A Selected Historical Recollection relating to Early Operations at Bafokeng 1966 – 1971.

Synopsis.

A general description of bringing Bafokeng Mine into production, 45 years ago, is presented.
Bafokeng, 16 km north – west of Rustenburg, associated with Union Corporation Impala Platinum.
The technical problems, overcame, are chiefly metallurgical.
Advantage not be taken of bringing the shallower workings into production even sooner,
because progress of mining operations hampered by inadequate supply of power and water.
Although protracted, through valuable assistance rendered by the Commission,
negotiations with Bafokeng Agricultural Community, are cordial.
Administration, service department offices, and housing for officials situated in Rustenburg.
Village of family dwellings for labour accommodated nearer to mine.
Because of shallower workings, rapid development achieved.
Sinking of three pairs of inclined shafts provides points from which development commences.
Second outlets and ventilation holings to surface achieved.
To avoid necessity of support pillars within mining operations at depth,
concentrator, smelter, labour accommodation, and hospital, sited behind outcrop.
Advantages gained through double – shift stoping :

- Reduction in capital cost of development to provide stope face.
- More rapid build – up in production.
- Reduction in capital cost of –
  - Compressors.
  - Locos.
  - Winches.
  - Rock Drills.
- Saving in power cost, because maximum demand is reduced by
  spreading compressed air load.

Respecting unpredictable nature of PGM Market,
policies relating to working costs and efficiencies are continually reviewed.

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1. Introduction.

Bafokeng Mine is situated 16 km north – west of Rustenburg.
Deposit worked is Merensky Reef of Bushveld Igneous Complex.
Mining lease area is 10 700 Ha containing 18 600 claims.

Ha = 100 m x 100 m.
= 10 000 m^2.
Claim = 1.7 Ha.

Position of the outcrop of the Merensky, in the southern region of the lease, obscured by black turf, is delineated by geochemical and geophysical surveys.
Prospecting aided by discovery of pits, trenches, and prospect winzes ,
which, in 1925, were developed by Hans Merensky.

1966, following agreement with The Bafokeng, drilling of 115 prospect boreholes,
including those on Wildebeesfontein.
1967 , shaft sinking commences.

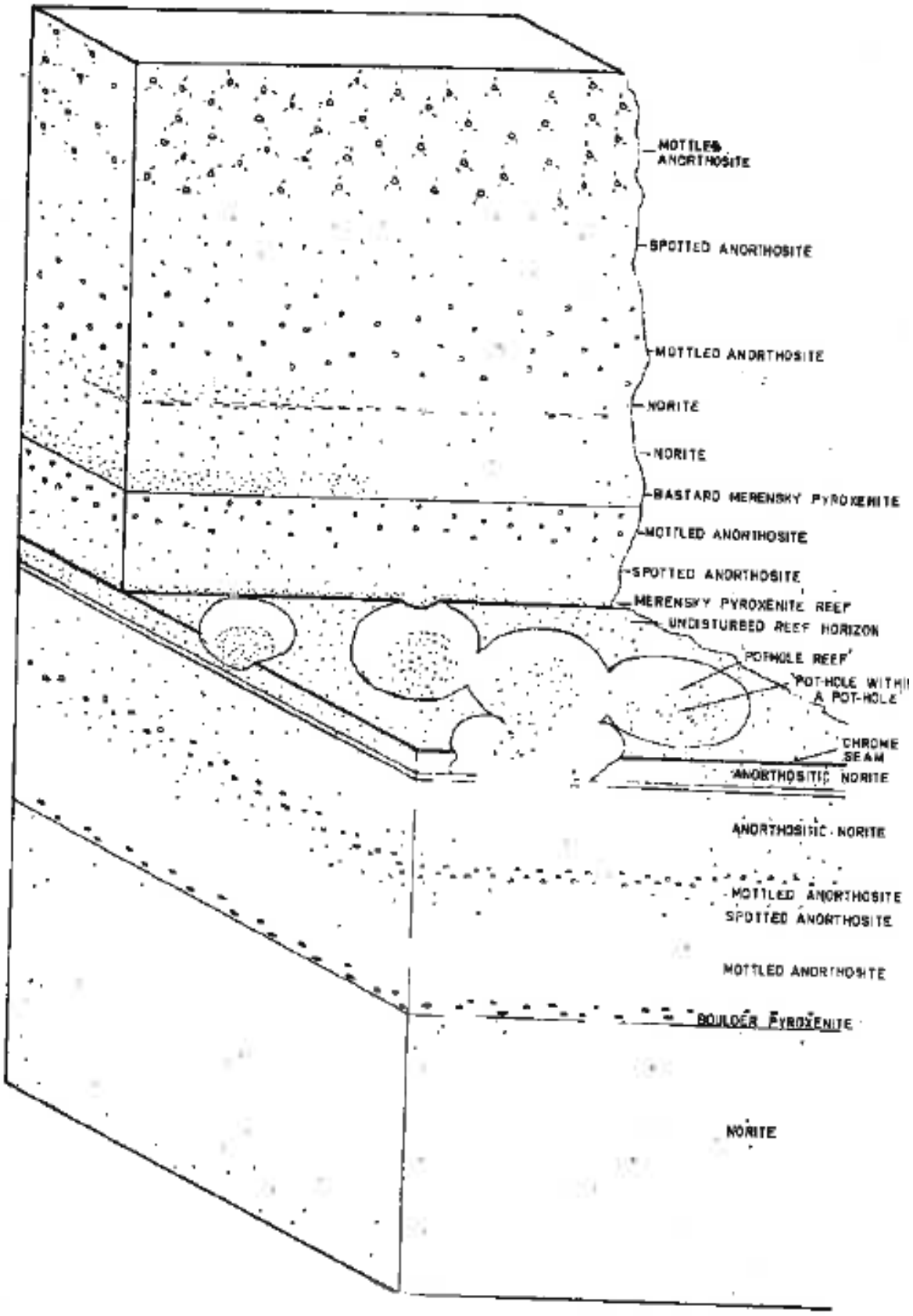
2. <u>Geology</u>.

