Bord and pillar applications on the platinum mine: T-cut mining method

by C.C. Oosthuizen*

Paper written on project work carried out in partial fulfilment of Technikon Practical Training

Synopsis

Frank shaft is mining both Merensky reef and UG2 reef. The Merensky orebody is almost depleted and this was the reason for starting to mine the UG2 ore reserves. It was decided to mine the UG2 orebody with trackless equipment using a bord and pillar mining method. Frank shaft has been mining the UG2 orebody for nearly 5 years. The T-cut mining method was introduced to see if it could improve the grade of the run of mine (ROM) as well the extraction percentage.

Introduction

This report follows an in-depth investigation into the T-cut mining method. This investigation was carried out to determine the optimal mining method to increase the run of mine (ROM) grade and extraction percentages in the bord and pillar mining of the UG2 orebody on Anglo Platinum mines. The site of investigation was Frank 1 shaft on Rustenburg Platinum Mine (RPM).

Problem statement

From the middle to the end of 2002, with the sharp weakening of the rand against the major currencies (up to R14/$), major capital expenditures were made by the mine. These expenditures include buying very expensive trackless equipment for mining the UG2 orebody. At this time it seemed to be a very good investment. Due to the sudden strengthening of the rand against the major currencies, the profit margins decreased. From the beginning to the middle of 2003 a good investment turned into a total loss. As the profit margin decreased and the rand strengthened the UG2 pay limit also increased, from 3.1 g/t to 3.4 g/t for platinum group metals (PGM).

Facing the facts of HIV/AIDS in South Africa, Anglo Platinum has carried out an intensified investigation into this problem. The results were shocking, showing that and alarming number of the current workforce is infected with HIV/AIDS. This means that in the next 5 to 10 years Anglo Platinum will lose a large number of its current workforce.

The world's demand for platinum group metals (PGM) has been identified by Anglo Platinum. The world's leader in platinum, Anglo Platinum wants to increase its lead in this market. Anglo Platinum announced that it would increase its platinum production to 2.9 million ounces per annum in 2006.[1]

Objectives

This is an in-depth investigation into the T-cut mining method. The outcome of this investigation is to see if there is a solution to the current problems in the problem statement. The management of Frank 1 shaft decided on the T-Cut mining method because the current bord and pillar development method don not have to be altered. The objective of the T-cut mining method is to increase the UG2 run of mine (ROM) grade to 3.4 g/t, to increase the current productivity of the workforce and to increase the extraction percentage of the UG2 orebody.

Geology

The UG2 orebody comprises a thick chromatite seam between a footwall of coarse crystalline pyroxenitic pegmatite and a hangingwall of pyroxenite. Figure 1 shows the detail of the local stratigraphy with minimum and maximum thickness derived from drill holes. Figure 2 also shows a generalized stratigraphic section with added photographs to clarify the actual underground appearance of the horizons.

Of note in these sections is the 'stringer parting' 23 cm above the main seam. This thickness varies from a few centimeters to many tens of centimeters. Mining is unlikely to undercut this, resulting in its inclusion in the evaluation of the mineable orebody.

* *Technikon Witwatersrand.*

 SA ISSN 0038–223X/3.00 + 0.00. Paper received Jan. 2005; revised paper received Feb. 2005.

