

History of Geological Endeavours along the Eastern Lobe of the Bushveld Complex

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SYNOPSIS

The discovery of Chromitite and Platinum bearing ores are briefly discussed as well as the development of the geological understanding of the form and nature of the Bushveld Complex.

DISCOVERY OF PLATINUM DEPOSITS

The South African Mining and Engineering Journal of November 1906 reported that a Mr. William Betel had assayed several samples of chrome-iron ore from an olivine gabbro, which contained up to 1,2 dwts (Penny Weights per Short Ton) of platinum. Two years later, AL Hall and WA Humphrey published a report in which they noted that certain chromitite seams in the Rustenburg and Sekhukhuneland areas contained up to 1,5 dwts PGE (Platinum Group Elements).

Adolph Erasmus discovered the "Waterberg Load" in about 1923 through panning termite mounds. This led to the first platinum mine in South Africa, which was operated by Transvaal Platinum Limited between 1924 and 1926.

Merensky Reef

During June 1924 a certain Andries Lombard panned native platinum from stream sediments on his farm Maandagshoek. The samples were sent to Hans Merensky who had it analyzed and identified as platinum. Merensky then persuaded two friends, Becker and Baerecke to finance an exploration programme and so the Lydenburg Platinum Syndicate was formed with each party contributing 500 pounds.

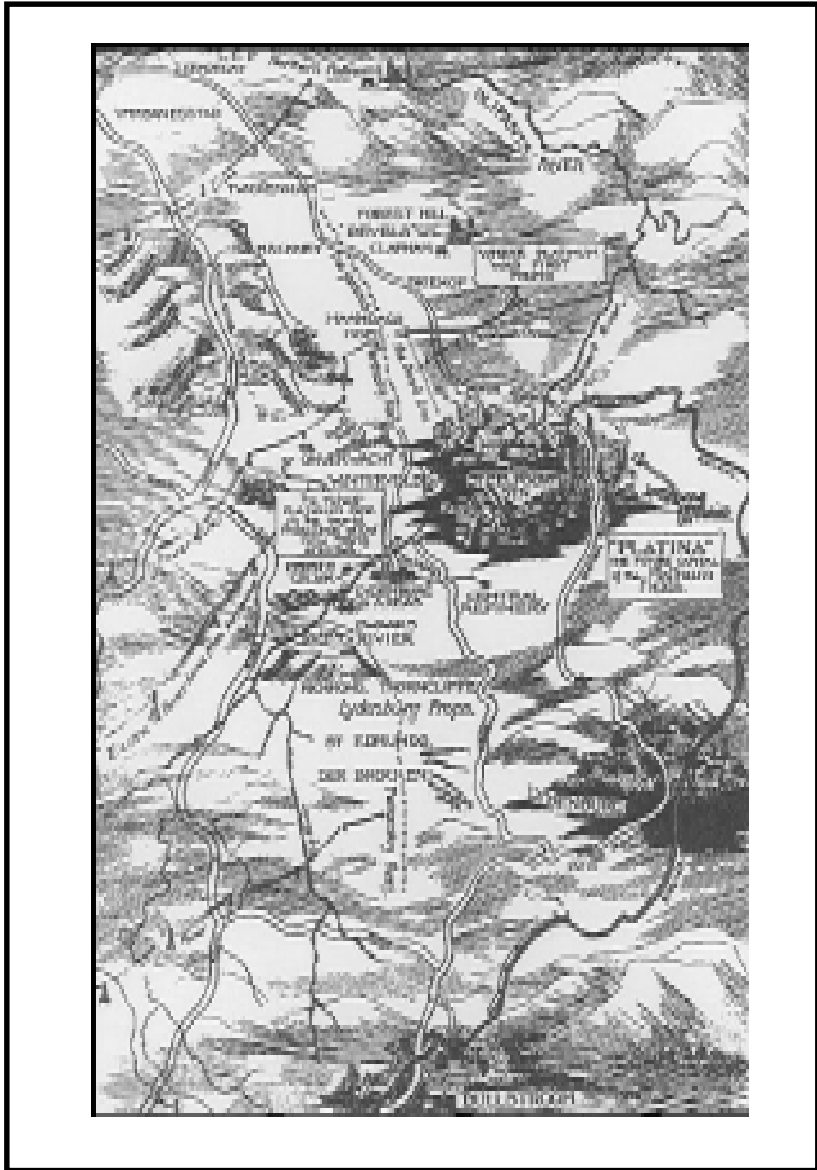
Lombard discovered the reef in September 1924 in a stream section close to the southern boundary of Maandagshoek. In the words of Merensky "..... a band of grayish-green norite varying in thickness up to 40 feet and carrying in its upper portion some gold and above all, platinum. The first assay values ranged from 2 to 4 dwts of platinoids. This ore body proved as remarkably persistent that it could be followed within a few days through several farms north of Maandagshoek. In the first days of October the continuity of the same ore-body was established to the south of the Steelpoort River". The reef was initially called the Lombard Reef but on the insistence of Lombard and the Schoeman brothers, K was renamed the **MERENSKY REEF**.

Pipe Deposits

After the formation of the Lydenburg Platinum Syndicate, Merensky took to the veld and commenced his fieldwork assisted by Lombard and two Schoeman brothers. Within three days they traced the source of the platinum panned by Lombard to small kopjes of pyroxenite and associated ultra basic rocks on the farm **MOOIHOEK**. The source was the **MOOIHOEK DUNITE PIPE**, which was later opened up and started producing metallic concentrates during 1927. Schoeman remembered that there was a similar kopje on the farm of Driekop. Rock samples from this kopje proved to be identical to those of the Mooihoek pipe.

In the meantime a prospector named F W Blaine employed by the Transvaal Consolidated Land and Exploration Company (TCL) discovered the **ONVERWACHT PLATINUM PIPE** through grains and even nuggets of native platinum that he had panned. In 1926 the Onverwacht Platinum Mine came into operation and mined until 1929 when the grades dropped below an economic level. To this day, some of the highest ever-recorded individual assay values were recorded here in the Onverwacht Platinum Pipe - 1 213 dwts. per short ton (2 086g/ton).

