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THE GEOLOGY OF THE COUNTRY AROUND PRETORIA

AN EXPLANATION OF SHEETS 2527DA, DB, DC, DD AND 2528CA, CB, CC, CD

compiled by

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THE GEOLOGY OF THE COUNTRY AROUND PRETORIA

ABSTRACT

The area is bounded by latitudes $25^{\circ}30'$ and $26^{\circ}0'$ S and longitudes $27^{\circ}30'$ and $28^{\circ}30'$ E and is approximately $5\ 440\ \text{km}^2$ in area. It is densely populated around Pretoria and well served by roads and railways. Altitudes usually range between 1 030 and 1 640 m, but prominent ridges are the Witwatersberg and the Magaliesberg, the latter attaining an altitude of 1 830 m. The present surface is dissected pre-Karoo topography with superimposed drainage by the Crocodile and Pienaars Rivers.

The Archaean Complex consists largely of granitic rocks such as biotite, tonalite, trondjemite, granodiorite, and gneissic and migmatitic varieties. The pre-granitic rocks are included in the Swaziland System and the Jamestown Igneous Suite. The Swaziland System is poorly developed and consists of quartz-sericite schist. Most of the schist, particularly below the Black Reef Series, is sheared granite and possibly younger acid lavas and sediments. The Jamestown Igneous Suite is largely composed of greenstones but pyroxenitic, gabbroic, dioritic and hybrid rocks also occur.

The post-granite pre-Transvaal formations form incomplete successions and occupy relatively small areas. The Dominion Reef System is represented by felsite and quartz porphyry, the Hospital Hill Series of the Witwatersrand System by quartzite and slate, in a synclinal structure, and the Ventersdorp System by argillaceous and arenaceous sediments with interbedded coarse clastics. Local occurrences of quartz porphyry under the Black Reef Series may belong either to the Dominion Reef or Ventersdorp Systems.

The Transvaal System rests unconformably on the Archaean granite and Ventersdorp System and contains the entire succession from the Black Reef Series to the Smelterskop Stage. It is also locally represented in xenolithic occurrences in the Bushveld Igneous Complex.

The Black Reef Series consists of conglomerate, grit and quartzite followed by alternating shale and quartzite and locally grades into the overlying Dolomite Series which is a thick succession of dolomite with interbedded shale and arenaceous sediments and, particularly near the top, numerous chert bands. Large masses of chert breccia accumulated during several erosion periods. The contact between the Dolomite and Pretoria Series is locally characterized by transition beds of alternating quartzite, conglomerate, shale and chert. The Timeball Hill Stage commences with an argillaceous succession (shale, siltstone, slate) followed by alternating beds of shale, quartzite and subgraywacke, including the magnetic quartzite. The Daspoort Stage is subdivided into a lowest substage of shale with interbedded oolitic ironstone, calcareous layers, tilloid and quartzite; the Ongeluk Substage largely of lava and pyroclastics; and an upper substage of shale with interbedded ferruginous and quartzitic layers and oolitic ironstone followed by the main quartzite at the top. The Magaliesberg Stage is a thick succession of shaly beds with interbedded carbonaceous, calcareous, cherty and, more rarely, agglomeratic layers, overlain by the main quartzite at the top. The beds of the Smelterskop Stage are as a rule invaded and transformed into metamorphic rocks by the Bushveld Igneous Complex and post-Waterberg intrusions. They are characterized by rapid alternation of shale, siltstone, quartzite and subgraywacke, locally with thin bands of limestone, dolomite and lava.

The Waterberg System occupies a broad syncline and consists largely of quartzitic sandstone and grit with conglomerate, breccia and, more rarely,

shaly bands. The patchy distribution of the Karoo System is mainly determined by pre-Karoo depressions and the beds are in general poorly exposed. The Dwyka Series consists of tillite, conglomerate and sandstone and the Eccca Series of sandstone, grit, conglomerate and shale, locally with coal seams. Surface deposits include alluvium, gravel, sand, scree, ferricrete and surface limestone.