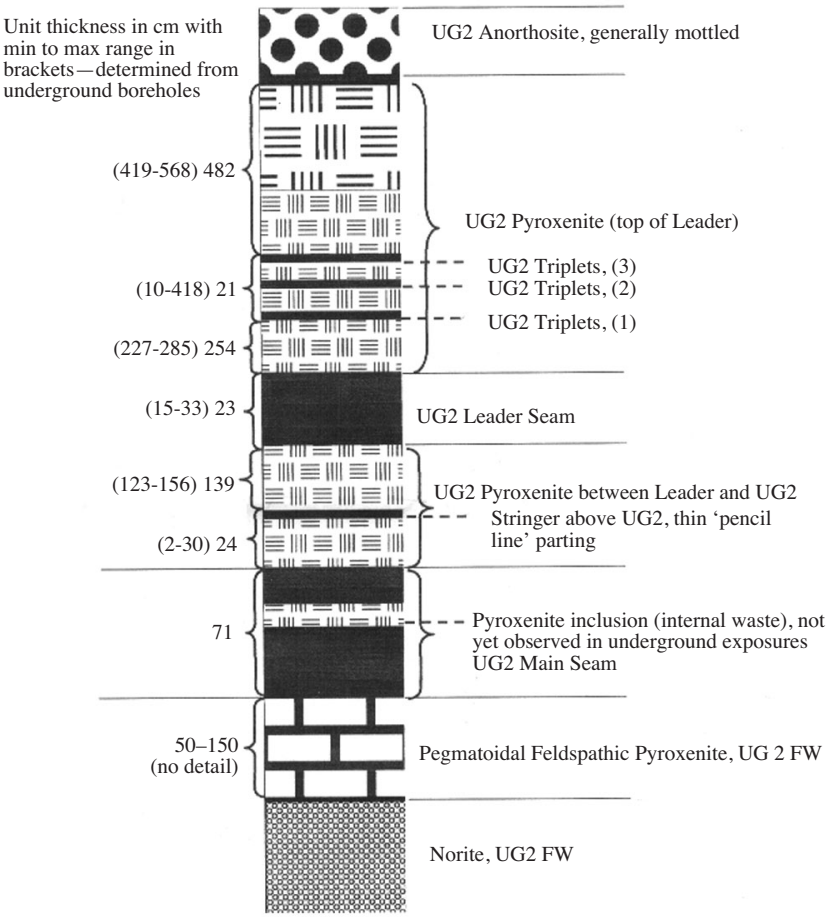

Figure 1—Detail of local stratigraphy with minumum and maximum thickness

The UG2 chromitite is unmistakable in this area and is easily distinguished from the leader by both its thickness and the different footwall lithologies.

The orebody is irregular and randomly disturbed by potholes, rolls and undulations. Departing from any academic definitions of these features, the following practical descriptions are given and their usage is encouraged for the purpose of clear communication:

- *Potholes*—these will include any drastic change in the stratigraphic position of the main seam (where it suddenly cuts through its regular footwall rocks) or a change in its elevation that cannot be easily negotiated by a 1.8 m development end. This change in elevation will often be associated with a thinning of the seam, or 'pinching'
- *Rolls*—these will include any change in elevation of the main seam, the amplitude of which is generally greater than the seam thickness. Rolls will generally not be contained within a 1.8 m development end and will cause minor reef losses. Thinning or 'pinching' of the seam may not occur, causing the waste thickness to vary considerably with the magnitude of the rolling
- *Undulations*—these can be likened to gentle waves, the amplitude of which is generally less than or equal to the seam thickness in that area. Generally, no reef loss is incurred if mining is suitably reactive.

Mining method

Description

The T-cut mining method is basically a partial pillar extraction method. The pillar (13 m x 13 m) created by the bord and pillar development is being stoped (only the UG2 reef) out for 2 m from the roadways on all sides, to leave an effective pillar of 9 m x 9 m. This method creates the required, higher extraction percentage and higher Run of mine ROM grade.

Mining layout

The mining layout is exactly the same as that of the normal bord and pillar layout (see Figure 3). The bords are 4 m wide and pillar sizes are 13 m x 13 m, thus creating centres of 17 m. The stopping width in the development phase is 1.8 m (0.2 m hanging wall, 0.8 m UG2 reef and 0.8 m footwall). The pillar that is created is then stoped out from the roadways for 2 m. The stopping width is only 1 m (0.2 m hangingwall and 0.8 m UG2 reef). When the T-cut is finished, an effective pillar of 9 m x 9 m is left behind. This creates a higher extraction percentage.

Equipment

The T-cut mining method does not require much capital. Only two trackless machines are required for the T-cut mining method. Firstly, a diesel-powered Tamrock EJC 115 load haul