Over sixty separate occurrences of hortonolite-dunite have been discovered in the Critical Zone of the Bushveld Complex. So far only two have been found to be of any economic worth - the Mooihoek



"... The Lydenburg Platinum Field: A pictorial map depicting the present and visualizing the future"

and Onverwacht Pipes. The Driekop Pipe is per definition not a hortonolite-dunite pipe but an example of the occurrence of platinum in segregations of iron-rich Dunite and wehrlite.

Geology of the Onverwacht Platinum Pipe

The pipe is an irregular carrot-shaped segregation of hortonolite-dunite and hortonolite-wehrlite within a much larger body of olivine-dunite that exhibits a transgressive relation with the surrounding pyroxenites.

The body is inclined at an average angle $780^{\circ} 30'$ in a direction South 280 East or in other words roughly at right angles to the psuedostratification of the Bushveld rocks.

The olivine-dunite enclosing the hortonolite-dunite "pipe" exhibits fairly advanced serpentinisation and is traversed by veins and seams of dense magnesite. These occupy three joint sets, two near vertical and one horizontal. The veins become thinner in depth and disappear altogether below 92 metres.

The main body of hortonolite-dunite measures roughly 19 meters across at surface with a coarse-grained core of 15 meters. Horizontal and vertical seams and veins of quartz, chalcedony and opal up to 10cm thick were much in evidence between surface and the 50ft level. The contact between the main body and the olivine-dunite was extremely irregular with offshoots from the main body transgressing into the surrounding host rock.

Below the 350ft level the main body split into three smaller branches or roots. The biggest of these persists below this level as a continuous body to the greatest depth the mining activities has attained on the 755ft level. The other two roots are replaced below the 450ft level and consist only of irregular patches of hortonolite-dunite.

Irregular tabular bodies of chromitite were intersected at 250ft. Originally it was thought that these bodies represented remnants of the LG6 Chromitite Layer (Steelpoort seam), which occurs at more or less the same horizon in the surrounding pyroxenite host

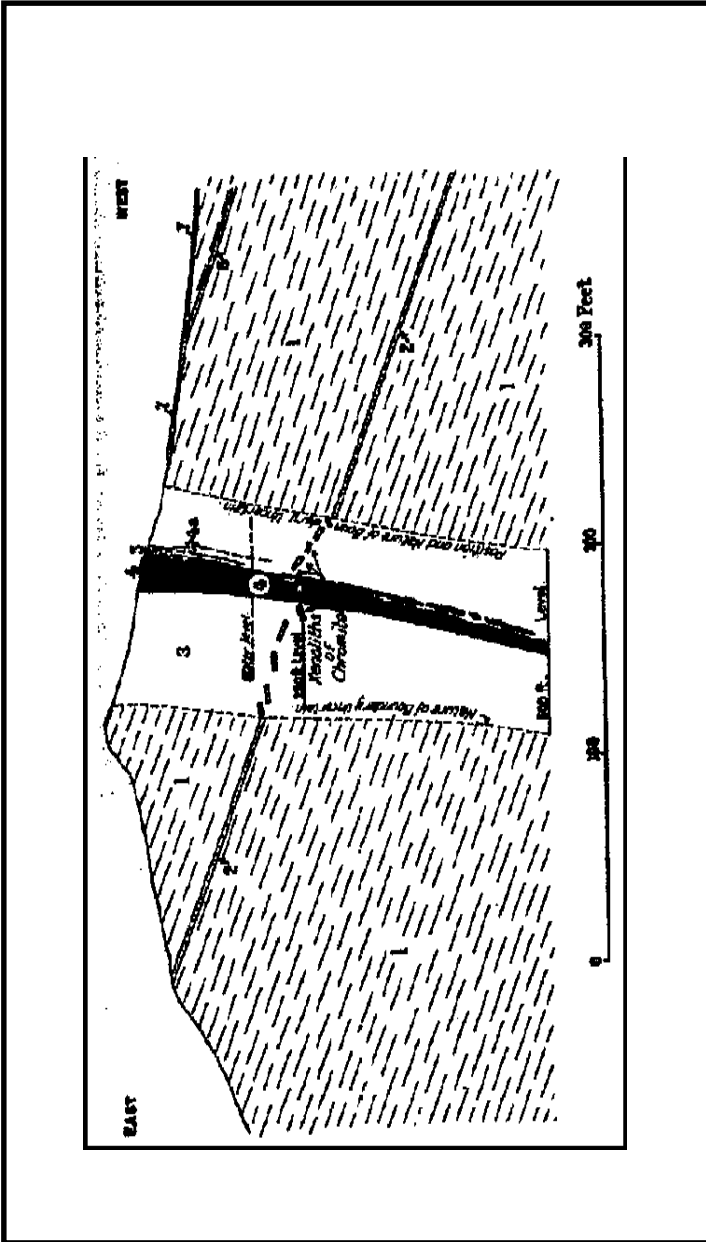


Figure 1
 Geological Section the Onverwacht Platinum Pipe

rocks. The highest assay values were struck in the vicinity or on the contacts of these xenoliths.

The richest part of the pipe was the core with the values decreasing towards the margins. The best average values were encountered on the 250ft level with an average of 18.4 dwts/short ton (31.65g/t) over a pay area of 210 square meters. Below this level the grades decreased steadily and between 550 feet and 700 feet the pipe was practically barren. At 700 feet good values were again struck and averaged 9.5 dwts/ton (16.34g/t) over 39 square meters. On the 800ft level much lower values were again encountered.

Mining of the pipe deposits

Initially the pipes were quarried down to a depth of 10 - 25m from surface. Below this Wagner described the mining as follows: "Three compartment shafts were sunk well outside the possible areas of enrichment. From these shafts cross-cuts are driven at intervals of 100 feet to intersect the 'pipes'. From the cross-cuts, levels were opened up and these in turn were connected by vertical development winzes sunk either within the 'pipes' or just outside them."

