inter-level spacing, i.e. between levels 113 and 116, and 116 and 120. There is no real requirement for a slusher gully since the raise itself is shorter than in option 1. This layout is being investigated for its cost of development since it involves the use of boring machines that may prove to be expensive. If so, then the expense would be recovered if the raiseline is of an invariably higher grade.

A suitable drill rig for downdip ledging is the Novatek Mk1 drill rig. For effective use of the drill rig, the support would have to be at a maximum distance of 1.2 m away from the face. The spacing between elongates or temporary support should be 1.5 m. The drill rigs have a high potential of being successful if they are correctly implemented. When the mine is ready to implement the drill rigs, a careful analysis of a systematic implementation should be carried out. It is difficult to change the mindset of experienced drillers from using handheld machines to drill rigs. It is thus important that the implementation phase is taken seriously. A thorough training programme should be revised for the drillers and the remaining crew. Each member of the crew from night shift and day shift should understand his role in making the drill rigs a success.

Longer drilled holes in a ledging process can work due to the free face provided by the raise. This will ensure that the required face advance of 1.5 m is obtained. This is further guaranteed with the use of EDD blasting technology. However, the major requirement for success with longer drilled holes is that the holes are drilled with precision and accuracy so as to ensure even burden spacing. This can be achieved by using the Novatek Mk1 drill rig.

The concept of Threshold Blasting could be a possibility for the future in ledging operations at Mponeng Mine. In establishing a functional Threshold Blasting system, this method of mining must be risk assessed by all the relevant disciplines in order to resolve all constraints.

Acknowledgements

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Leading crime researcher takes up sustainable mining mantle*

Just twelve months into a new job as head of the University of Queensland's Centre for Social Responsibility in Mining, former CJC Research Director, Professor David Brereton says the critical issue confronting the mining industry is how to translate high level policy commitments into improved social and environmental performance.

David is concerned with how the people on the ground—such as mining managers—will be required to work within a cost effective framework to deal with and report social risks attached to mining operations.

In terms of a global push to build a sustainable mining industry, he believes there is much work to be done to translate political will into improved practices on the ground—the key being through social research.

'A lot of people struggle with those issues, which is an area where our Centre can make a contribution through a practical and applied focus'. he said.

Consequently David and his team at UQ have wasted no time getting out to mining operations and talking to as many people as possible.

David sees the Centre for Social Responsibility in Mining as offering the industry objective and independent research, focused on assisting people at the 'coal face' of an operation.

'What sites need to be able to do is systematically look at what the risks and opportunities are', he said. 'They do that now in an economic and production sense, but there is now a need to expand that out to social and environmental aspects as well.'

David said his aim was to establish a pattern of research appropriate for each situation that would lead to a measurable problem-solving outcome.

'The first step we're working on is developing ways to help sites to work through and fit into a framework that people are comfortable with', he said.

'It's out of that process that you identify the main social and environmental issues that a particular site has to deal with.'

After this stage of the social research process is 'nailed', then the effort goes into 'metrics', which is how you measure, categorize and explain the problem or issue.

'There's not a lot of political controversy around technical issues that have to be dealt with in mining, but when you start talking about social and environmental issues you encounter people with particular agendas they wish to push—and many points of view.'

He said his Centre's role is not to take an advocacy role, but to do objective research that helps bring reform along those discussions.

That might sound like a sales pitch, but there are some very strong parallels between this new research centre—formed under the umbrella of UQ's Sustainable Minerals Institute—and the early guise of his former employer, the Criminal Justice Commission.

It may be an accident of timing, but David Brereton has found himself entering an industry locked into reformist mode. A decade ago, David was similarly positioned at the crest of a wave of change at the Criminal Justice Commission.

He sees himself coming into the mining industry at a time when it is looking for information it doesn't have in order to think seriously about the issues relevant to sustainability, David said.

'It was the same at the CJC, although the CJC was a more controversial organization, but there was certainly a view in that post-Fitzgerald period about re-thinking how the business of government was conducted and the value research could bring to that process.

'So', says David, 'there is a parallel of sorts.

'Criminal justice is a very emotive area, so the role for research is to inject some objective information, and it is true in relation to mining which is also very emotive.'

So why make the switch from criminal justice to mining?

'For a long time I had been working on looking at ways of improving organizational performance', David explains.

'My efforts there has been focused on the public sector criminal justice agencies and I really felt like it was time for a change.'

David said that making the switch had been a lot easier than he anticipated.

'When you change fields you go back certain steps to acquire knowledge about the new industry', he said. 'You have to get to know people, and your ability to be effective to a large extent depends upon the networks you have.'

In a broader sense from a social science view, David says that the issues he has so far dealt with in relation to the mining industry are similar to the issues he has dealt with in other contexts.

'At UQ I'm thinking about research problems, the questions and how to collect data to answer these questions in the same way as before,' he said. 'Over the eight years I was Director of Research at the CJCI I was doing that the whole time.'

He says a strength of the SMI is the people in its constituent, well-established research centres who are well known and respected in the industry.

'The model at UQ is unique in that you have this new social science research unit sitting in amongst centres that have a more technical focus.'

David said this model immediately gave him access to a practical understanding of the industry.

'You've got to take into account some of the technical imperatives that drive the industry in terms of what is practical and reasonable,' he said.

'Companies have become more focused about improving their record of socal performance, improving the way they deal with communities and so on', he said.

'I think there is a real interest within the industry about doing that kind of work, and there are some real opportunities.' ◆

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