On mine, Merensky , which dips 9 ^{o} north east , contains economic quantities of PGM ,
as well as, recoverable by – product copper and nickel.
Reef formed as a result of settling of heavier material within magma.
Merensky is coarse dark pegmatoid and pyroxenite, together with chromite at the base.
Chromite grades upward to norite over 1 m.
Norite grades upward into spotted anorthosite,
and finally a mottled anorthosite at top of Merensky magma.
Footwall of reef is , 1 m thick , anorthosite norite.

Reef channel varies slightly throughout mine.
Payable zone embraces 300 mm wide chromite seam.
In chromite , and in close proximity to it, is a concentration of platinum group metals.
Chromite serves as a marker , and establishes hangingwall and footwall limits in stopes.

As a resulting of re – melting to varying depths , pothole geological disturbances ,
in which original reef slumps, leaves reef resting on a lower footwall , than original reef.
Potholes , circular in plan , vary in diameter , from 1 m to 70 m , with average 30 m.
Potholes , which merge , cause loss in grade.
The sloped edges of potholes , where reef is not present , causes loss of ground.
Potholes, showing overturned edge, cause gain in ground.
Faults of displacement occur.

Hangingwall and Footwall of Merensky , indicating Pot Hole Slump Structures.



3. Prospecting.

1967 July, trenching and pit blasting locate sub - outcrop of Merensky, covered by layer of black turf.
Prospect winze , sunk by Hans Merensky , dewatered and geologically logged.
After strike and dip of reef confirmed, 2 prospects, vertical winze and winze, inclined on reef, sunk.

With steady progress of single - shift sinking of winzes , 1967 September , plans, to open mine, laid.
Initially , progress adversely affected, through delayed delivery of :

- Electric Power.
- Water Supply.
- Telephones.
- Roads.
- Rail Links.

4. Earlier Challenges.

Fortunately , radio transmission available at prospect drilling,
through which emergency messages relayed to office.

On site, 2 boreholes provide enough water for :

1. Drilling.
2. Domestic supply in accommodation.

Through connected pipeline, water also drawn from farm , 11 km away.

3 mobile generator sets , 2 operational + 1 standby ,
supply electric power for early prospect development.

Development restricted , until 500 – case explosive magazine replaced 36 – case storage, because , explosives , delivered fortnightly from nearby chrome mine, exercised with maximum economy.
This subjected labourers to trying conditions, which was aggravated by their temporary housing.

5. Staff Housing.

Staff and supervisory personnel housed in Rustenburg.
Prior to their own building programme, mine purchased 100 houses.
According to their own preference, staff spread among those of other occupations.
Advantage gained through existing availability of sporting facilities.

6. Services.

6.1 Water Supply.

Initially mining and domestic water obtained from boreholes.
1968, Rand Water Board supply , via Rustenburg , along 24 km line.
Owing to minimal water from workings, underground circuits topped up with RWB water.
Settling done underground and on surface.

6.2 Power Supply.

Prior to 1968 October supply of initial Eskom 500 kW power ,
demand generated by four 500 kW mobile generators and two 500 kW stationary generators.
Expansion at mine tailored to availability of power.
Maximum demand during peak period , 0800 am - 1400 pm , restricted.

6.3 Compressed Air.

2 x 17 m^3 / min mobile diesel compressors supply initial compressed air for prospecting.
Mobile Compressors : 5 x 17 m^3 / min + 1 x 34 m^3 / min supply sinking and development.

