Dollar Driven Mining – Focussing on Maximising Shareholder Value

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Introduction

Changes to share ownership are forcing corporate executives to reassess their view of mining company performance. The shift to institutional share ownership, with its associated rigorous analysis of shareholder value, is increasing the emphasis on operating cashflow as the true measure of creating wealth. Mine Managers need to understand that predictable, steady growing, positive cashflow is what corporate executives and stockmarket investors want.

This discussion paper will present the stockmarket trends which are driving this view, the way corporate executives should be responding, and some guiding principles for managers to implement dollar driven mining.

The Stockmarket View

Increasing proportions of mining company shares are now owned by insurance companies, superannuation funds, unit trusts and other institutional investors. These professional investors employ astute analysts who use sophisticated techniques to evaluate companies. These analysts look through the superficial performance indicators of earnings per share, dividend payouts, and reported profit to the real measure of value creation - net operating cashflow.

The Corporate 'Shareholder Value' view is based on:

1. Shareholder Value = Corporate Value - Corporate Debt
2. Corporate Value = $\frac{\text{Future Cashflows}}{\text{Cost of Capital}}$
3. Profit is an Opinion, but Cash is a fact

Price Waterhouse Urwick

Analysts regard profit as an opinion, but cash as a fact. Consequently forecasts of operating cashflow are becoming the primary measure for assessing the value of a company to its shareholders.

The Corporate View

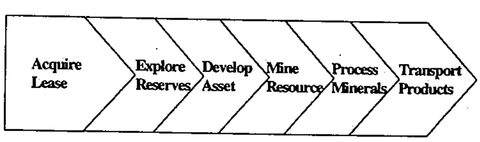
To respond to the analyst's view that shareholder value is predominantly driven by net operating cashflow, corporate executives are realigning company's objectives and operational priorities. The share market analysts search for clearly reported predicable cashflow is influencing a trend away from diverse conglomerate companies trading in different sectors each contributing to consolidated earnings, toward discrete investment vehicles which focus on single market core businesses.

Corporate executives wanting to maximise their company's share price must articulate a clear and cohesive strategy of which markets they are in, what sector is their focus, and what are their business objectives. Smaller and medium sized companies in particular, will enhance their stockmarket value by clearly stating their corporate strategy. For example, is the corporate strategy to be a mining company or metals producer, an exploration prospector or a mineral processor?

Clearly a company's ore resource is a predictor of future cashflow, as the rate of depletion of reserves is an indicator of the sustainability of the operation. Exploration results and sampling data are key components used to forecast revenues, hence determine the value of companies.

For corporate management, the operational side of the business should be seen as a chain of activities or processes each oriented towards adding value to the company's cashflow. Revenue maximisation and cost minimisation need to be the guiding principles in the context of a medium term view orientated towards producing a predictable, growing and sustainable positive cashflow over the life of the mine.

Operational Effectiveness
Where can we add Shareholder Value?



- Product Quality
  - Reliability of Supply
    - Capacity Utilisation
      - Cost Minimisation

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The Operational Management View

Having gained an insight to the share market analysts view on the importance of cashflow, and corporate management emphasis on adding value it is clear the Operational Management Team must focus on producing dollars, not tonnes or BCM.

Although managers may feel they are constrained from achieving this goal, squeezed between resource geology and world commodity markets, there are options open to them for adding value and maximising cashflow. Managers may also believe that the majority of mine operating costs are fixed, but in fact very few costs remain fixed over longer time frames.

Maximise Margins
Many Costs are Variable in the Long Term

Timing	Near Term	Medium Term	Long Term
	> 1 < 3 Months	> 3m < 1 Year	> 1yr < 3 Years
Decisions	Labour Allocation Fleet Utilisation Plan Maintenance	Manning Levels Fleet Assignment Plant Modification	Outsource/Contracting Fleet Replacement New Technology
Cost Behaviour	Many Costs "Fixed"	Costs Become "Stepped"	Many Costs "Variable"

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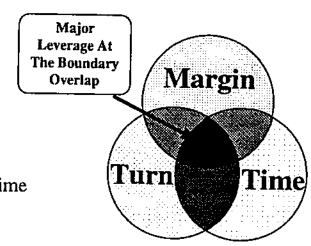
Applying the core strategies of improving profit margin, maximising asset turnover and minimising production time are fundamental to achieving a predictable, steady growing positive cashflow.

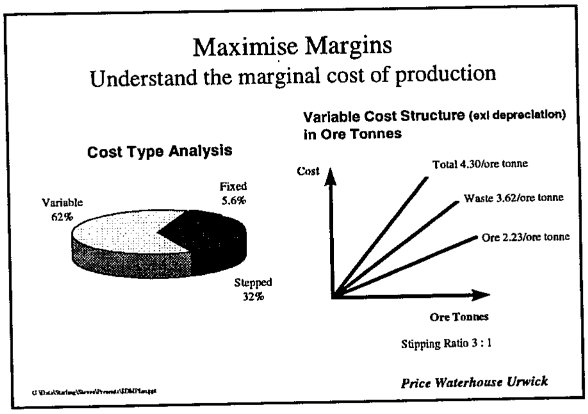
Core Strategies to Improve Cashflow
& Increase Shareholder Value

- ✦ Improve Profit Margin
  Eliminate Non Value Adding
- ✦ Maximise Asset Turn
  Lift Process Plant Throughput
- ✦ Minimise Production Time
  Increase Mining Rate

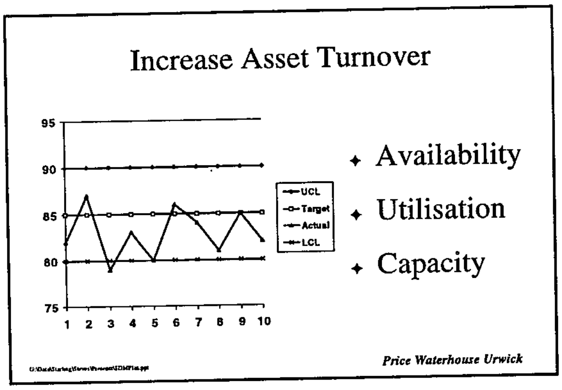


Price Waterhouse

Understanding cost structures, particularly identifying and controlling the drivers of variable costs and appreciating the marginal cost of incremental variations in production rates, are the keys to improving profit margins.

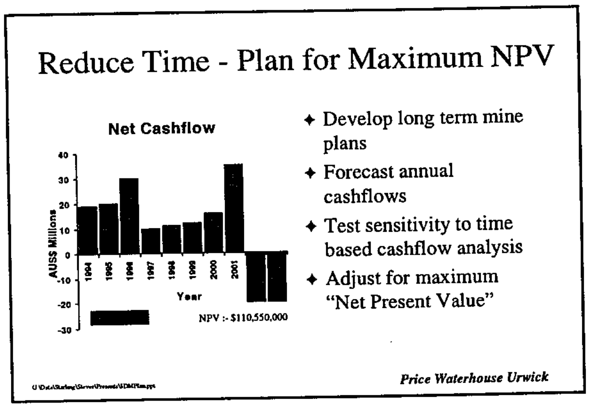


Mining plant and equipment are high value capital items which incur standing interest and depreciation costs even when idle. To earn their keep, the use of these valuable assets must be maximised in productive, revenue generating work. Equipment availability and capacity utilisation are critical indicators of maximising asset turnover, hence generating positive cashflows.