At Onverwacht a method of overhand stoping was employed between the levels, which was 50 feet apart. Backfilling of the excavated area was done using waste from the development winzes. Wooden ore passes were constructed in the waste to allow broken ore to be transferred to the level below for tramping and hoisting.

DISCOVERY OF CHROMITE IN THE EASTERN BUSHVELD

The occurrence of chromite outside Russia was noted in 1799 at La Bastide de la Carrade near Gassin in France. In South Africa chromite was first noted in 1865 by German explorer Carl Mauch in outcrop along the Hex River in the Rustenburg district. The prominent outcrops in the Eastern Transvaal must have been observed by the Voortrekkers and early settlers, but these pioneers were doubtless more interested in the acquisition of land. These deposits have been identified as such by the turn of the century.

The earliest official record of chromium and iron ore in the Bushveld Complex is contained in the Annual Report for 1898 issued by the State Geologist of the former South African Republic, Professor GAP Molengraaff. The first report devoted entirely to the chromite deposits appears to have been published in 1908 by Drs AL Hall and WA Humphrey in the Transactions of the Geological Society of South Africa, Volume XI. Dr Hall again dealt with the chromitite and magnetite bands of the Lydenburg district in his Annual Report of the Geological Survey (Transvaal) of 1909 and referred to the exposure of an impressive series of stratified layers at a place known as Dwars River.

A Geological Survey map published by Dr Hall in 1911 clearly illustrated the chromitite occurrences of Sekhukhuneland in the Eastern Bushveld, while a detailed geological, petrographical and chemical description of the chromitite layers was published in 1923 by Dr. PA Wagner in the South African Journal of Science, Volume 21.

Early Mining

Chromite mining in South Africa apparently began during the First World War, but there is no official record of production until 1921. By word-of-mouth, a certain HW Pursglove mined ore on the farm of Mooihoek 255 KT during 1917 and sent a consignment of 200 tonne to the British Munitions Board, which was not accepted because of the low Cr/Fe ratio of 1,5:1. According to another oral report, a Mr. Findlay initially mined chromitite on the nearby farm Goudmyn 337 KT in 1916.

The first company established to produce chromite in the Union of South Africa was the Transvaal Chrome & Magnesite Syndicate Ltd. The company was registered in Cape Town during 1918 to mine on the farm Jagdlust. It would seem that nothing came of this prospect.

In 1931, a M Hersov founded the African Mining & Trust Co. (Pty) Ltd., to mine chromite on the farm Onverwacht after closure of the Onverwacht Platinum Mine.

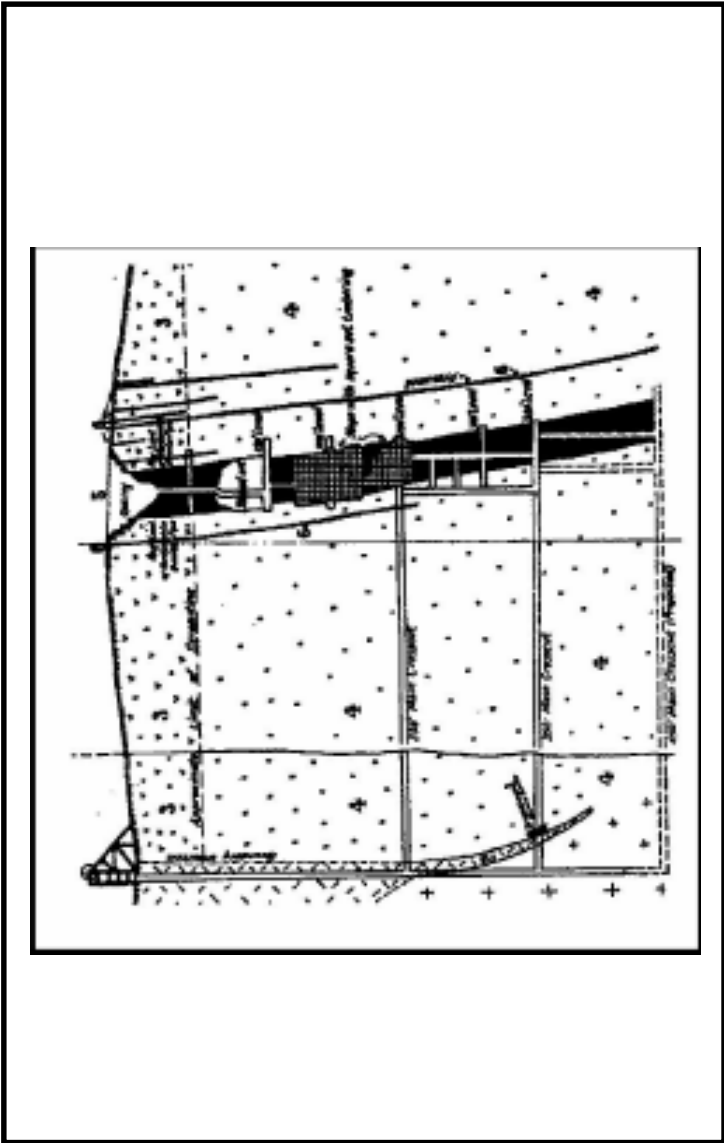


Figure 2

Section through the Mooihoek Platinum Pipe. The Overwacht Pipe was mined in similar fashion.

