HARRISON, G.A. Anglo Platinum extra low profile (XLP) mechanized equipment implementation—an update. *Third International Platinum Conference 'Platinum in Transformation'*, The Southern African Institute of Mining and Metallurgy, 2008.

Anglo Platinum extra low profile (XLP) mechanized equipment implementation—an update

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Anglo Platinum New Mining Technologies

The introduction of Extra Low Profile (XLP) mechanized equipment within Anglo Platinum is aligned with the overall new mining technologies strategy to focus on continuing modernization of our mining operations' to achieve injury free sustainable production and cost-effective mining technologies.

The method allows for the introduction of a suite of XLP and low profile (LP) equipment in a narrow reef (1.2 m) mining environment. For the first time it is now possible to achieve total trackless mechanization at these stoping widths and XLP breast mining has the potential to add more value when benchmarked with conventional mining and other mechanized methods.

Various types of XLP equipment were tested at different sites within Anglo Platinum, and this paper describes the XLP equipment evolution to date. It concludes with recommendations on our future strategy for implementation and roll-out of the XLP technology within Anglo Platinum.

Introduction

There has been a steady increase in trackless mining within Anglo Platinum underground narrow reef operations over the past five years. Seventeen sites currently apply trackless mining to various degrees.

Increased mechanization can create opportunities to achieve injury-free sustainable production and drive down unit cost. The current levels of mechanization at Anglo Platinum are still low, but higher than competitors and other narrow reef industry segments (e.g. gold mining).

The challenges and constraints inherent in increased mechanization have historically been underestimated by AP and our competitors. This resulted in slower progress and lower economic value created than expected from mechanization in a narrow reef tabular orebody

Our current mechanization programme is based on an assessment of the mechanization full potential at each shaft, given the specific mine design and geological constraints.

Extra low profile (XLP) trackless equipment suites have been successfully introduced at Waterval and Townlands shafts. At Amandelbult and Union Declines XLP dozers are being used in semi-steep reef dips up to 30° in hybrid breast mining for stope face cleaning to replace face scraper winches. Roll out of these dozers are now in progress

Executive summary

Mechanization in Anglo Platinum needs to be achieved in a narrow tabular orebody in stope widths as low as 90 centimetres and reef dips up to 30 degrees in undulated areas. XLP technologies that have been trialed and proven are effective in reef widths of >1.2 metres and reef dips of <12 degrees. A track mounted XLP suite (dozer, bolter and face drill rig) developed by Atlas Copco, is due to be trialed at stope widths of >1.2 metres and an average reef dip of 18 degrees at Amandelbult Mine. Concerns remain about traction through undulations that will be addressed with the trials.

XLP technology needs to be trialed and proven successful prior to roll-out at reef dips >12 degrees. Greenfield projects are being designed and financially evaluated for hybrid mining on reef to facilitate conversion to XLP once successfully developed and proven for roll out. There is currently no technology existing for XLP drilling at reef dips of between 18 and 30°

Why XLP mining

- Improved safety by removing operator from the sharp end of the production face
- Improved productivity by more accurate drilling, higher face advance and square metres per employee (fully mechanized stoping and development)
- Improved profitability compared to conventional mining
- Replace components of conventional stoping e.g. dozer face cleaning to replace scrapers.

XLP equipment requirements

- Ability to function safely, effectively and productively at average dips of up to 22 degrees and ability to maintain traction and remain stable at dips of 30 degrees through undulations. Further reengineering is necessary to ensure that the XLP equipment functions effectively in reef dips of >18 degrees
- Ability to work in 90–160 centimetres stope widths to cater for narrow and wide reef resource areas
- Need for reduced dimensions (height, width and length) to fit in with mechanized mine design optimization, support standards and enhance mobility of equipment in stopes

- Leverage value from synergistic use of drive train and electro-hydraulics for lower capital cost, operating cost and skills levels requirements for ongoing maintenance
- Scope the environment properly in which equipment needs to operate.