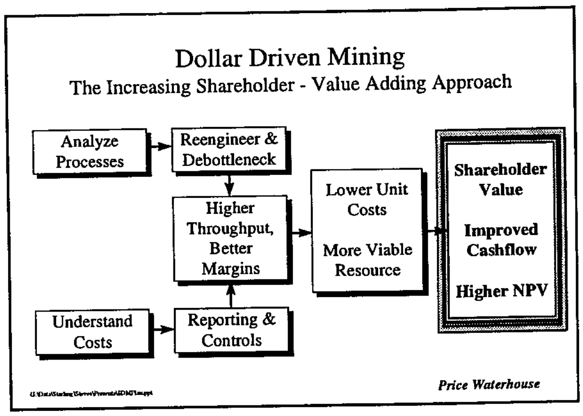
A dollar today is worth more than a dollar next year, consequently if prices remain stable, selling a tonne of ore this year is worth more in real terms than in selling the same tonne next year or the year after. The current Net Present Value view of future cashflows can dramatically influence the market worth of a mining company.

Mine plans should bring forward revenue, particularly production from new mines and balance periods of low-grade mining with contributions from higher-grade areas. Often taking this Net Present Value view of future cashflows will justify capital expenditure to relieve capacity constraints on getting product to the market earlier.



Conclusion

The corporate view of dollar driven mine planning may be seen by some as high level and simplistic. Admittedly it does not incorporate the complexity of geological interpretation nor the sophisticated simulator modelling of pit design. But the core strategies of improving profit margin, maximising asset turnover and minimising production time can improve operating cashflow and increase shareholder value.



Applying these simple principles to understanding costs and optimising processes can achieve better margins and higher throughput which will result in lower unit production costs. This in turn can make lower grade ore economically viable to mine, thus delivering increased reserves, extend mine life, sustained cashflow, higher net present value. Taking this corporate view of dollar driven mine planning can improve the share price to your company.

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Kroondal Platinum Mine: Not Using Whittle Four-D – A Case Study

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Abstract

This paper explores the reasons why Whittle Four-D could not be used to optimally design an open-pit for a client.

SRK was approached by Aquarius Exploration NL, based in Perth, Australia to undertake a feasibility study for an open-pit and underground platinum mine in South Africa.

SRK were assisted by Snowden Associates in Perth, who were charged with the Resource and Reserve estimation, and the underground study.

Whittle Four-D was used to evaluate the orebody, and produce a series of nested pits. The exercise showed ideally the orebody could be mined economically, as dictated by the nested pits, but these proved impractical due to constraints of mining and processing characteristics.

The initial mining units from the first series of pits were too small and dispersed, to mine practically and efficiently. The higher quality reef was below the initial weathered cap, which was needed by the plant, due to its better metallurgical properties. Access to the underground was required as soon as possible, because of improved financial returns, but the Whittle nested pits did not allow access soon enough.

The approach, though not conventional, has resulted in a successful study, with the client having secured finance to allow the project to progress to an operating mine.

Introduction

Kroondal Platinum Mines (Pty) Ltd (Kroondal), was listed on the Johannesburg Stock Exchange in August 1998. The major shareholder, retaining 45%, is Australian-listed Aquarius Platinum NL (Aquarius), an Australian mining company based in Perth, Australia.

Aquarius undertook exploration during the period 1994 to 1997, along the strike of the UG2 reef to the east of the town of Rustenburg in the North West Province of South Africa. Very promising exploration results were obtained from a 6km strike length of UG2 reef on the farm Kroondal 304 JQ, as well as on the farm Waterval 307 JQ. In March 1997, a decision was made to undertake a full feasibility study of the mining of this deposit to bankable document standards.

SRK Consulting (SRK) were approached by Aquarius, together with Snowden Associates (Snowden) to undertake the study. The open-pit mining component of this study was undertaken by SRK's Perth office, whilst the geological modelling and underground component was completed by

Snowden's Perth office, who liaised closely with SRK. The other aspects of the study, geotechnical, tailings dam design, environmental, economic analysis and project management were completed by SRK, South Africa. The metallurgical plant and process design was contracted to Dowding, Reynard and Associates, with the assistance of Mintek, both based in South Africa. Other specialised consultants were also involved during the study.

The Kroondal project will mine using a combination of open-pit and underground mining methods. The project has a total resource of 21.7 million tonnes comprising an open-pit mineable reserve of 3.96 million tonnes at a grade of 3.97 g/t platinum equivalent, and the underground mineable reserve of 10.9 million tonnes at a grade of 4.4 g/t platinum equivalent.

The tonnages and grades reported here are based on published information.

The open-pit mine will extend from surface to a maximum depth of 30m using a series of parallel strike cuts 50m wide. The open-pit will be mined by contractor at a steady-state rate of 250 000 tonnes of reef per annum. Rehabilitation will take place as open-pit mining proceeds by backfilling the mined out areas with waste rock, except for the initial box-cuts used for the underground operation.

The underground operation will be divided into three operating sections; each centred on a box-cut, which will remain open for the life of the underground section. The underground mining method will be a semi-mechanised room and pillar layout, utilising hand-held drills and low profile LHD's loading onto strike conveyors close to the face. The reef is conveyed via a series of conveyors out of the mine into the crusher shared with the open-pit operation.

Steady state mining will produce a mill feed of approximately 1.2 million tonnes per annum, 950 000 tonnes from underground and 250 000 tonnes from the open-pit. The mine has a life of approximately 14 years.

Project Description

The project is situated in the North West Province of South Africa, approximately 10km to the east of the town of Rustenburg (Figure 1). It is located in the Rustenburg sector of the Bushveld Igneous Complex, an area well known world-wide for the production of platinum group metals, as well as chromite ores. The western lobe of this sector, where the Kroondal and Waterval tenements are located, supplies most of South Africa's production of these metals. Locally, the Kroondal deposit is situated to the south of the existing Rustenburg Platinum Mine (RPM) (mining the Merensky and UG2 reefs), and to the north and west of the Chrome Resources Mine and the Rustenburg Chrome Mine respectively (both mining the LG6 reef).

The topography around the Kroondal and Waterval tenements is flat to gently undulating terrain at an elevation of 1 200 a.m.s.l. The climate is typically temperate, with average temperatures ranging from 17 to 27°C in summer (from October to April) and 0 to 13°C in winter (from May to September). The area's average annual rainfall is 650mm, occurring primarily in the summer.

The infrastructure in the area is well developed and mining is the predominant industry, hence an established skill pool exists for mining-related labour and mining suppliers.