1968 February , half of 80 drill compressor, with cooling pond , completed.
1968 May , extended to 160 drills.
Owing to insufficient electric power, air pressure restricted to 4 604 bar.
1969 April , installed capacity extended to 610 drills.

6.4 Workshops.

With bulk of jobbing and fabrication done at Rustenburg, limited facilities established at mine.

6.5 Surface Ore Transport.

Ore hauled , from shaft headgear boxes ,
in 45 ton bottom – discharge hoppers, by 32 ton 3 290 k W diesel – electric locos.
Discharged into 1 400 ton live load transfer bin at concentrator.
Track is standard SAR (Transnet) gauge ,
permitting delivery of SAR material trucks direct to shaft banks.
After hours, employee drive locos.
During day shift , staff driver exchanges trucks on SAR siding .
Staff driver organises and controls transport of ore from shafts , and movement of rolling stock.

7. Administration.

Factors influencing the situating of mine general office in Rustenburg.

- Administer ground east of Rustenburg.
- In line with Government Policy ,
  minimise number of staff members allocated at Bafokeng Site.
- Reduction of travelling time and cost for majority of staff , who reside in Rustenburg.
- Viability of remoting the Survey , Sampling , and Geological offices , from site.
- With respect to local community, conduct of Staff , is commissionally prescribed.

8. The Bafokeng Community.

Mine does not own surface area of lease area.
Rental , per – hectare , for whole area , together with an additional amount ,
on areas occupied for mining purposes, is paid to the Authority.
Until owners' reservations are negotiated ,
operation is conducted in terms of prospecting agreements , drawn up with the Authority.

Agreements are continuously negotiated with Kgotla , through mining committee ,
comprising 10 elders , who are proved , sound , and reasonable negotiators.
With inspections held *in loco* ,
meetings between management and committee are held at shaft offices.
With no recourse to Mining Commissioner until lease agreement is finally signed ,
surface required for mining purposes is negotiated.

All trading rights are vested in the Bafokeng Authority.
The Bafokeng own a concession store near the mine labour housing.
Their own selected trained members run this business.

On the property ,
The Bafokeng operate transport contracts to truck waste rock to stone crushers.

Tswana represent 2 % on labour force.
Since they demonstrate a preference for
surface , clerical , truck driving , loco , small hoist driving , and process operation positions ,
there are only 10 Bafokeng employees working underground.

Leavers from the Kutlawanong Tswana School for the Hearing and Speech Impaired , 5 km away ,
employed as , energetic and reliable , sweepers at the labour accommodation ,
are sympathetically treated by mine labour.

9. Shafts.

9.1 Inclined Shafts.

Shallower part of lease served by three pairs of inclined shafts :

: # 1 Shaft.
: # 2 Shaft.
: # 3 Shaft.

Each pair consists of :

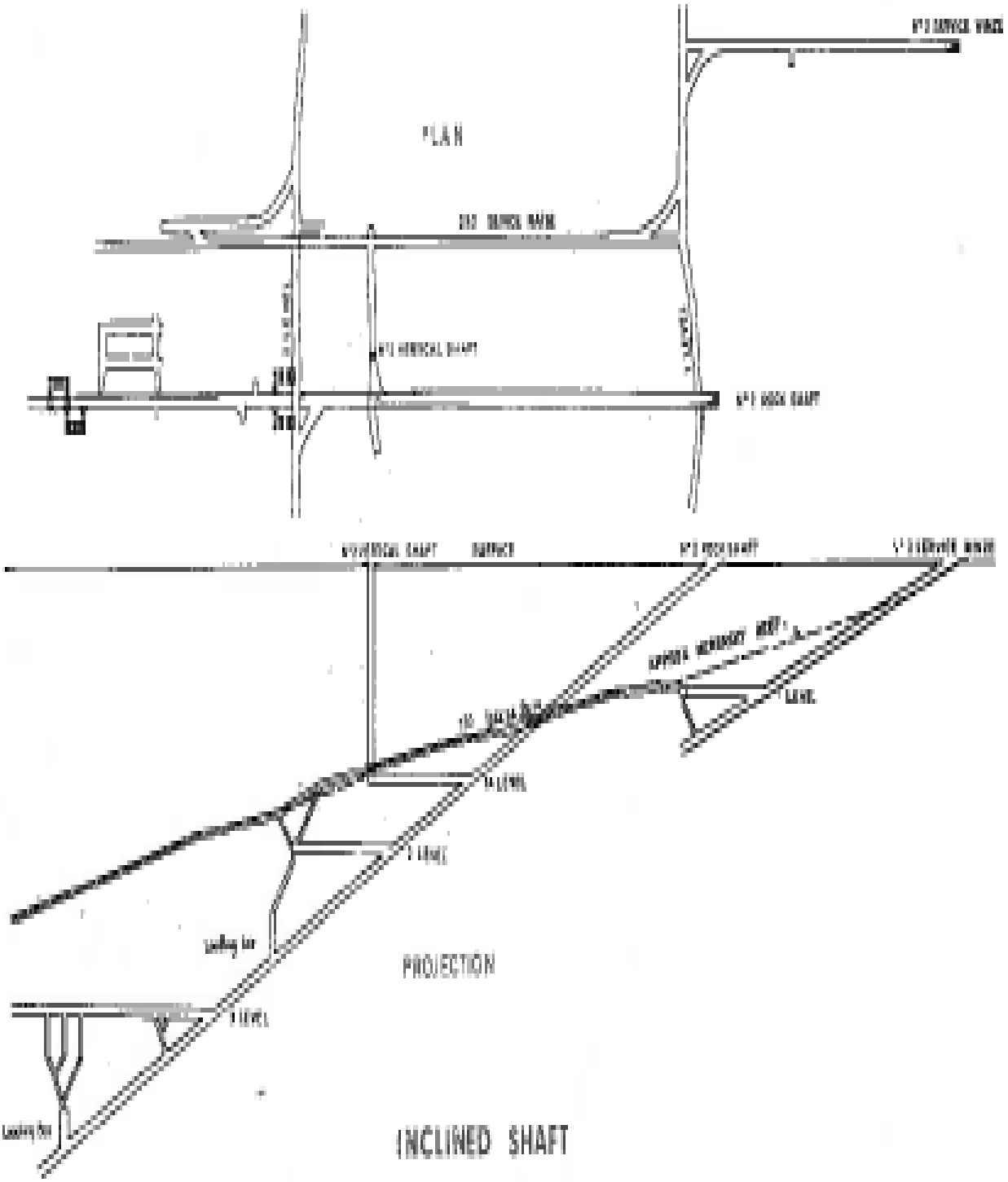
- Rock – Hoisting Shaft , dipping at 25 ^{o} .
- Service Shaft , dipping at 20 ^{o}.