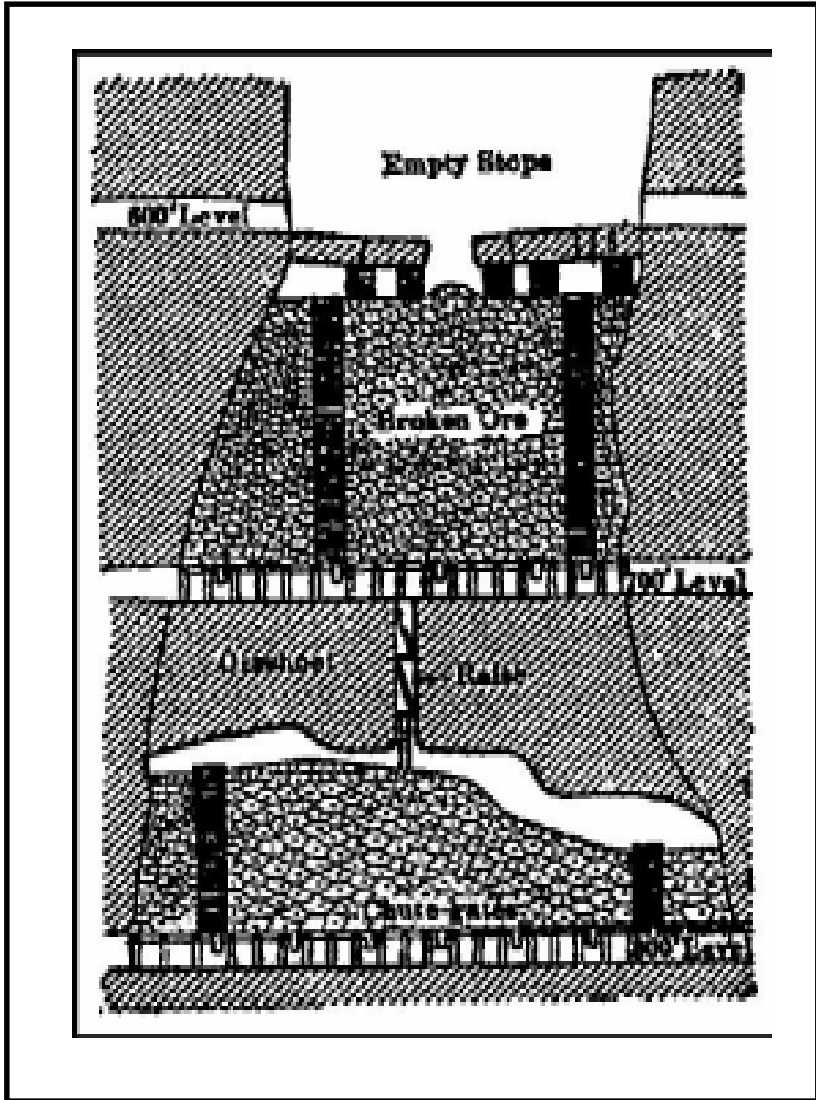


Figure 3
Detail of underground stoping

HISTORY OF SOME OF THE INITIAL CHROME MINES IN THE EASTERN BUSHVELD

Jagdlust - Jagdlust 416 KS

Jagdlust is one of the oldest and more known chromite mines in South Africa with the famous Cameron Section traversing the property. The first company officially established to produce chromite in South Africa was the South African & Magnesite Syndicate Ltd., which was registered in Cape Town in 1918 to mine on the farm Jagdlust. Nothing came of this venture. Mining on Jagdlust started in 1936 by African German Investments Ltd, which was later sold again to Dr Hans Merensky. Hans Merensky again sold the mine to Union Carbide of America in 1952 for 500 000 pounds. The mine remained in the bands of Union Carbide up to 1986 when all the Union Carbide assets were taken over by General Mining Union Corporation (Gencor). The mine produced on and off since its inception in 1936 and attained a maximum average production in 1987 - 1992 of 6 850 tonne month. Despite the high grade ore produced here the distance to the nearest railhead at Steelpoort proved to be too great and the mine was finally stripped during 1993.

Groothoek - Groothoek 256 KT

African Mining and Trust Company Ltd carried out prospecting operations on the farm Groothoek during 1937. They obtained a mining lease from the Government and together with Union Corporation Ltd formed a new company Chrome Mines of SA Ltd, a subsidiary of Union Corporation Limited. Mining operations commenced during 1937 with the sinking of the GH Anderson incline shaft in the southern portion of Groothoek. Production costs, including mining and sorting at the time was stated as Shillings (50 cents) per ton of chromitite. General Mining acquired the Groothoek Mine during 1974 with all the other holdings of Chrome Mines of SA Ltd. The Groothoek Mine extend across the farms of Groothoek 256 KT, Driekop 253 KT and Twyfelaar 119 KT. The Groothoek Mine was finally closed towards the end of 1992.

Mooihoek - Mooihoek 255 KT

As mentioned above, a certain Mr. H W Pursglove mined chromitite on the southern portion of Mooihoek farm during 1917. His venture came to an end when the British Munitions Board turned his consignment of 200 tons of chromitite down because of the low Cr/Fe ratio.

It is not known what happened between 1917 and 1940 when African Metals Corporation (Amcor), a subsidiary of Iscor, began mining on Mooihoek. The first stainless steel produced in South Africa was in 1943 and presumably some, if not all the chromite came from Mooihoek Mine.

In 1975 Amcor merged with South African Manganese to become SA Manganese - Amcor Ltd (Samancor). Samancor in turn was taken over by Gencor in 1983 - 1984.

Montrose - Hendriksplaats 281 KT

The farm Hendriksplaats was surveyed in 1907. Mr. Bill Holmes started the original Montrose Mine on the adjacent farm of Mooihoek. The controlling company was the Montrose Exploration Co. A certain Mr. Guido Sacco prospected on Hendriksplaats in the early 1930's but it is not known if he ever mined or even owned any mineral rights on Hendriksplaats. There is evidence of shallow mining on the southern portion of Hendriksplaats on the boundary with Onverwacht. These mining activities presumably took place during the middle 1930's. In 1954 General Mining and Finance Corporation Ltd entered the chromite mining industry by purchasing Strathmore Investments Ltd, the owners of the Montrose Exploration Co.

Mining must have started during the late 1950's or early 1960's.

Onverwacht - Onverwacht 292 KT

Mr. Hersov started the Onverwacht Chrome Mine after the closure of the Onverwacht Platinum Mine in 1931. His controlling company was the African Mining & Trust Co. (Pty) Ltd. Presumably this company was owned by the Transvaal Consolidated Land & Exploration

Company (TCL), which in turn was owned by Rand Mines. Rand Mines Ltd was formed in 1893 to develop gold-mining interests on the Witwatersrand. The founders of Rand Mines had taken the precaution to register mineral and surface rights over a large number of farms in the eastern and western Transvaal in case their expectations from the Wits goldfields failed to materialize.