The intrusive rocks in the area display a great variety in age, origin and composition. Dykes of pre-Transvaal age in the Archaean granite are composed of lamprophyre, diabase and quartz felsite. The Bushveld Igneous Complex of post-Transvaal age occupies the northern and north-western portions of the area. Its emplacement was preceded by the extrusion of felsite on the uppermost beds of the Smelterskop Stage and by the intrusion of numerous sills of diabase and related rocks in the Pretoria Series. In the western portion of the area the sills contain noritic, pyroxenitic and peridotitic differentiates.

The basic portion of the complex was emplaced before the acid portion. The layered basic and ultrabasic rocks are chronologically subdivided into basal norite, pyroxenite, anorthosite, norite, porphyritic pyroxenite, gabbro and ferrogabbro units. Belts of mostly metamorphosed sediments of the Smelterskop Stage intervene in the layered sequence near the floor and between the basic and acid portions of the complex. Assimilation of the floor has led to the formation of hybrid and migmatitic rocks which are associated with the basal norite unit. North of Pretoria the pyroxenite, anorthosite, norite and porphyritic pyroxenite units, including chromitite bands and the Merensky Reef (pegmatite sub-unit of the porphyritic pyroxenite unit) are not developed. North-east of Pretoria the basal norite, gabbro and ferrogabbro units terminate against the Smelterskop beds. The gabbro unit contains noritic and locally anorthositic and pyroxenitic rocks near the base. In the ferrogabbro unit magnetite bands, troctolite and anorthositic rocks occur and, at the top, locally also intermediate rocks such as ferrodiorite and syenite.

Pipes of ultrabasic pegmatoids, harzburgite, dunite, serpentinite, pyroxenite and magnetite are intrusive in the layered basic and ultrabasic rocks.

The younger portion of the complex consists of granophyre and granite. The latter is subdivided into coarse-grained and medium-grained varieties.

Metamorphic rocks within the complex and in the metamorphic aureole south of it are andalusite or chiastolite slate, cordierite hornfels, different types of calc-silicate hornfels, feldspathised quartzite and "leptite".

Intrusions of post-Waterberg age consist of numerous dykes which partly belong to the dyke swarm radiating from the Pilanesberg, and several complexes of predominantly alkaline rocks in the north-eastern portion of the area, namely the Leeuwfontein and Franspoort Complexes and the Roodeplaat Complex or volcano. Other intrusions are transgressive sills of basic and hybrid rocks, the Derdepoort diatrema and small kimberlite pipes. The dykes are mainly of diabase with gabbroidal varieties and syenitic rocks, i.e. syenite, foyaite or tinguaitite, and lamprophyric varieties. They are partly composite. The alkaline complexes contain a great variety of rocks ranging from syenodiorite, syenite and umtekite to undersaturated rocks such as foyaite, urtite and jacupirangite. The effusive rocks are trachyandesite, trachyte, felsite, breccia or agglomerate and tuffaceous rocks. Breccia and carbonatite are the chief constituents of the Derdepoort diatrema. The basic and hybrid rocks are partly granophyric and grade into pseudofelsite, which is considered to be a product of concomitant diffe-

rentiation of the basic magma and assimilation of quartzite.

The ages of the following suites have not been definitely established: intrusive bodies or pipes of pyroxenitic, gabbroid and hybrid rocks in the Archaean granite, sills of syenitic to intermediate rocks mainly in the Dolomite Series, and some doleritic dykes. A few dykes and sills of dolerite are of post-Karoo age.

The main structural features are the southern portion of the Transvaal basin, which has been invaded by the Bushveld Igneous Complex, and a dome-like structure with a core of Archaean granite in the south. The latter probably originated as a dome during and after the emplacement of the Bushveld Igneous Complex. Finally, large-scale faulting took place in the vicinity of Pretoria and to the south-east. Oblique tear faults and local overthrusts were formed by shearing couples. Faulting has not affected the dykes of the Pilanesberg dyke system.