Modelling

The in-situ grade model estimated by Snowden's, using 'GEMCOM' software was provided to SRK as a regular block model with percentage reef content and grade. Using the three identified reef bands, Main, Leader and pegmatoid, separate zone models were supplied, each containing five grade labels.

The three zone models were combined to a single model for the deposit. The individual grades within the 50m x 50m x 5m blocks for each of the supplied models were weight averaged and combined to form a single grade for each particular grade label.

It was assumed that during open-pit mining, the Leader and Main seams would be mined selectively by the open-pit mining contractor. An allowance for dilution from the pegmatoid in the immediate footwall has been assumed at 10cm (750 tonnes from 7500 tonnes) at the block pegmatoid grade. A further loss of 10% was applied to the block tonnage to allow for geological losses due to potholes, structures, etc. The waste footwall was set to zero tonnage to ensure that during the pit optimisation process no footwall waste was included in the optimal pit outlines.

The 4E grade was not used for the open-pit mining model. This grade is a sum of the four main metals (Pt, Pd, Rh, and Au) and is not meaningful from an economic or pit-design viewpoint. A weight-averaged platinum equivalent grade was calculated from the four main metals using the following projected metal prices:

Platinum	=	US$ 500/oz
Palladium	=	US$ 150/oz
Rhodium	=	US$ 300/oz
Gold	=	US$ 360/oz

Weight Averaged Platinum Equivalent Grade = Σ (Grade x Price) / Platinum Price

The above prices were based on projections from a New York metal trading company.

From the initial exploration drilling and further in-fill drilling, the depth of weathering extended to 15m below surface. All reef blocks above this horizon were flagged as oxide, with reduced plant recoveries for the pit optimisation process. The oxide reef occurring in the initial 5m was treated as waste due to the excessive weathering resulting in uneconomic recoveries. The effect of this was to reduce the in-situ resource tonnage from 21.7 million tonnes (combined Leader and Main) to 20 million tonnes. This has no impact on the underground mine, but reduces the resource tonnage available to the open-pit.

Open-pit Optimisation

The combined block model with equivalent platinum grades was exported to Whittle Four-D to generate a series of pit shells for two scenarios:

Scenario 1 : Open-pit mine only.

Scenario 2 : Open-pit and underground mine.

The first scenario was investigated to evaluate the deposit as an open-pit option only. This would be the case should the underground mine not prove successful. The second scenario was selected as the base case which results in a smaller open-pit than Scenario 1, but will also include underground reef resulting in overall more reef being mined.

For a given set of economic parameters, the difference between the two optimisation scenarios is the reef that lies between the "open-pit only" mine (Scenario 1) and the "combination" mine (Scenario 2) that can be mined at a lower cost-to-metal by the underground mine. If this reef is mined by the open-pit a positive cash flow will still result, but it will be lower than if the reef was mined by the underground mine. Since marginal costing is used in the analysis the difference between the "combination" mine and the "open-pit only" mine will be small. It should be noted that this analysis makes no allowance for the capital required to establish the underground mine.

In addition to the block tonnage and grade, the following input parameters were used for the initial Four-D runs:

Slope angles	=	0 – 15m	45°
		15 – 30m	60°
Rock mining cost	=	R3.80/tonne	
Additional reef mining cost	=	R5.22/tonne (includes R1.08/tonne contractors admin cost and rock-breaker)	
Concentrator/Process cost	=	R3.80/tonne	
Royalties	=	A percentage of net revenue (Price - Off mine costs)	
	=	R54.00/oz platinum equivalent (Approximately)	
Plant Recovery	=	5 – 15m	60%
		15 – 30m	80%
		Underground	83%
Underground mining costs	=	R58.75/tonne reef	
Off mine costs	=	R450/oz platinum equivalent (Approximately)	
Base metal price	=	R1 800/oz platinum equivalent (Approximately)	

No allowance was made for the sale of chromite ore.

The slope angles were determined by SRK following geotechnical logging of a number of exploration drill holes across the project area. The slope angles modelled in the optimisation process were approximated from those given due to the model block size (50m x 50m x 5m). Generally an overall slope angle of 60° was used.

The open-pit mining operating costs were determined from several budget quotations from local South African contractors specialising in open-pit mining. Capital costs, for example, site establishment and dis-establishment, are excluded from the costs used in the optimisation and only marginal costs are assigned to waste.

Optimisation Results

Pit optimisation will produce a nest of pit shells by calculating the optimal outline for a range of economic scenarios (price or mining cost). This process ensures that a small pit in the nest will be within a larger pit in the nest and pits will not overlap. The smallest pit generated by the lowest price or cost will therefore be the best pit to start mining. Traditionally, the sequence of mining will follow the nested pit outlines to maximise the cash flow for the project in the early years of its life. It has to be noted that there is a difference between an economic pit generated with a computer and software, and a practical mineable pit. The economic pit will not take cognisance of the practicality of mining. So the mining engineer must use his discretion and knowledge to design the pit using the guidelines of the economic outlines.

In the case of Kroondal however, the methodology of using nested pit outlines was not adopted for a number of reasons:

- The deposit is such, that the smaller pits in the nest of optimised pit shells comprise a series of "holes" that would not be practical to mine. An example of this is shown in Figure 2, which illustrates the "optimal" pit yielding 1.2

million tonnes reef (approximately the first 18 months of plant feed).

- The higher quality reef, available for underground mining would provide higher returns than the lower quality open-pit reef due to the metallurgical properties of the reef associated with the weathering. When considered as a separate product, the oxide reef (5m - 15m) is uneconomical to process, due to the low yield. The open-pit would therefore be planned to mine the reef that could not be mined by underground (within 30m depth of cover limitation).
- Access for the underground mine would be from the open-pit highwalls, which would dictate the start locations for the open-pit boxcuts.
- The limited down dip extensions within the final pit shell will preclude an open-pit mining sequence that includes a number of cutbacks/pushbacks.
- The reef mined from the open-pit can be blended in pit by mining a series of strike cuts that expose the total reef available for mining in the cut. Deeper higher quality reef can be blended with shallower lower quality reef during the mining cycle to provide a consistent blend to the plant.
- Each 50m wide cut is mined to final limits and can be considered as a separate pit. The extent of the cut will be determined by the cost-to-metal at the time the cut is mined. The mine will therefore be able to rapidly react to fluctuations in price by altering the depth of the cut and since several cuts will be mined in a year this will reduce the exposure of the mine to price risk.

The pit optimisation was undertaken to determine the limits of open-pit mining and the location of the 20m barrier pillar between the open-pit highwall and the underground workings. The base case pit was selected using the expected metal price, approximately US$400/oz platinum equivalent.

The results from the optimisation runs for both scenarios investigated are presented in Table 1 and Table 2, and Figure 3 and Figure 4.