Onverwacht Section was operated intermittently up to the end of 1979 when the mine was finally left to be flooded by ground water. Mining operation was hampered, especially on the southern side, by adverse structural conditions associated with the Onverwacht Platinum Pipe.

Doornbosch-Dunn-Steelpoort - Doornbosch 294 KT

The Winterveld Chrome Mine (TCL) was established in 1956 after an agreement with a Mrs. LR Josephthal's, Johannesburg Ore Corporation. (Pty) Ltd. The Dunn shaft was the first shaft to be sunk. The Doornbosch Section was started in 1975 and the Steelpoort Section in 1978. The Onverwacht Chrome Mine was also regarded as one of the Winterveld Chrome Mine sections.

Chrome Corporation's old mine next to the Steelpoortriver became one of the Winterveld Chrome Mine sections when Union Carbide's lease was not renewed in 1976.

Rand Mines sold 99.9 per cent of the shareholding in Winterveld Chrome Mine (Pty) Ltd to Vansa Vanadium SA in 1986. Rand Mines operated the mine up to 1991 when all the Rand Mines chrome interests passed hands to Gencor.

Chrome Corporation - Winterveld 292 KT

In 1929 TCL leased the mining rights over a portion of the farm Winterveld to the Great Western Chrome Co. Ltd. This lease was taken over by Chrome Corporation SA (Pty) Ltd when it acquired the assets of the Great Western Chrome Co. Ltd in 1929 and in 1932 the ownership passed to the Union Carbide Corporation SA (Pty) Ltd through its Southern Rhodesian subsidiary, African Chrome

Mines Ltd. Ucar operated the mine until 1976 when they did not renew the mineral lease and the mine passed back to the hands of Winterveld Chrome Mine, which continued operations up to the end of 1981.

The mine is currently flooded and was used previously as an underground reservoir.

Annex - Annex Grootboom 335 KT

In, The Mineral Resources of the Union of South Africa, of approximately 1935, under the heading for Chromium, it was reported that chrome ore has been mined in the past on Annex Grootboom No 473. No tonnage or grades were mentioned.

EN Cameron and HE Abendroth compiled a plane table geological map in 1952 of a portion of Annex Grootboom. It is however not known in whose employment they were. Cameron was a researcher from the University of Wisconsin USA, and may have carried out academic research work. There could also have been a link between himself and Ucar. Another geologist IS Hollingsworth compiled a comprehensive report on a drilling program drilled on Annex Grootboom by Union Carbide Exploration Corporation in 1973. The project amounted to \$40 000 and Hollingsworth final remarks was, "My impressions are that the low Cr:Fe ratio, marginal Cr²⁰₃, and minimal tonnage make Annex less attractive for a mining operation than the Jagdlust area where reserves and grades are much better."

As mentioned earlier all the Ucar chromium assets were taken over by Gencor in 1986.

Twefontein - Twefontein 360 KT

Several old adits and stopes exist on the southeastern and northern portion of Twefontein farm. It is not known when or by whom the original mining activities were carried out. In The Mineral Resources of the Union of South Africa of approximately 1935 under the heading of Chromium, it was reported that hard lumpy ore was mined on the farm Twefontein No 35 by African Mining & Trust (Pty) Ltd.

Assay values are also given for the hard lumpy Tweefontein ore:

Cr ₂ O ₃	43.38%
SiO ₂	1.70%
Al ₂ O ₃	18.65%
FeO	25.72%
MgO	<u>10.66%</u>
	100.11%

Various Models Depicting the Shape of the Complex (Figures 4 - 10)

Molengraaff (1905) envisaged the complex as one big "sourcer shaped" body, called a laccolite or laccolith. Geological knowledge at the time was limited and in its infant stage. One single feeder channel was postulated.

Alex du Toit (1954) also envisaged the continuation of the layered sequences across the full extent of the complex, suggesting a much larger volume of layered rocks than is believed to be the case today. The Rooiberg fragment was seen as a dislodged portion of the Transvaal floor rocks (older than the complex).

Cousins (1959). Geophysical data (Gravity) come into play and the first evidence is put forward to suggest that the eastern and western lobes of the complex probably are not connected in depth. He also interpreted the Layered Suites as a sequence of lava injections.

Understanding of the complex expanded rapidly after 1959 and numerous researchers undertook the task of gathering scientific data to promote their sometimes highly differing theories on the emplacement and shape of the complex

Meyer and de Beer (1987) using geophysical data (electrical sounding and gravity) postulated the eastern and western limbs as wedge shaped dipping bodies reaching depths of 15 km.

Sharpe et al (1981) brought forward the concept of major conical fractures developed in the crust as the result of a mantle diaper rising in the center of the underlying Transvaal Basin. Gravity