Scope the other requirements:

- Safety; productivity; automation; simplification; integration; modularity; productivity; cost; ease of operation and maintenance.

Development work in progress with OEMs:

- *XLP development*—redesign required/traction and dilution. Steeper reef dips (~30°) including undulations as well as XXLP for lower stoping widths (90 cm)
- *Ventilation*—diesel engines to be at least Euro Tier 2 compliant
- *Supply*—mining and infrastructure equipment will be selected, sized and specified in accordance with appropriate Anglo Platinum specification.

Technology developments:

- XLP drilling rig tests at steeper dips at Amandelbult 16 West Decline as from May 2008. Potential for large-scale roll-out of XLP fully mechanized mining at Amandelbult and Union declines once successful
- For XLP equipment interpanel movement a mobile bridge will be utilized to move XLP equipment across the ASDs from panel to panel. The same UV will be used to transport the XLP drill rig and bolter to the workshop for services.

XLP breast mining optimization

Optimizing the XLP fleet for higher production performance and reduced operating costs:

- XLP bolter capacity, dozer design, interpanel mobility
- Achieve more than one panel blasted/8 hour shift per XLP drill rig and bolter
- Determine the optimum number of panels and mining cycle
- Target a monthly production rate of at least 3 000 m²/month per XLP suite
- Increasing the stope face length to improve equipment efficiency and improve extraction and productivity
- Timberless stope support with tensioned cable anchors and grout packs:
  - Roll-out of additional XLP and LP supporting suite will allow the benefits of economy of scale to be achieved (efficiency and costs) Move to the next level of production performance, the full potential of XLP mining is still to achieved. (Figure 1).

Development of XLP mining equipment in Anglo Platinum

Sandvik

XLP drill rig and roofbolter in operation at Waterval and Townlands shafts and units performing well. XLP 'Shark' dozer successfully implemented at Waterval shaft.

Current available XLP equipment suite design suited for ≥1.2 m stoping width and <12° reef dips only. Current design of XLP drill rig and bolter is electric drive fixed on rubber tyred wheels; rigid design of the unit requires operator intervention to keep all four wheels on the footwall making it unsuitable for use in the steeper reef dips. Trials of Sandvik XLP drill rig at Amandelbult and XLP dozer at Union Declines proved unsuccessful with slipping and sliding of the units at the 18–30 degrees reef dip.

DOK-ING

XLP Dozers have been implemented at Townlands (2) and Amandelbult (7) and are performing well, also successfully tested at Union Declines.

DOK-ING does not build XLP drill rigs or bolters and will have to buy in drifter and rock drill technologies. Well suited for both flat and steep dipping environments equipment in order to supply a complete suite of XLP equipment.

Atlas Copco

Conceptual design of full XLP suite of crawler mounted equipment designed for stope widths of ≥1.2 metres and at flat and steeply dipping orebodies. Drill Rig completed—One boom with two feeds, one operator drills two holes simultaneously. Diesel engine for 'unplugged' tramming and no need to handle electric trailing cable during tramming. Rigid track design with dual diesel and electro-hydraulic drive.

Atlas Copco is about to test the first full suite of XLP equipment that they have developed for trial in the steeper dips at Amandelbult.

Form XLP drill rig

Deliver prototype crawler mounted drill rig to Amandelbult. Drill rig will offer low cost solution in terms of simplicity and operational costs (total cost of ownership). The XR7 design and user requirements have been based on the current successful XLP drilling technology. Much effort has been put in to make the XR7 as user friendly as possible. The core machinery components are proven technology and local proven Boart drifters and drills will be used. Design modifications are easily achieved as FORM is situated in Krugersdorp.