Shafts provide points, from which development commences simultaneously.

Each service winze equipped with 56 kW single drum hoist.
Rock Shafts , # 1 & # 2 , balanced 150 kW double – drum , hoists skipload 5.4 tons.
3 Shaft equipped with two 75 kW single – drum hoists.

Persons do not travel in any conveyance in rock shafts ,
which are operated by employee drivers.

Inclined Shaft.



5 A , fully concrete lined , Elliptical , 4.9 m x 3.2 m , 61 m deep , completed in 1 month.
Easier sinking shallower vertical shaft.
Advantage in raising an inclined shaft rather than sinking it.
Vertical Shaft utilised as service way , whist persons access through inclined rock shaft.
Cleaning done by hand lashing into a 2.7 ton kibble , operated by a jib crane ,
which slews kibble on surface , to waiting tip trucks.

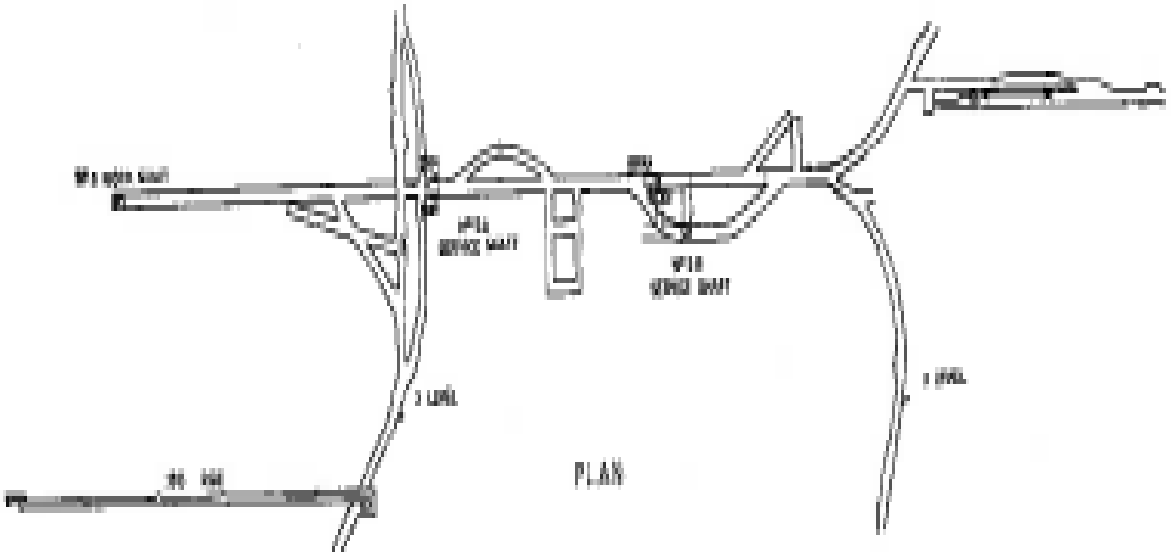
3 months after commencement of shaft sinking operations at vertical shaft ,
5 Inclined Rock Shaft raised from bottom of vertical shaft.
This shaft holed back to surface into a prepared collar.