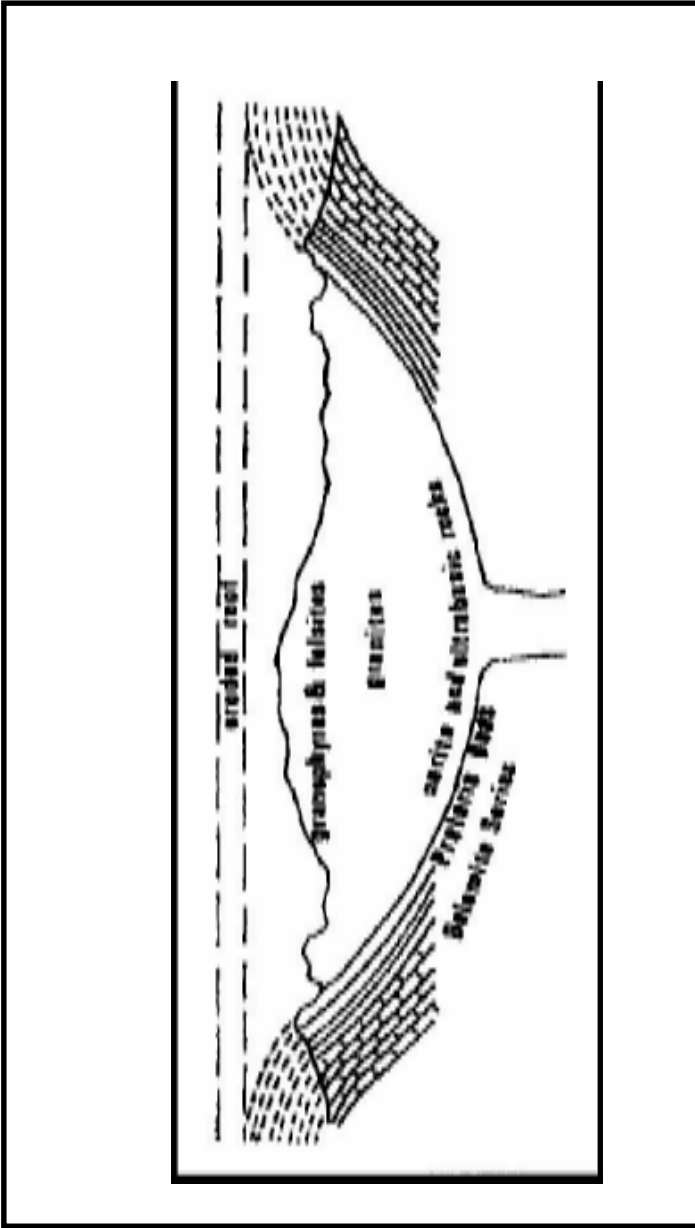


Figure 4

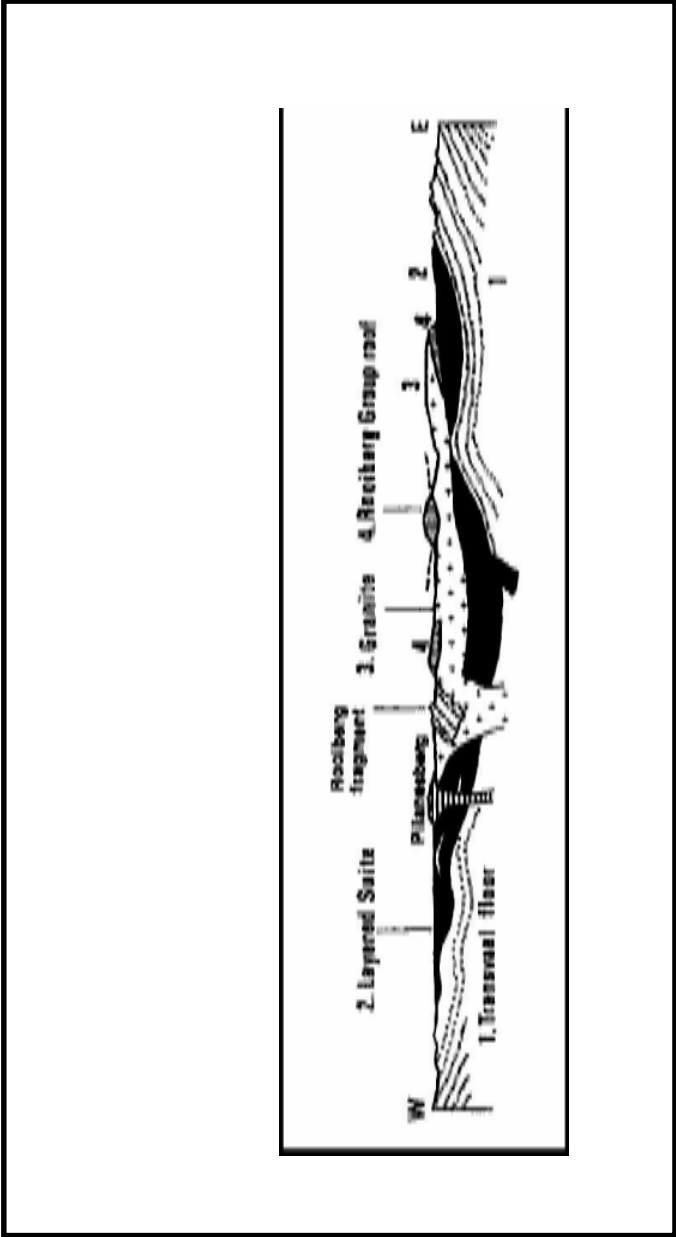


Figure 5

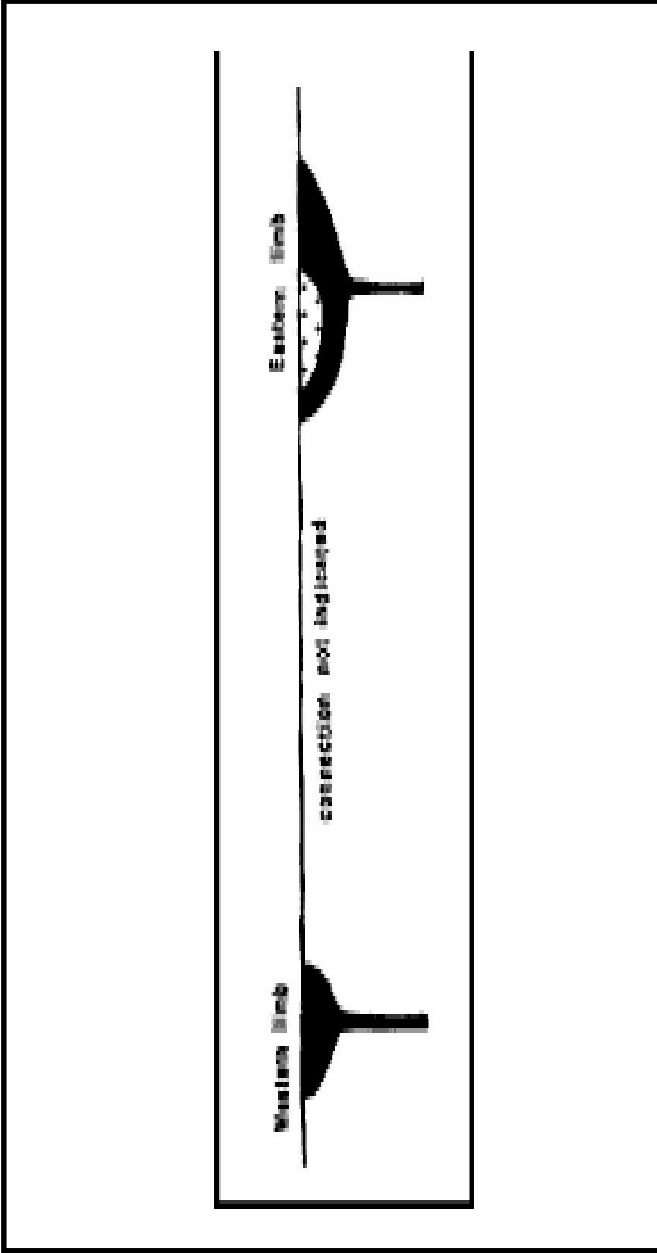