Reference to these results indicates the following:

- For the given operating costs, there is no reef worth mining below a price of US$246/oz platinum equivalent.
- At the base case price (US$400/oz platinum equivalent) the Scenario 1 pit (open-pit only) yields 5.3 million tonnes at an average grade of 4.0 g/t platinum equivalent, with 71.4 million tonnes waste. The corresponding Scenario 2 pit (open-pit / underground combination mine) yields 4.1 million tonnes at 3.9 g/t platinum equivalent, with 44.0 million tonnes waste.
- For the Scenario 1 case (open-pit only) a 10% decrease in price from US$400 to US$360 results in a decrease of 23% of the reef tonnage and 32% in waste tonnage. The effect is less for the Scenario 2 case in which the underground mine, was limited to sulphide reef.

The optimal outlines at the base case price are shown in Figure 5. The Scenario 1 pit indicates the maximum profitable pit for the selected economic parameters. If there were no underground mine this would be the optimum pit limit. The Scenario 2 pit is smaller and the reef between the two pits can be mined at a lower cost by underground methods. For the optimisation runs the Scenario 2 underground mine was not constrained by the 30m depth of cover.

Open-Pit Mining Methodology

The project area has been divided into three blocks defined by the access requirements for the underground mine, the Centre block, the Eastern block and the Western block.

At this stage it has been assumed that the highly oxidised reef from surface to a depth of 15m will not be processed for the first 18 months of the mine's life. This oxidised open-pit reef will be blended with the higher quality reef from the underground mine at the end of the open-pit life. It is also believed at this stage that the best quality open-pit reef occurs in the Eastern block. The exact blend and marketability of the open-pit reef has yet to be confirmed by further metallurgical test work.

The mining sequence will begin with the removal and stockpiling of topsoil. The soil investigation has indicated that topsoil will occur to a depth of 1.5m. This will be stockpiled on the highwall side of the pit within 10m of the pit limit. An initial 100m wide boxcut will then be developed, from outcrop to the final pit highwall in the Centre and Eastern blocks. The location of these initial cuts has been selected to allow access to the underground mine. The waste will be removed and dumped either in the flood protection bund wall, the tailings dam wall or adjacent to the final cut position at the eastern end of the mining lease area. The highly oxidised reef from outcrop to a depth of 15m will be stockpiled separately from reef taken from 15m to the final pit limit, which will be used for the initial plant feed.

Once the boxcuts have been developed, open-pit mining will commence in the Centre and Eastern blocks from 50m wide cuts developed on strike from a depth of 15m to the final pit limits. Mining will then continue on both sides of the initial boxcut. Most of the Eastern block will be mined in this way. Waste from the first two cuts after the boxcut will be removed from the pit. Thereafter waste from each cut will be blasted/dumped into the void from the previous mined out cut. Reef from surface to 15m will be mined at the end of the open-pit mine life.

The Eastern and Centre blocks will be mined simultaneously, the four faces giving flexibility in mining scheduling. Underground reef will become available after approximately 18 months of full production. Production of open-pit reef will then be decreased, and the Centre and Eastern blocks will have been mined out. The Western block will then be developed to allow access to the underground workings in that sector.

Once open-pit mining has been completed in the Eastern block the remaining highly oxidised reef will be mined. This will have low stripping ratios and plant recoveries.

Mining the open-pit in sequence of horizontal cuts enables the rehabilitation to be carried out as mining proceeds. This will involve profiling the waste dumps and replacing the stockpiled topsoil. The mining sequence will involve drilling and blasting the overburden and reef together to the full highwall depth. The overburden will be bulk mined down to the Leader seam contact. Selective mining will remove the Leader seam (reef), the parting (waste) and the Main seam (reef) separately. An allowance of 10% waste dilution has been made in the open-pit mining schedule for overburden and parting, together with 10cm of pegmatoid from the pit floor.

Practical Pit Design

The selected optimised pit shell from the Whittle Four-D program represents an optimal pit outline that is used as a guideline for a practical pit design. The pit design was constrained by the following factors:

- During the first 18 months of mining no highly oxidised reef could be mined. The starter pit will commence mining at 15m depth and extend to the final pit limits;

- The practical pit limits were controlled by the limits of the Scenario 2 pit unless the depth of cover was less than 30m. In this case the pit limits were extended to either the Scenario 1 pit limits or the 30m depth limit (which ever occurs first).

The pit design for this project consists of a starter pit mining from 15m to 30m, the initial 18 months and a final pit, which will be mined as a series of 50m wide cuts. Figure 6, shows the final practical design pit outline, mining to a depth of 30m.

Mining Schedule

The mining schedule was developed in conjunction with the underground mine. The tonnage profile provides the necessary feed to the plant, the majority of which is supplied by higher-quality underground reef. The lower-quality open-pit reef supplements this. The mill capacity is nominally 1.2 million tonnes per annum and the tonnage split is shown in Table 3. Figure 7 shows how the open-pit mine develops, and Figure 8 details how the underground mine develops.

Conclusion

This paper has described the process that was followed during the feasibility study for the Kroondal Platinum Mine Project. Subsequent to this, further drilling has been done of the reef to identify geological structures and for further grade interpretation which has been used in the detail design work which is presently on-going.

Having secured finance, Kroondal Platinum Mine has now moved into the detail design phase of the mine and plant. Preliminary work has started with the clearing of the site and preparation of foundations and roads. It is planned that the commissioning will be complete by the end of 1999, and full production will start in 2000.

Further work is being done in order to move the underground production forward and smooth the open-pit tonnage profile, as well as scheduling changes associated with the geological anomalies identified with the recent drilling. Tenders for the open-pit and underground mining contractors have been adjudicated and contracts are being negotiated at present. These are likely to be awarded during the early part of 1999.

The feasibility financial analysis shows that the project will be a success story for Kroondal, Aquarius and the shareholders.

Acknowledgements

The author wishes to thank Mr Dave Evans, General Manager and Mr Dave Starley, Mining Manager of Kroondal Platinum Mines Ltd for their kind permission to use the Kroondal project as a case study. Thanks are also due to Dr Clive Seymour of SRK (Australia) and Mr Graham Murray of SRK (South Africa), as well as all those involved in the project for their help in writing this paper.