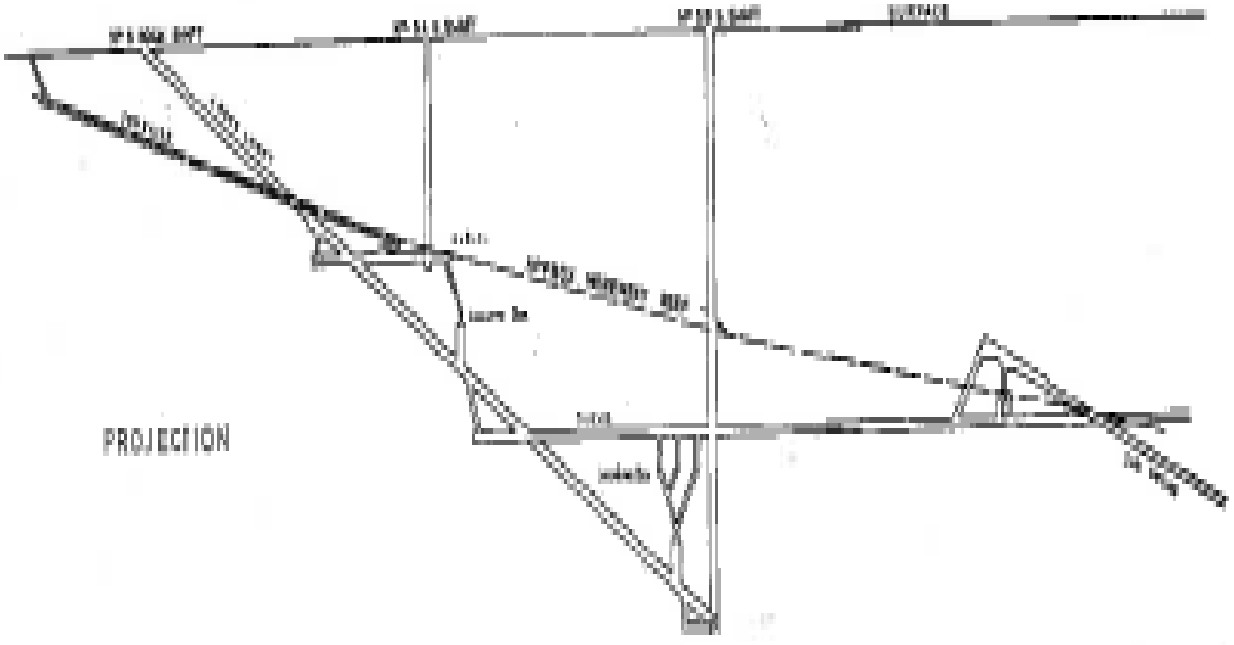
Inclined Rock Shaft equipped from surface down , then sunk to 2 Level Loading Box position.
Development , east and west of this shaft , then commenced.

5 B , identical to # 5 A , sunk down dip , on line with Inclined Shaft , to 3 Level Loading Box .
From bottom of # 5 B , spillage arrangements , below 3 Level Loading Boxes , cut .
Below 2 Level Loading Boxes , Inclined Shaft raised to hole with operating shaft.
Holing achieved 1969 December.
Working from below penthouse in shaft , permanent equipment installed.

Production at # 5 Shaft commenced 7 months after commencement of sinking operations.
5 B is equipped with an elevator to take heavier equipment , and 40 persons per trip.