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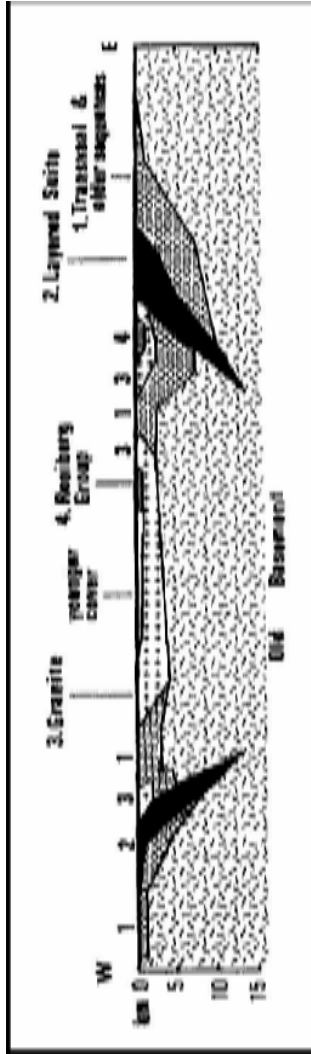


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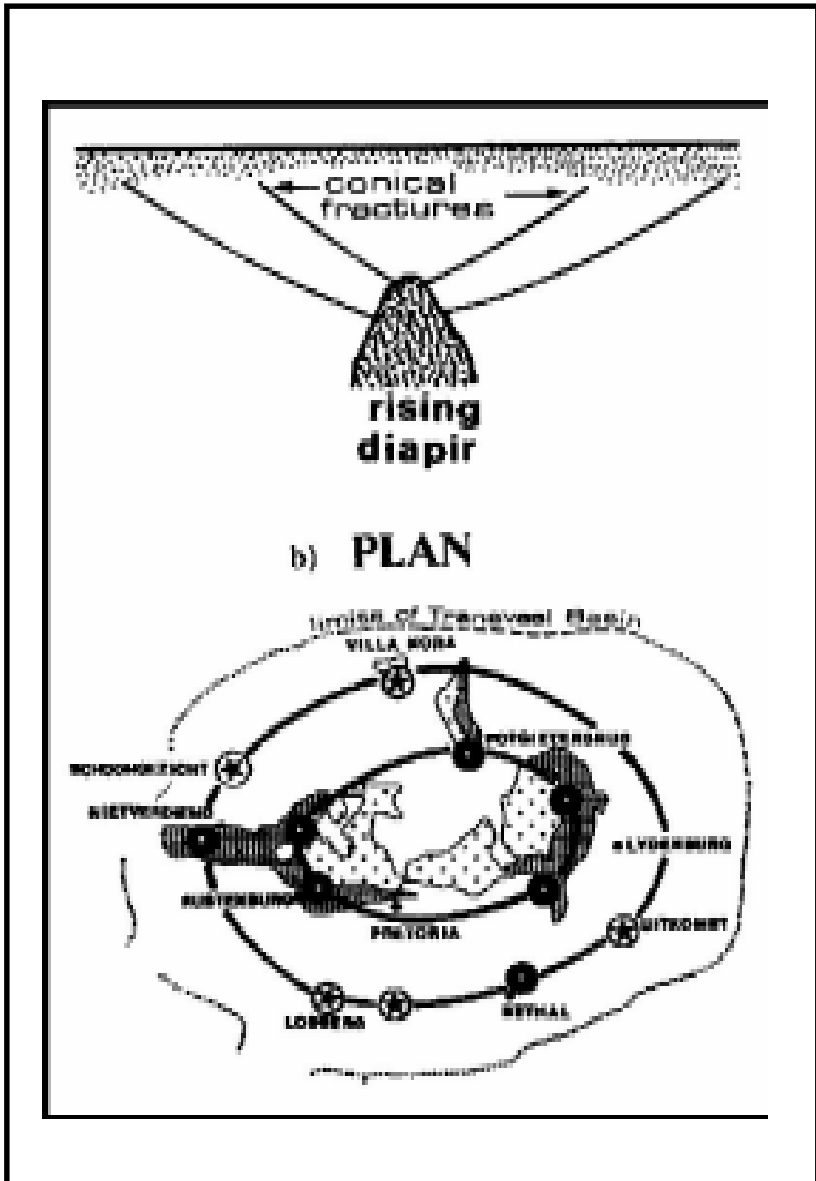