Several mineral deposits have been exploited, for instance gold and iron at the old Waaikraal Mine, lead at the old Edendale Mine, coal at the old Rogerston Colliery, small copper, silver and mercury deposits east and north-east of Pretoria, talc deposits on Hennopsrivier 489 JQ, and South African jade on Buffelsfontein 465 JQ and Turffontein 462 JQ. At present the clay deposits on Olifantsfontein, Boekenhoutskloofdrift 286 JR and other localities are exploited for the manufacture of ceramics and bricks. Mineral deposits of potential economic value in the area are the vanadium-bearing titaniferous magnetite bands, the chromite bands, and possibly the platiniferous Merensky Reef in the Bushveld Igneous Complex.

The water-bearing properties of the formations differ considerably. Good aquifers are the Dolomite Series, quartzite and some shale bands in the Pretoria Series, the Archaean granite, and the norite and granite of the Bushveld Igneous Complex when deeply weathered and jointed. High yields are obtained from springs in the Dolomite Series, which are generally of the fracture type and occasionally also of the contact or barrier type.

I. INTRODUCTION

A. LOCATION AND AREA OF REGION

The 8 sheets (2527DA, DB, DC, DD and 2528CA, CB, CC, CD) are bounded by latitudes $25^{\circ}30'$ and $26^{\circ}0'$ S and longitudes $27^{\circ}30'$ and $28^{\circ}30'$ E and covers an area approximately $5\ 440\text{ km}^2$. It includes portions of the following districts: Pretoria, Brits, Rustenburg, Krugersdorp, Kempton Park, Cullinan and Bronkhorstspuit. The central portion is densely populated, containing the fast-growing capital and the town of Verwoerdburg. The rest is less densely populated and mainly devoted to agriculture with Brits as a farming and industrial centre in the north-west.

B. COMMUNICATIONS

The road network is continuously expanding as a result of the rapid growth of Pretoria and industrial development. Pretoria is also a railway centre from which several lines lead to the Northern, Western and Eastern Transvaal and the Witwatersrand.

C. PREVIOUS WORK

The present map is a revised edition of Sheet No. 1 which was published in 1929, with the explanation entitled: "The geology of the country surrounding Pretoria" by H. Kynaston, revised by L.J. Krige and B.V. Lombaard. The map and explanation are out of print and since their publication data on the geological and economic aspects have accumulated to such an extent that a revised edition is more than justified. Several others also contributed to the previous edition, notably A.L. du Toit, P.A. Wagner and S.J. Shand.

D. PRESENT INVESTIGATION

The revision of the area started in 1949. The following members of Geological Survey have taken part in this programme: L.W.R. Blom (1952, 1953); F.J. Coertze (1949, 1952, 1963); R. Cooke (1956); C.P. Fourie (1954); P.J. Loubser (1956); R.P.E. Morgan (1949); K.G. Seeger (1960); W.J. Smith (1956); A.A. Snyman (1954); R.F.H. Teichmann (1962); B.N. Temperley (1972, 1973) and H.N. Visser (1951, 1952).

Certain portions of the area have been investigated in more detail, mainly in connection with mineral deposits, foundation problems and underground water resources. In particular the dolomite area south of Pretoria has been the subject of detailed investigations, including detailed mapping, geophysical surveys and drilling programmes. The results of these special investigations are incorporated in part in the text and accompanying maps. The contributors are listed in Table 1.