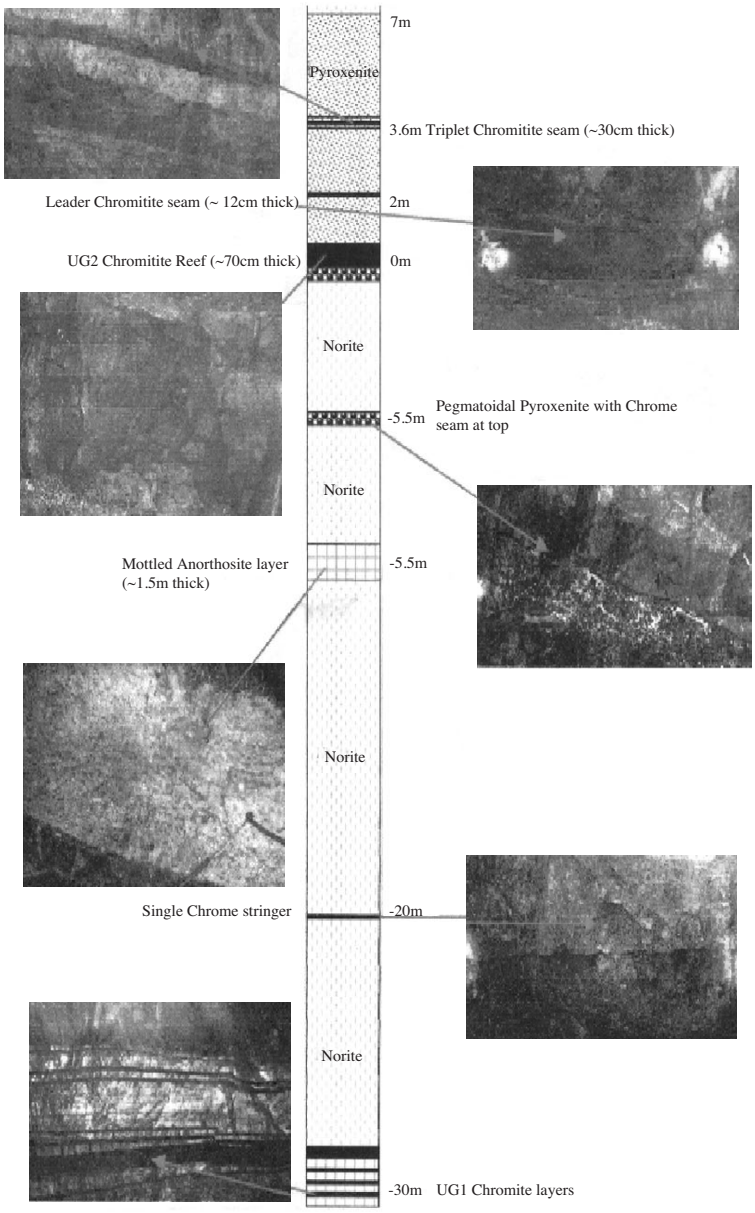

Figure 2—Generalized stratigraphic section

dumper (LHD) is required. The EJC 115 has a loading capacity of 2.3 m^3—or ± 5 tons and a weight of almost 15 tons. The EJC 115 is used to load the broken ore and transport it to the nearest tipping point.

Secondly, an electrical powered Tamrock Micro Scoop E100 is required. The Micro Scoop E100 is a multifunctional trackless machine; it can be used as a LHD or a drill rig, depending on the conversion. The Micro Scoop E100 in the T-cut mining method is used as a drill rig. The Micro Scoop E100 is capable of drilling 15, 2.1 m holes per hour. A 40 kW electrical motor powers it, which drives a series of hydraulic pumps, which is used for tramming and drilling.

Labour

The problem that is been creating by HIV/AIDS, a rapid depleting workforce, is a very serious problem in South-African mines. The T-cut mining method creates a partial solution for this depleting workforce, by optimizing labour efficiency.

- 1 x miner
- 1 x LHD operator
- 2 x drill rig operators (day shift, night shift)
- 1 x miner assistance (blasting operations)
- 5 x stope timbers

Drilling

The drilling is done with the Micro Scoop E100. The hole must be drilled 90º to the local panel. The burdens are 0.5 m x 0.5 m, with an extra hole in the centre (see Figure 4). The extra hole is to ensure a full 2 m advance. The Micro Scoop is able to drill 15 (2.1 m effective) holes an hour, with a 38 mm diameter.