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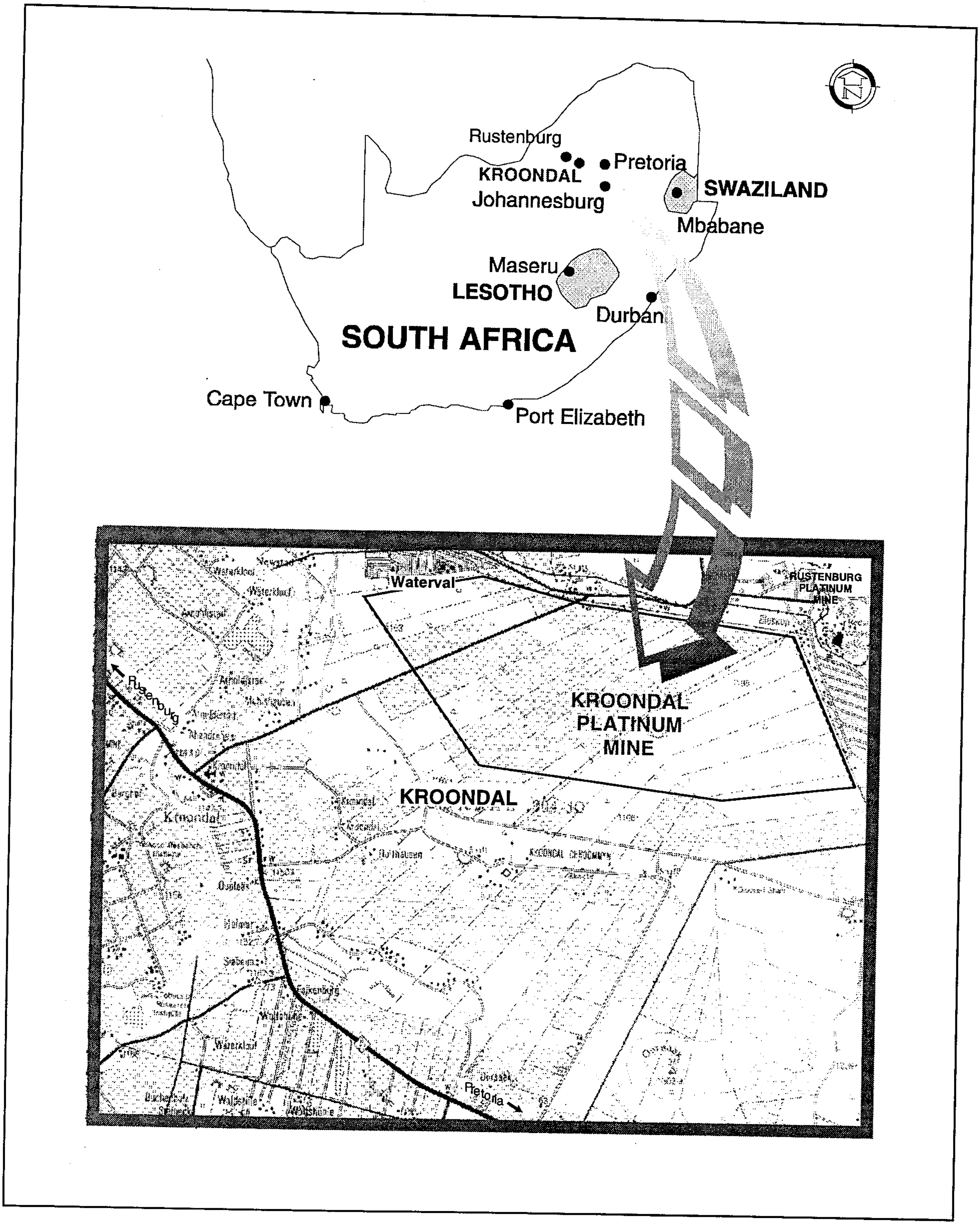

Figure 1: Kroondal Platinum Mine – Location Plan

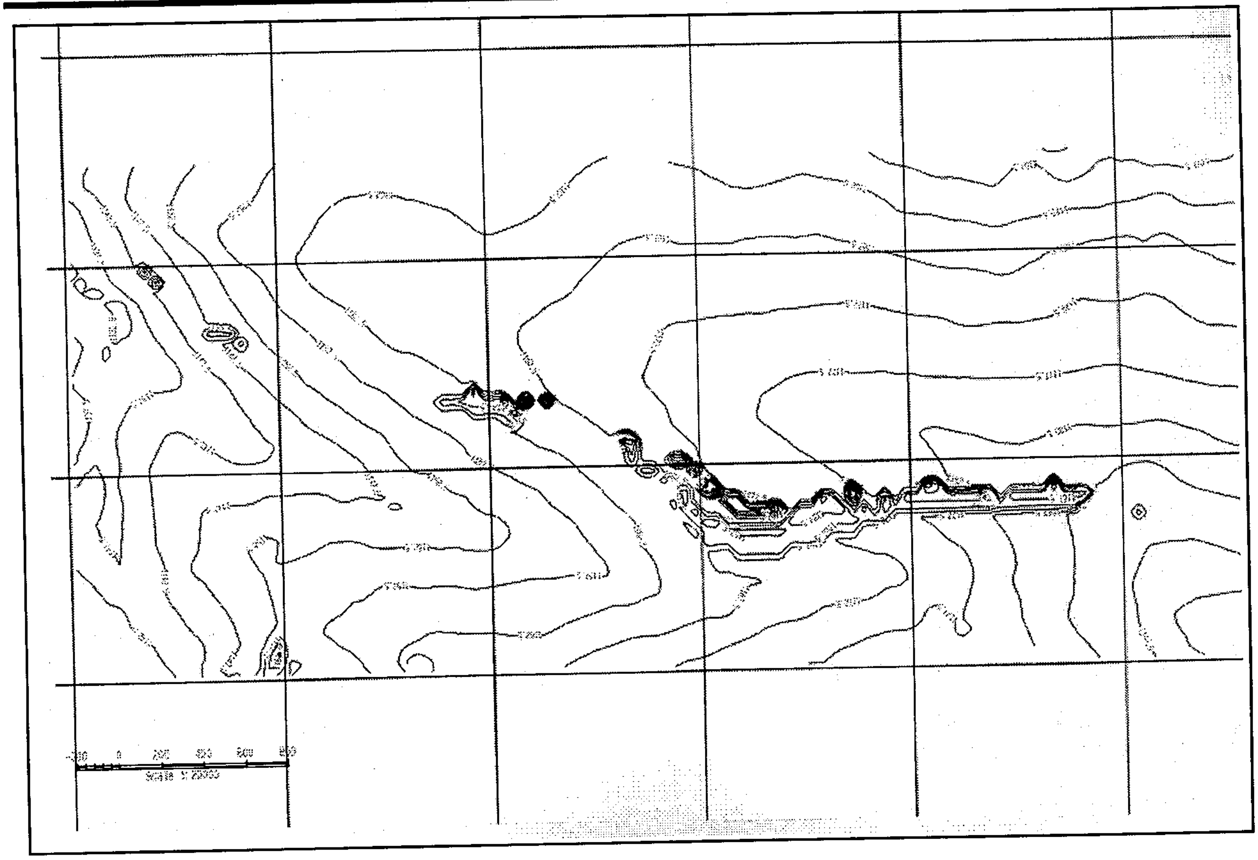

Figure 2: Optimised Pit Outline – First 18 Months

PRICE		PIT	WASTE	OXIDE		SULPHIDE		TOTAL REEF		STRIP
US$/g	US$/oz		Kt	Kt	G/t	Kt	G/t	Kt	G/t	Ratio
7.91	246	1	78	15	4.57	0	0.00	15	4.57	5.20
9.00	280	5	4 256	488	4.36	95	4.43	583	4.37	7.30
9.80	305	7	12 868	997	4.24	436	4.33	1 433	4.27	8.98
10.29	320	8	20 617	1 243	4.19	823	4.23	2 066	4.21	9.98
11.57	360	11	48 317	2 152	3.98	1 942	4.13	4 094	4.05	11.80
12.86	**400**	**13**	**71 476**	**2 452**	**3.92**	**2 889**	**4.06**	**5 341**	**4.00**	**13.38**
14.15	440	15	96 634	2 533	3.90	3 829	4.02	6 362	3.97	15.19
15.43	480	17	137 574	2 564	3.90	5 144	3.97	7 708	3.95	17.85
16.72	520	18	155 063	2 572	3.90	5 647	3.96	8 219	3.94	18.87
18.00	560	19	176 738	2 578	3.90	6 225	3.93	8 803	3.92	20.08
19.29	600	20	207 855	2 583	3.90	6 970	3.90	9 553	3.90	21.76