5 Shaft.





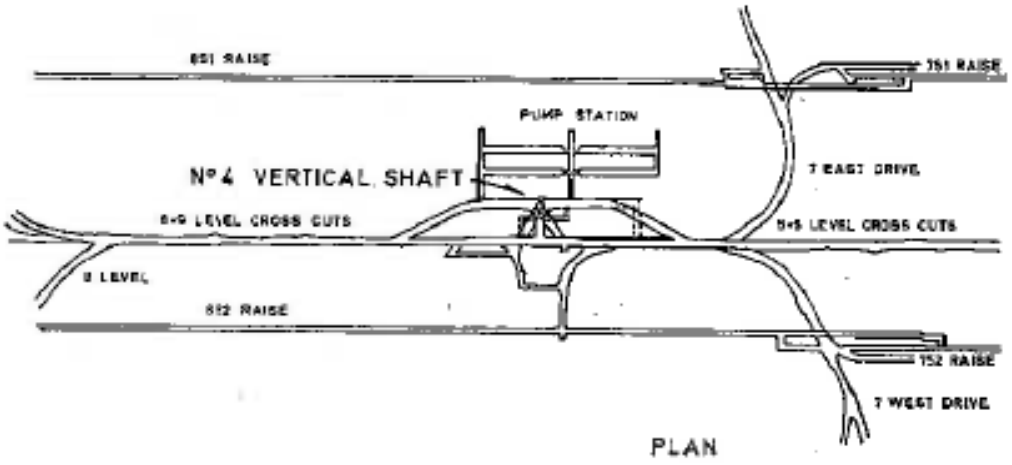
5 SHAFT

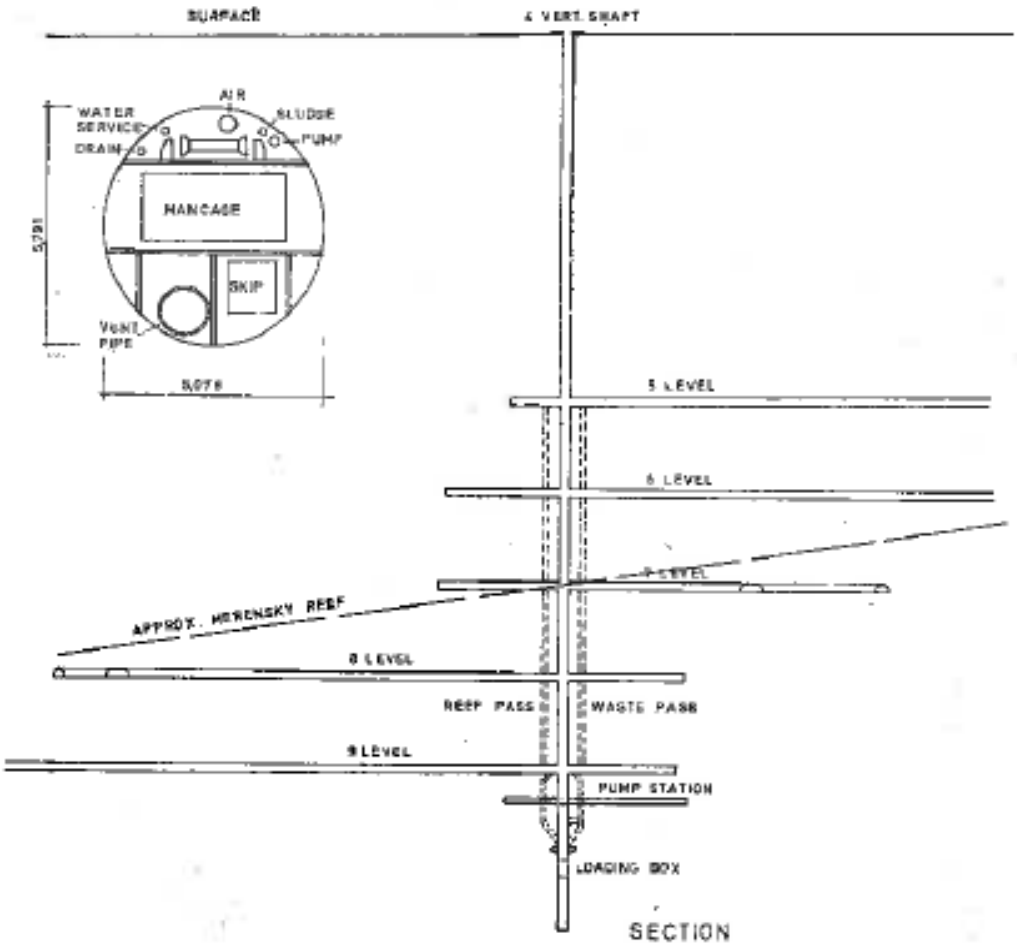
9.3 # 4 Shaft.

4 Shaft , vertical elliptical , 5.8 m x 5.1 m , accesses deeper resource , north of inclined shafts.
Sunk and lined with 750 mm concrete rings , spaced 4.5 m apart.
Cleaning done by hand lashing into 4.5 ton kibbles , operated by a single – hoist drum.

Including 5 Levels and a pump chamber , shaft took 11 months to complete.
Crosscut , from upper most level , is connected to workings of # 2 Inclined Shaft.