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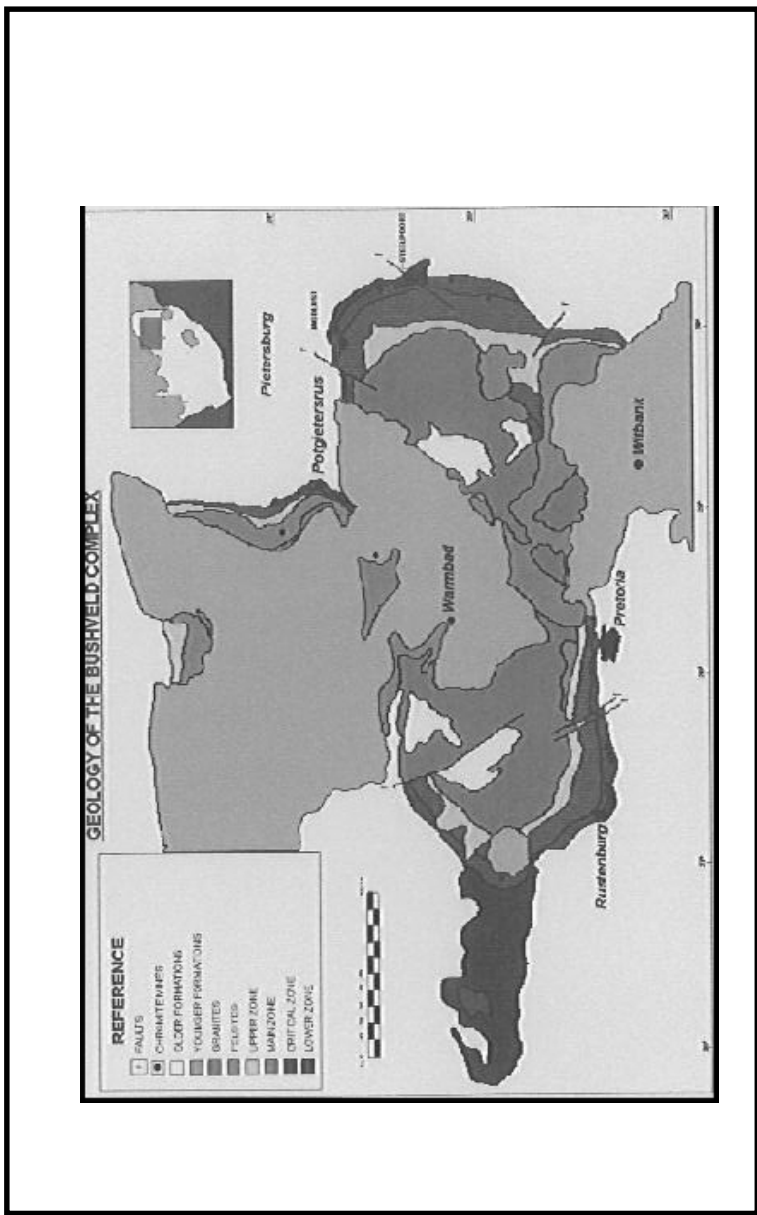


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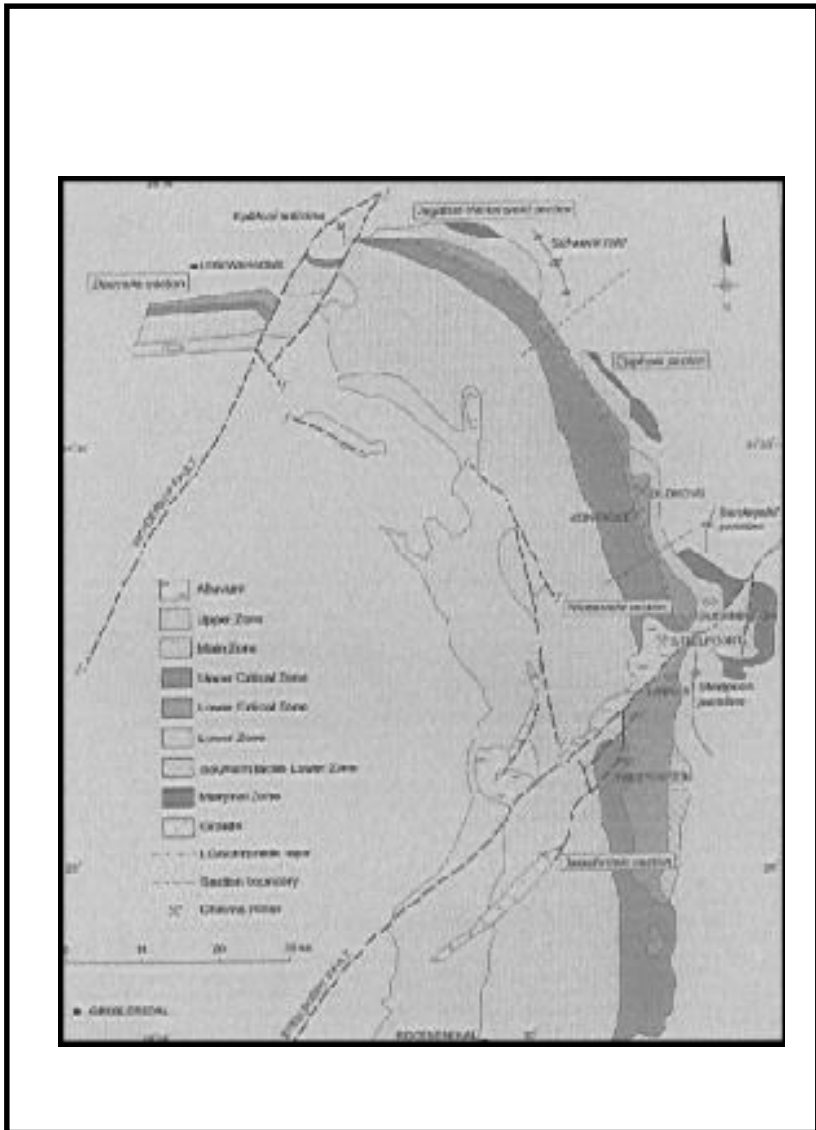


Figure 10

highs spread (full circles) along a girdle intersecting the major outcrops of the Layered Suite. A second girdle intersects the satellite bodies surrounding the complex.

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