Table 1: Pit Optimisation Results Scenario 1- Open-pit only

PRICE		PIT	WASTE	OXIDE		SULPHIDE		TOTAL REEF		STRIP
US$/g	US$/oz		Kt	Kt	G/t	Kt	G/t	Kt	G/t	Ratio
7.91	246	1	78	15	4.57	0	0.00	15	4.57	5.20
9.00	280	5	4 256	488	4.36	95	4.43	583	4.37	7.30
9.80	305	7	12 714	993	4.24	428	4.32	1 421	4.26	8.96
10.29	320	8	19 050	1 233	4.20	734	4.20	1 967	4.20	9.68
11.57	360	11	34 970	2 150	3.98	1 265	4.06	3 415	4.01	10.24
12.86	**400**	**13**	**44 008**	**2 441**	**3.92**	**1 630**	**3.98**	**4 071**	**3.94**	**10.81**
14.15	440	15	46 334	2 524	3.90	1 704	3.97	4 228	3.93	10.96
15.43	480	17	51 427	2 563	3.90	1 933	3.96	4 496	3.93	11.44
16.72	520	18	54 033	2 572	3.90	2 055	3.96	4 627	3.93	11.68
18.00	560	19	57 962	2 578	3.89	2 241	3.96	4 819	3.92	12.03
19.29	600	20	61 474	2 583	3.90	2 398	3.97	4 981	3.93	12.34

Table 2: Pit Optimisation Results Scenario 2- Open-pit and Underground Combination Mine