Blasting

The blasting operation is outsourced to Sasol Mining Explosives (SMX), which is in charge of all the blasting

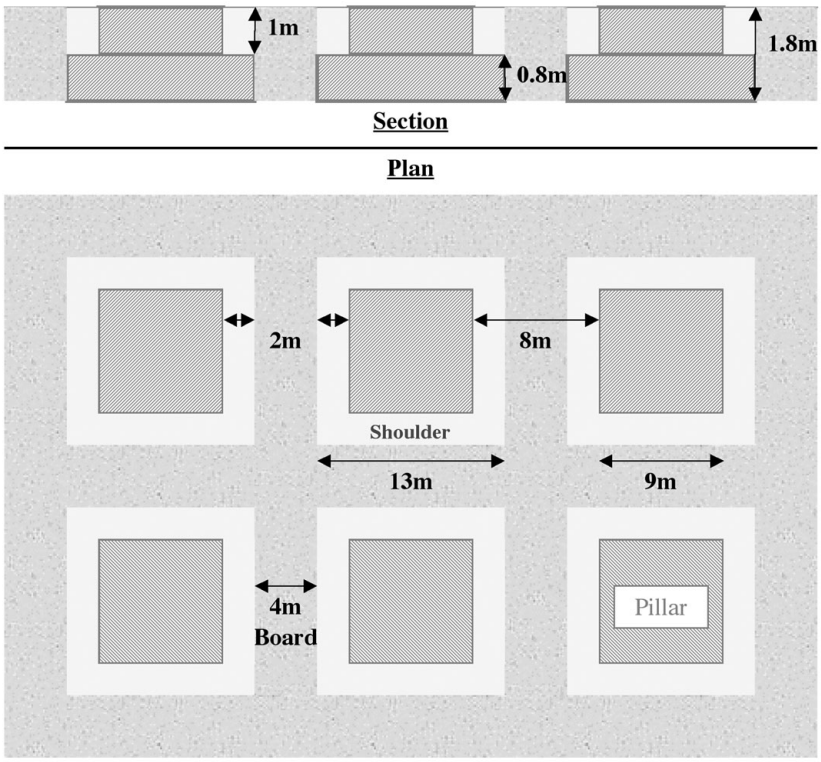

Figure 3—Mining layout

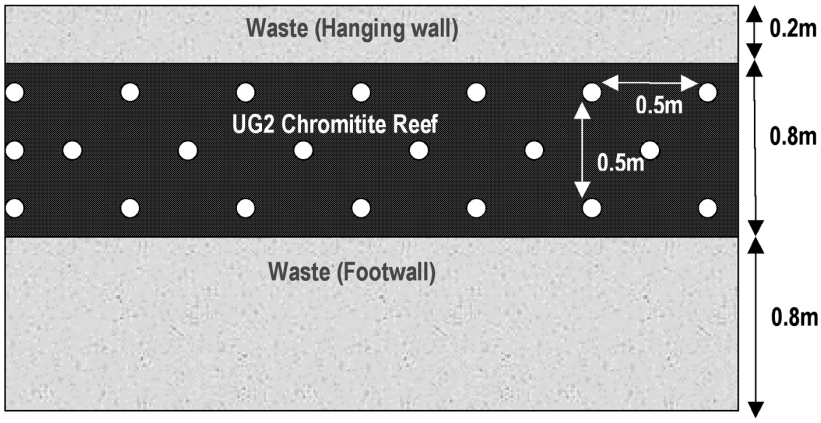

Figure 4—Drlling pattern

operations. This operation is carried out with a mixing and pumping plant, mounted on a Bord Longyear multi purpose vehicle (MPV). The explosives are gassed emulsions. The initiation is done by an EZ-Drifter detonator and a 15 mg Stinger Booster (15 mg PETN). The millisecond delay between the detonators creates a through blast.

Cleaning

Due to the through blast created by the millisecond delay of the detonators, only a small amount (±10%) of the ore is left in the panel. This ore is then blasted out with a Bestline water jet into the roadway. The ore in the roadway is then loaded by the Tamrock LHD and tipped onto the Buffalo- or Continental feeders. The cleaning is only done on the day shift.

Support

The pillar is used as the primary support. Secondary support in the T-cut mining method is to install –250 mm pencil elongate. The pencil elongate are then pre-stressed to 5 kN (5 ton) with 4" Jackpots. The support pattern is to install the pencil elongate 1.5 m apart and 1 m from the panel face (see Figure 5).

Production results

The T-cut mining only started on the 1 May 2003 at Frank #1. From the first month a large improvement on the ROM grade could be seen. In July only 452 m^2 could be delivered, due to a major breakdown on the Micro Scoop. As seen from the Table I, the ROM grade also decreased in July.