Stope Production		
Description	**Quantity**	**Performance**
XLP Drill Rig	2	40 holes/h; 1 x 26.5m panel drilled/shift (159 holes/shift = **4.9 h/shift**, includes 60 min drill rig move in and set up time)
XLP Roofbolter	2	1,6m bolts = 5 bolts/h (30 bolts/panel @ 1,5m x 1,2m spacing = **6,0 h/panel** with one bolter used for 1 panel. (If 1,2m bolts = 8 bolts/h)
XLP Dozer	2	50 tons/h; 258 face tons/blast = 145 tons after 40% throw-blast in ASD = **3.1 h/shift** excl sweepings
ASD & Siding Production		
Description	**Quantity**	**Performance**
LP Axess Rig/Bolter	2	Drilling - 28 holes/h; Bolting – 10 bolts/hr; 1 x ASD and siding drill 54 holes and bolt 8 holes per shift = **3.3 h/ASD and siding**
LP LHD	3	36 tons/h/LHD; clean 1 panel ,1 ASD and a siding/shift = 339 tons/shift = **3.1 h/LHD/shift**

Figure 1. KPIs from a typical XLP equipment suite for a breast mining layout (9 stope panels)

Fermel

Design of XLP ramp for interpanel movement of XLP drill rig and bolter

Challenges

- Orebody (geology; geotechnical; resource width and dip)
- Human resources (mechanized mining skills shortage, training and development)
- Long lead times for OEM equipment delivery
- Maintenance capability (dire shortage of artisans)
- Social (labour strategy)
- Brownfield (mature) infrastructure not suited for mechanization.

Conclusion

Good progress has been made with the mechanization roll-out compared to our competitors. Benchmark levels of productivity and costs have not yet been achieved and a continuous improvement programme is being rolled out to leverage value. Safety improvements have been achieved where XLP technologies have been rolled out. XLP breast mechanized mining indicates enhanced economic value above conventional mining with productivity gains and cost benefits in the case of greenfield projects. Skills availability remains a key area of focus to address the supply and demand for scarce skills going forward. Anglo Platinum is focused on advancing the XLP technology to leverage value from our narrow reef orebodies. (Figure 2).

Way forward for XLP technologies in Anglo Platinum

XLP technology will be expanded to the next phase of multiple suites at appropriate sites

Acknowledgements

The author wishes to thank Anglo Platinum management for permission to publish this paper

Stope face drilling and blasting

Stope face drilled with double boom XLP drill rig. Face drilled at 90° to allow throw blasting of at least 40% of ore into ASD. Shock tubes and emulsion explosives used for charging up. Stope face advanced at 1.8 m/blast whilst ASD and east siding will be advanced at 2.0 m/blast. A breast face shape is maintained to avoid excessive travelling distances of XLP equipment from panel to panel i.e. preferably travel to only one panel during a shift. (Figure 3.)

Stope face roofbolting

Stope roofbolt support with a single boom XLP roofbolter. Support is site specific based on rock quality structures, joint angle/spacing, filling condition and hangingwall stratigraphy. Bolting maximum distance from face is 2.5 m after the blast. (Figure 4.)

Stope face cleaning

Stope face cleaning is by XLP dozer where the broken ore is pushed into the ASD. LP LHD collects broken ore in ASD and hauled to tipping point. Stope sweepings (95%) carried out by dozer. Blasting barricade is kept 6 to 8 metres from the face (last row of sticks). (Figure 5.)

Stope ASD drilling and bolting

This dual operation is done with an LP axess rig. Bolting standard is done according to rock engineering recommendations.

Stope ASD loading and ore removal

ASD loaded by LP LHD and transported to the strike or dip belt tipping point. Tipping point maintained within an average tramming distance of 75 m from the loading point. (Figure 7.)