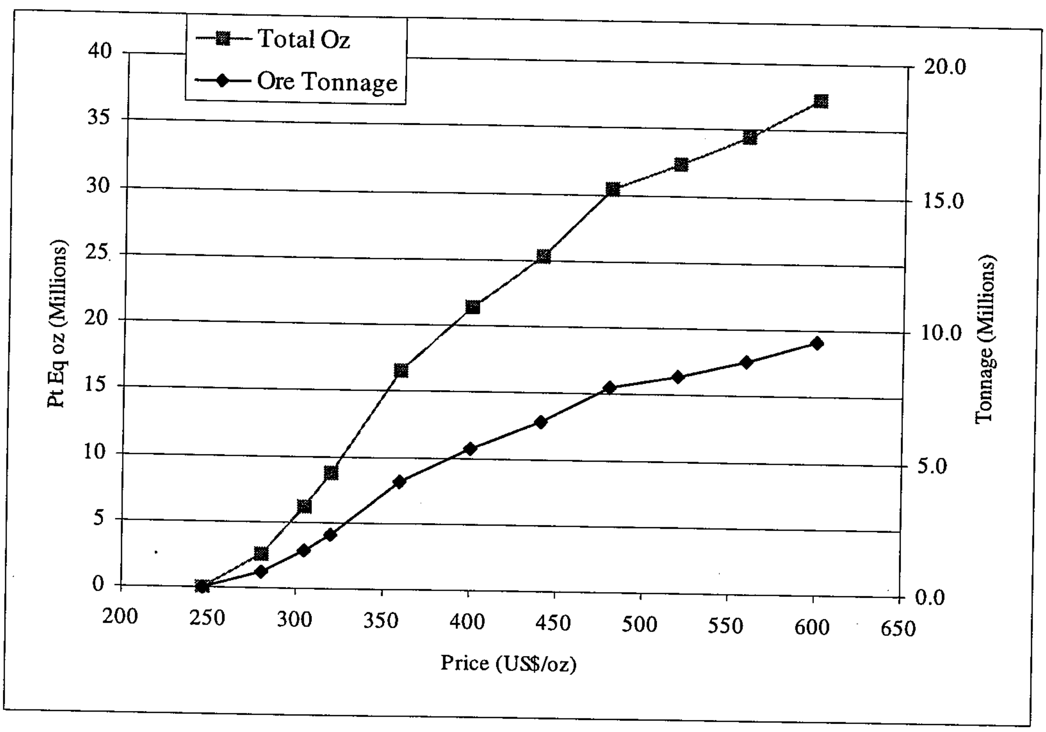

Figure 3: Scenario 1 – Selected Optimum Pit Outline

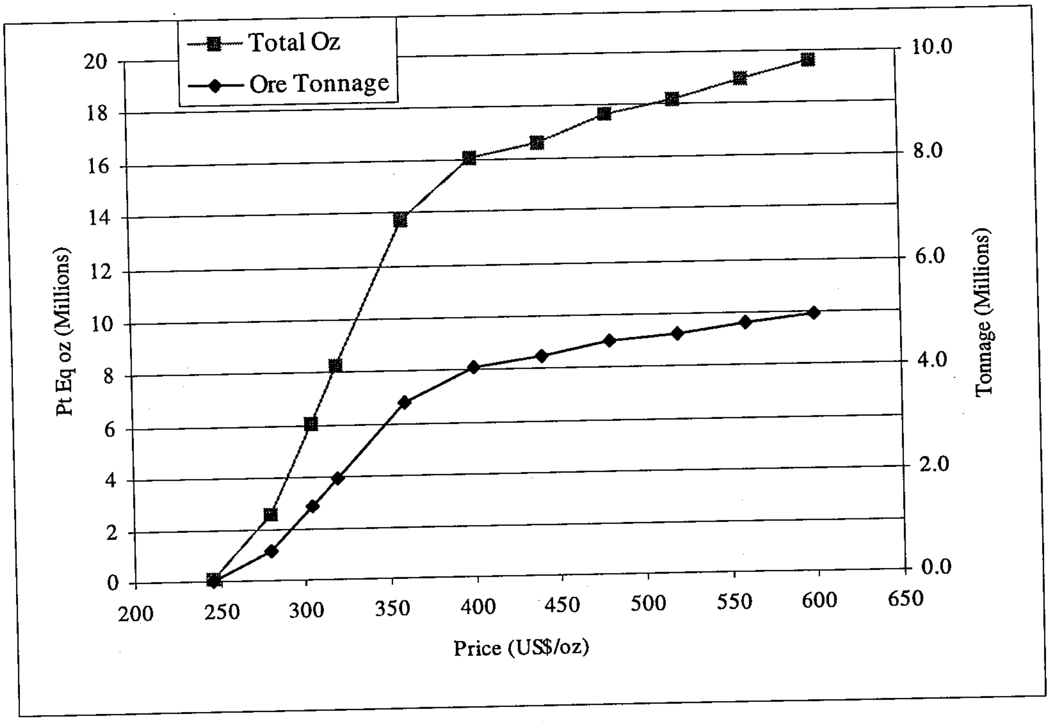

Figure 4: Scenario 2 – Selected Optimum Pit Outline

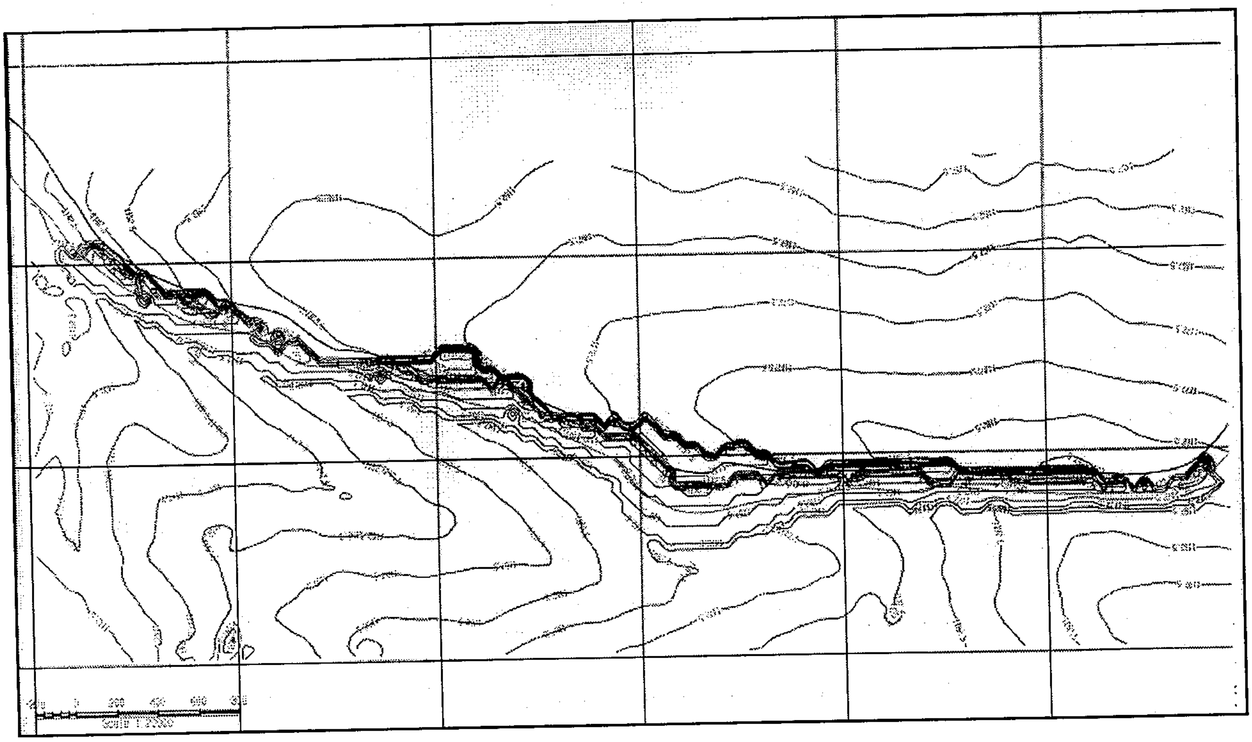

Figure 5: Optimised Pit Outline

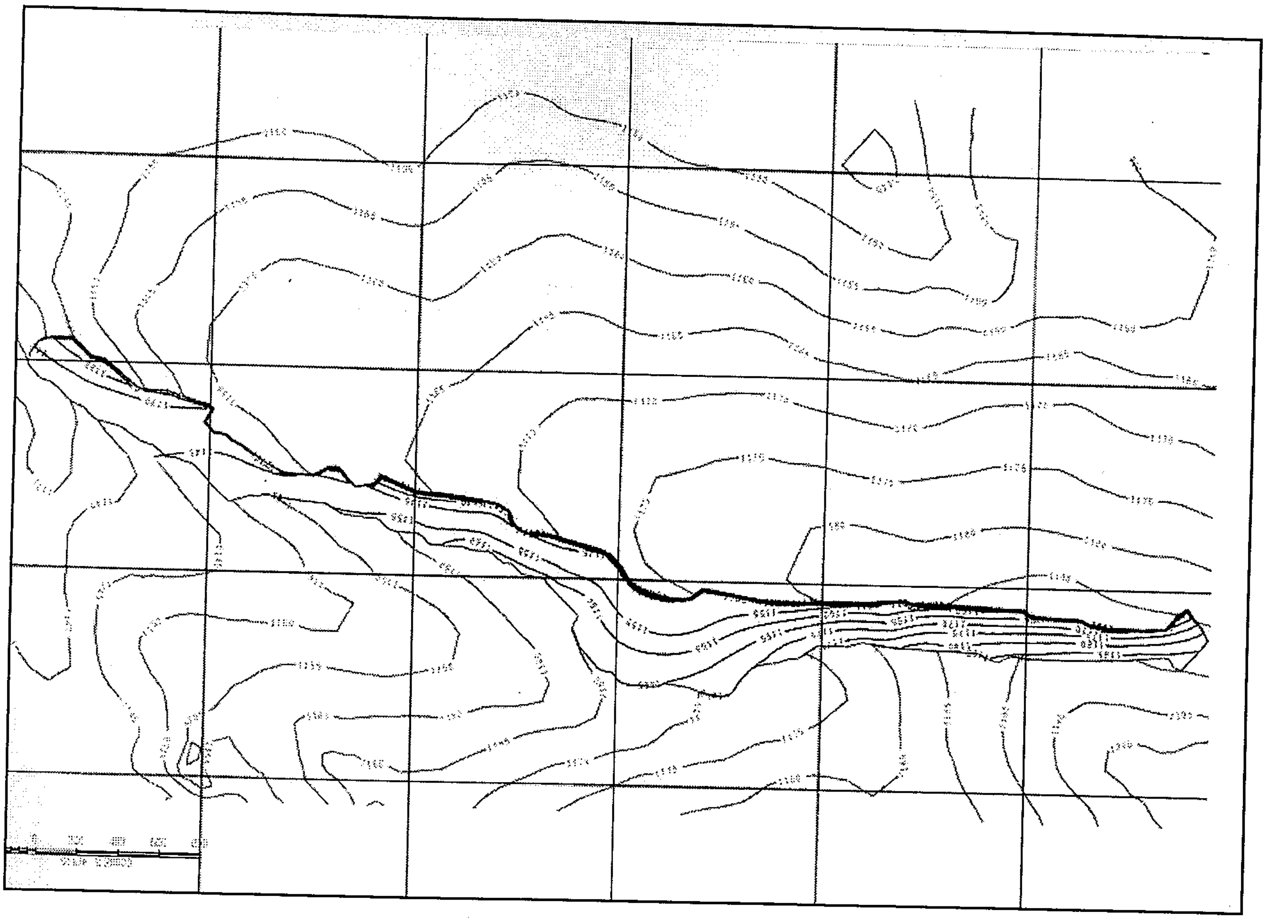

Figure 6: Final Practical Design Pit Outline

YEAR	REEF TONNAGE (KT)		COMMENTS
	Open-pit	Underground	
1	125	0	Open-pit only
2	1100	100	Open-pit full production; underground development
3	600	600	Open-pit & underground
4 – 11	250	950	Open-pit & underground (steady state production)
12	45	950	Open-pit & underground (open-pit reserve exhausted)
13	0	950	Underground only
14	0	250	Underground only (reserve exhausted)