Problems

Overbreaking in the development phase is a major problem. When the development breaks over into the pillars, these pillars become too small to mine with the T-cut method due to the pillar strength and pillar safety factor, and are left as is. This then influences the ROM grade. Geological losses, such as rolling reef and potholes within the pillar, leave the pillar unminable. The geological losses make up 23% of T-cut pillars lost. Breakdowns are also one of the major problems, and the effects can be seen in the July 2003 results in Table I.

Comparison

Table II compares the results of conventional stoping, normal bord and pillar, and bord and pillar with the T-cut mining method, within the UG2 orebody.

Conclusion

The slightly higher cost per ton than for bord and pillar is a very good trade-off for the higher ROM grade and extraction percentage. The high productivity is a very good solution for a depleting workforce. The T-cut mining method is surely the answer to all the problems in the problem statement. The average ROM grade is improved to 3.69 g/t, productivity increased to 108.6 m^2 /person/month and the extraction percentage increased to 71%. T-cut mining is surely a must in UG2 bord and pillar.

References

Anglo American Platinum Corporation (Ltd) Annual Report 2002.

Surveying department Frank 1 shaft.

Geology department Frank 1 shaft.

Planning department Frank 1 shaft. ◆

Table I

Production resluts

Month (2003)	Area mined (m^2)	ROM grade (g/t)
February	0	3.18
March	849	3.41
April	972	3.49
May	1017	3.61
June	1195	3.79
July **	452	3.24
August	1261	3.84
September	1278	3.89
October	1293	3.91
November	1267	3.84
December	1274	3.87
Average	1086	3.69

**Note decreases

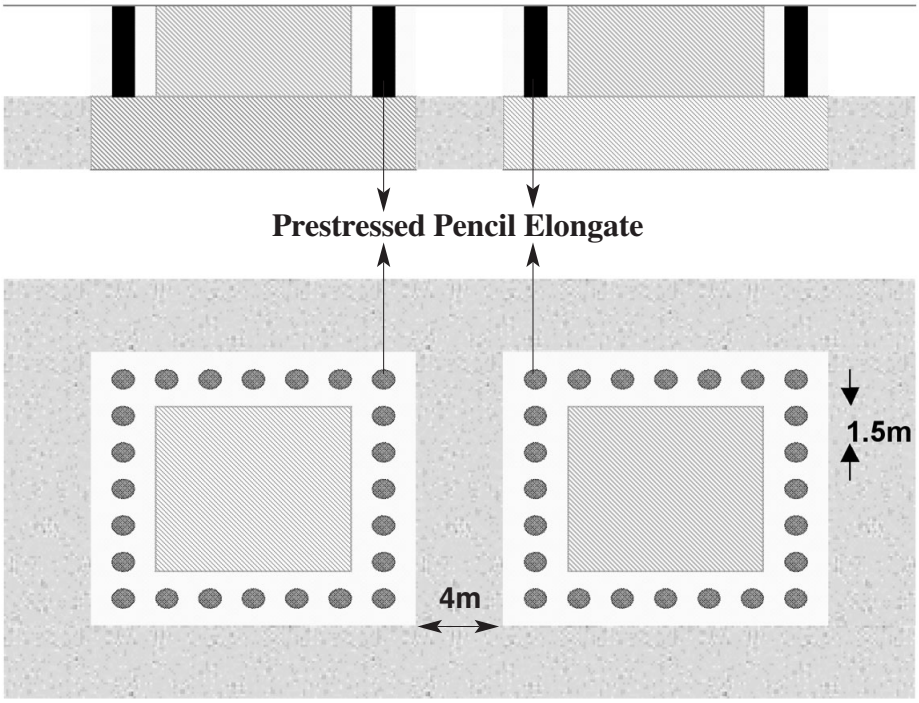

Figure 5—Pencil elongate support pattern

Table II

Comparison of mining methods

System	Grade (g/t)	Extraction (%)	Cost/ton (R)	Productivity
Conventional	3.98	84	176.12	46 m^2/person/month
Bord and pillar	3.10	42	147.00	N/A
Bord and pillar with T-cut	3.69	71	149.59	108.6 m^2 person/month