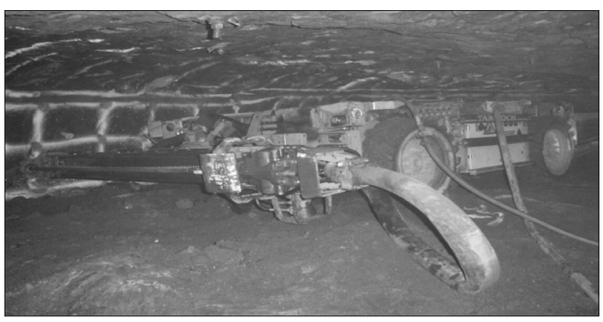

Figure 3. Double boom XLP drill rig on stope face

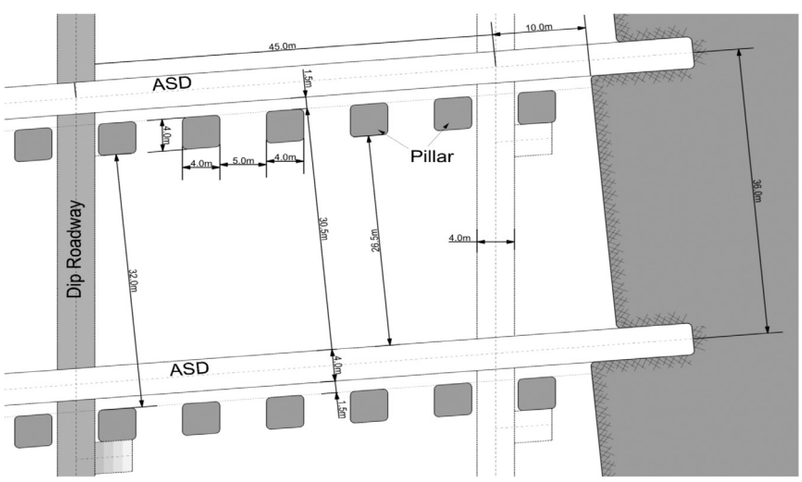

Figure 2. Typical XLP breast panel layout

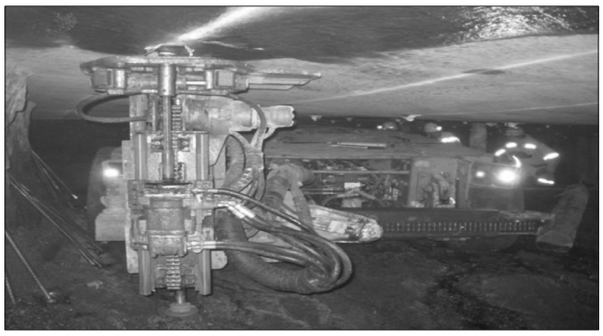

Figure 4. XLP roofbolter on stope face

Figure 6. Axess development rig (face drilling and bolting)

Figure 5. XLP dozer on stope face

Figrure 7. LP LHD (ASD loading and ore removal)

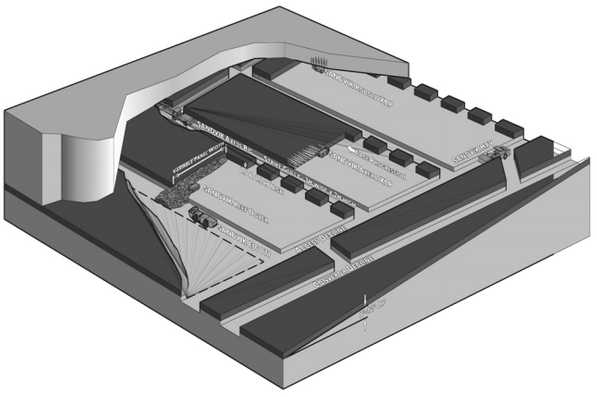

Figure 8. Typical XLP breast mining layout with XLP andLP equipment

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Started at Western Areas Gold Mine in 1973 as a learner official, transferred to Randfontein Estates Gold Mine in 1974 where I worked as a Shift Supervisor and Mine Overseer. In 1982 I was transferred to Amandelbult Platinum Mine where I worked as Section Manager and Production Manager. In 1994 I was transferred to Anglo Platinum Head Office where I still work as a Technology Manager in New Mining Technologies which is a department in the Mine Technical Services Division