Table 3: Nominal Open-pit and Underground Tonnage Split

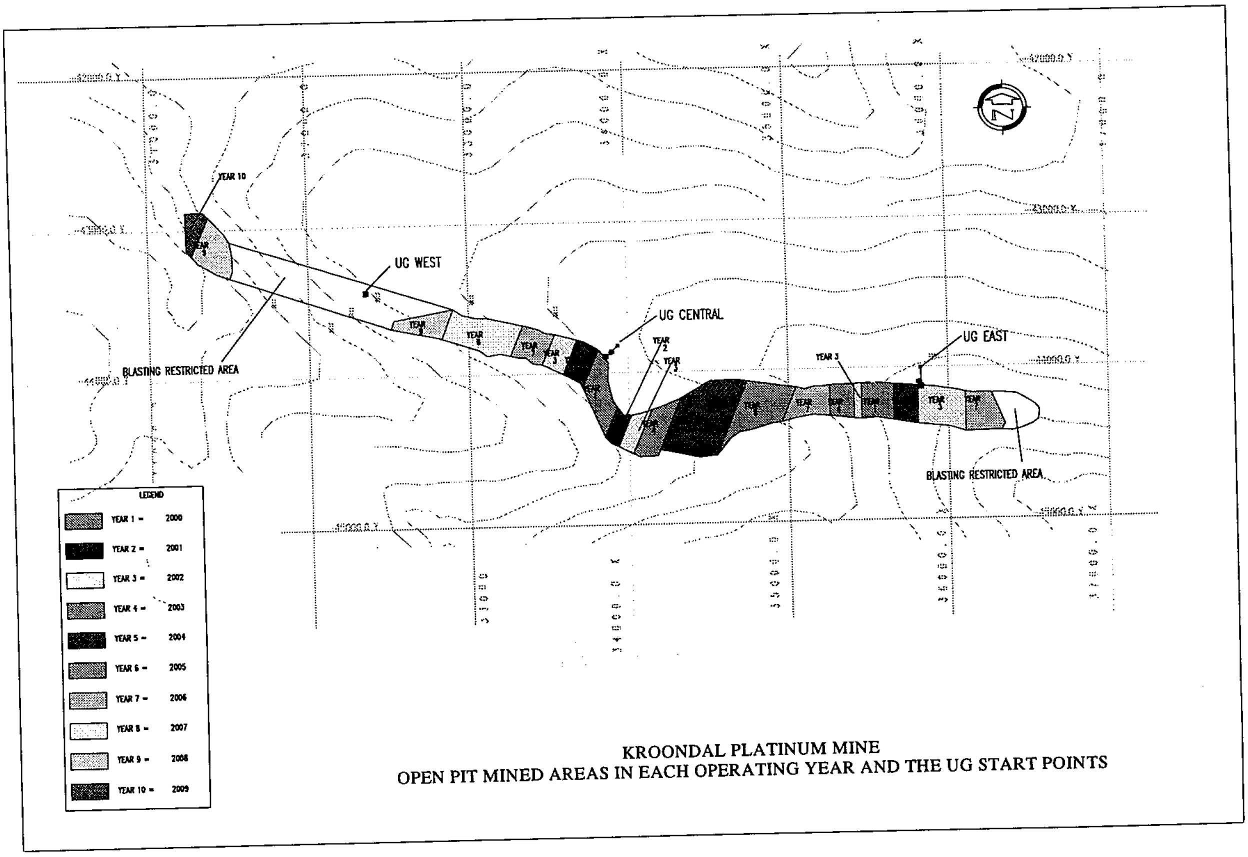

Figure 7: Open-pit Schedule

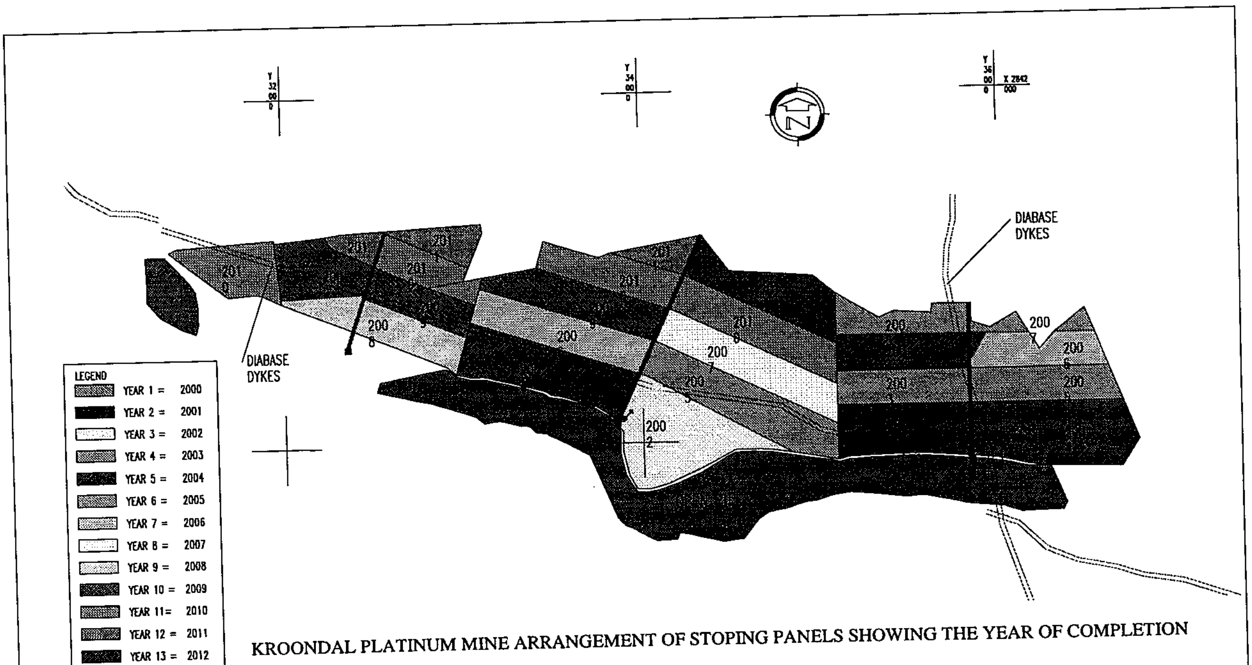

Figure 8: Underground Schedule

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