4 Shaft.

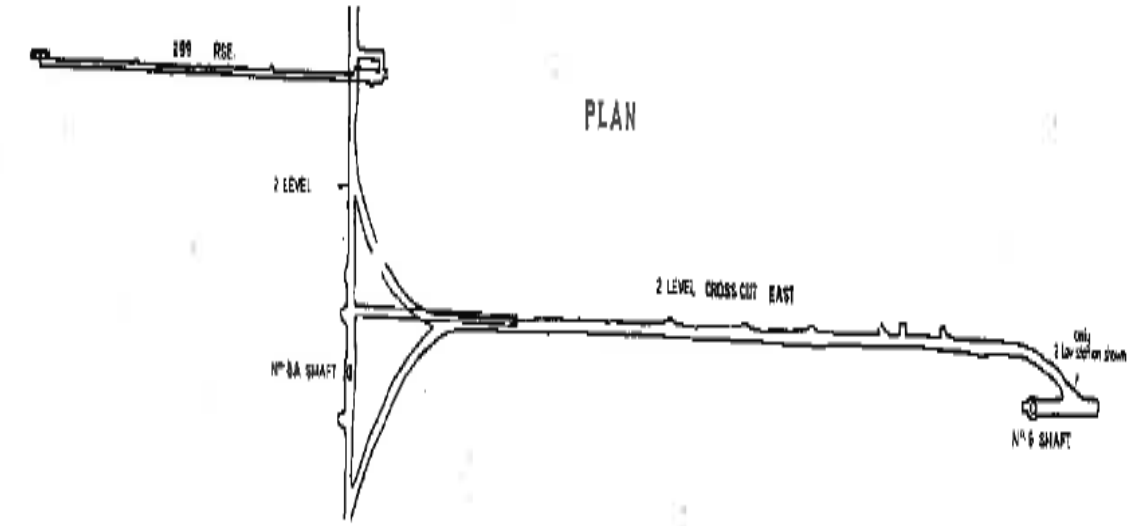


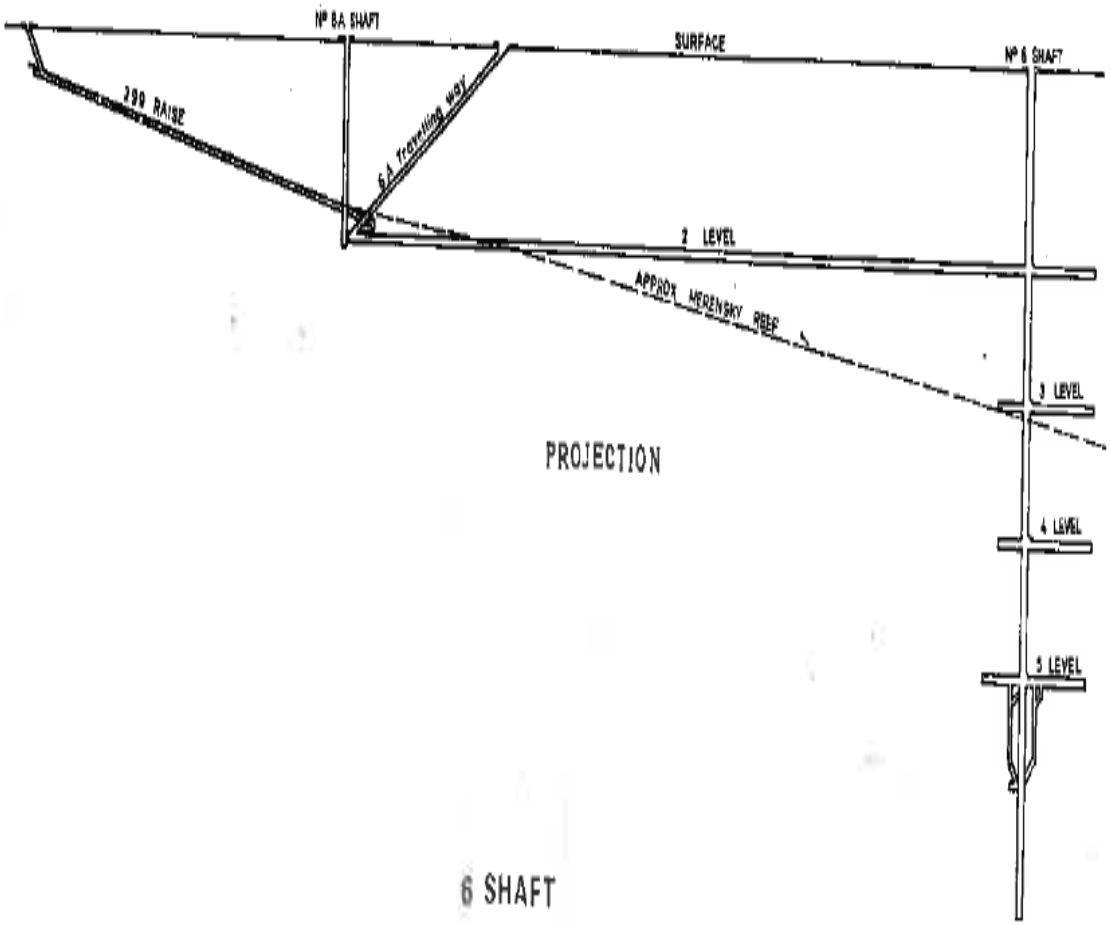


4 SHAFT

Situated , to explore lower levels , towards western boundary of lease area.
2 Vertical Shafts.
6 A , Elliptical , 4.9 m x 3.2 m , Headgear A – Frame , to 2 Level , 61 m below surface.
Lined with 750 mm concrete rings , spaced 4.5 m apart.
6 Shaft , diameter 4.5 m , sited 420 m down dip from # 6 A , to depth 258 m.
Providing second outlet and walkway for personnel ,
from bottom of # 6 A , travelling way , 35 ^{o} , raises back to surface.
Travelling Way carries columns for main exhaust , air and water.
Equipped shaft , installed with skeleton cage large enough to take heavier equipment.
Hoisted in this cage , broken development rock handled in 2.3 ton side – tippers ,
tipped , over a ramp on surface , into tipper trucks.
Employee hoist drivers on # 6 A Shaft operations.
Official hoist drivers on sinking of # 6 Shaft.
Main Rock – Hoisting Shaft sunk concurrently with development from subsidiary shaft.

6 Shaft.


299 RISE.
PLAN
2 LEVEL
2 LEVEL CROSS CUT EAST
Nº 6A SHAFT
Nº 6 SHAFT


Nº 6A SHAFT
SURFACE
Nº 6 SHAFT
299 RAISE
6A Travelling way
2 LEVEL
APPROX HERENSKY REEF
3 LEVEL
PROJECTION
4 LEVEL
5 LEVEL
6 SHAFT

10. Stoping. Page 14.

Twelve months after arrival of Sinkers at Mine ,
favourable progress of sinking and development of # 1 , # 2 , and # 3 Shafts,
facilitated earlier commencement of stoping , during 1968 November.
Union Corporation Strike – Track , with centre scraper gulley employed at Bafokeng.

Firmly – Bedded down fines in strike gullies provide a reasonable running surface ,
for 450 kg rubber – tyred cars , without use of tracks.

In conjunction with Anfex , and centralised loaders , concentrated drilling,
with holes drilled in a staggered pattern , top & bottom , with 300 mm burden , is standard.
Rigid support is formed through pillars , 3 m x 5 m , on a 30 m square grid ,
supplemented by 600 mm square matpacks and 150 mm sticks.

Shared contract , double – shift stoping , over period , 0600 am to 2200 pm , is practised.
Contract partners alternate morning and afternoon shifts.
Shift Supervisors alternate with their team.
Mine Overseers overlap their shifts with the morning and afternoon shifts ,
and cover a normal shift.

11. Processing.

11.1 Concentrator.

12 months from commencement of first foundation , Milling started in 1969 January.

Ore railed from shafts to transfer bin of 1 400 ton live load capacity ,
from where conveyed to mine silos.

Parallel circuits , each , comprise :

Two storage silos , of 1 400 ton capacity , feeding directly into mill , 4.3 m diameter x 5 m long ,
in closed circuit with a cyclone.
ROM run of mine ore is reduced in single stage milling to a product of required fineness.

Cyclone overflows to Flotation.
Two conditioners , in series , ahead of each bank of rougher flotation cells.
Three banks of sixteen 66 / 50 cells.
Tailings are cycloned .
Coarser underflow pumped directly to tailings dam.
Finer overflow gravitates to 46 m diameter tailings thickeners.
Dewatered thickened pulp is directed , with coarser cyclone underflow , to tailings dam.
Clear , thickener overflow , water recirculates to milling and flotation circuits.

Rougher concentrate is pumped to twelve 44 / 44 cleaner cells.
Cleaner tailings return to head of rougher circuit.
Cleaner concentrate pumped to thickeners at Smelter.

Construction started 1968 August.
First converter Blow 1969 May.

Flotation concentrate dewatered in 15 m diameter thickener.
Filtered on rotary vacuum filters.
Dried in coal – fired turbo – tray drier.
Together with limestone flux , concentrate is conveyed to furnace feed bin.
Concentrate + Flux conveyor fed into electric furnace.

Rectangular Furnace , 20 m long x 6 m wide , rated at 7.5 MVA,
has six 890 mm diameter, in – line , electrodes .
Concentrate and flux melted to form slag and furnace matte.
Tapped slag , granulated with water , is trucked to slag dump.
Matte , containing PGM , Nickel , Copper , Iron , Sulphur , is ladled to Pierce Smith Converter.
To remove Iron , low pressure , compressed air , is blown through molten furnace matte.
On completion of reaction , converter matte , granulated with water , is bagged.
Bagged converter matte is despatched to Springs Refinery.

Prior to discharging up stack , gases from electric furnace and furnace ,
are passed through electrostatic precipitator.

12. Reflection.

We are inspired by some of the progressive Union Corporation Innovations ,
introduced at Bafokeng , during an era when competitors may have been constrained ,
through their conservatism.

13. Reference.

Mr R C Bovell
Bafokeng Mine
1971 November.