The compilation of the data was carried out by H. Jansen, assisted by G. Schifano and M. D. du Plessis,

TABLE 1

Subject	Contributors
Dolomite area (dolomite and sinkhole investigation)	D.R. Pike, R. J. Kleywegt, H. Jansen, B. Sekirsky, T. Stratten, P. Roux, W. Rech, G. Schifano, T. Torre
City of Pretoria and area to the south (detailed surveys, also of excavations)	B.N. Temperley and staff, D.R. Pike and staff, M.D. du Plessis
Area around Pelindaba	J.W. von Backström, E.R. Magni
Engineering and foundation problems (see also dolomite area)	D.R. Pike, R. J. Kleywegt, A. van Schalkwyk, P. Roux, E.R. Magni
Underground water	J.F. Enslin, L.E. Kent, J.R. Vegter, T.E. Dicker
Clay investigation	K.P. Bennetts, W. Simpson, D.D. van Reenen
Magnetite in Bushveld gabbro	F.J. Coertze, F.S.J. de Jager

Table 1 (contd)

Subject	Contributors
Derdepoort diatrema	W.J. Verwoerd
Talc deposits	D.J.L. Visser.

Since the publication of the previous map and explanation, valuable contributions have been made by several authors not attached to the staff of Geological Survey. They also have been incorporated in part in the text and accompanying map. In the text reference is frequently made to publications of these contributors, which are also listed in the bibliography. Most publications by members of Geological Survey have appeared in the Annals, Bulletins and Memoirs of Geological Survey and in the Transactions of the Geological Society of South Africa. Less accessible, however, are the results of special investigations of portions of the area which are compiled in theses by students of the Pretoria University.

The subjects of the more important contributions since 1929 are as follows:

Jamestown Igneous Suite	- Hendriks 1963
Archaean granite	- Willemse 1933; Anhaeusser 1971
Witwatersrand and Ventersdorp Systems	- Hendriks 1963, - Button 1970
Transvaal System	- Coertze 1961
Pretoria Series	- Van Biljon 1949; Le R. Cilliers 1953; Visser 1969; Button 1969.
Bushveld Igneous Complex	- { Hall 1932; Lombaard 1934; Boshoff 1939; Nel 1940; Kuschke 1950; Steyn 1955; Willemse 1959; Coertze 1971
Leeuwfontein and Franspoort Complexes	- Toens 1952
Roodeplaat volcano	- Lombaard 1929; Venter 1933
Basic and hybrid rocks of post-Waterberg age	- Toens 1954
Derdepoort diatrema	- Verwoerd 1967
Pretoria dyke and other dykes	- Le R. Cilliers 1953
Iron ore deposits in the Pretoria Series	- Schweigart 1965
Chrome, iron and vanadium deposits of the Bushveld Igneous Complex	- { Schwellnus and Willemse 1943; Lombaard 1956; Cousins and Feringa 1964; Coertze 1971
Glass sand	- Meintjes and Nel 1947
Clay	- Simpson 1955; Bennetts 1965.

E. ACKNOWLEDGEMENTS

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Dr. J. Ferguson, University of the Witwatersrand, for a detailed petrographical description of a lamprophyre on The Willows 340 JR;

the management of Falconbridge Explorations Ltd for making available the results of a drilling programme on the Merensky Reef west of Brits, including assay values;

the Geological Department of Anglo-Transvaal Consolidated Investment Company Ltd for the results of a drilling programme south-east of Pretoria;

Dr. J.R. McIver and Dr. C.R. Anhaeusser, University of the Witwatersrand, for valuable suggestions in connection with several problems dealing with the Archaean granite, the Witwatersrand System and structures displayed by the latter.

II. PHYSIOGRAPHY

The following text is in part a summary of the geomorphological features of the area described by Kynaston (1929, p. 7-10) to which some new data on drainage and vegetation have been added.

A. TOPOGRAPHY

The most elevated portion of the area is situated along its southern boundary. The country displays a gradual regional slope to the north, the continuity of which is locally broken by hills and ridges of resistant rocks such as the chert bands in the upper Dolomite Series and the quartzite bands of the Pretoria Series. Prominent quartzite ridges are the Magaliesberg and Witwatersberg.

The highest portions of the Archaean granite attain a height of 1 640 m above sea-level and the Magaliesberg 1 830 m, whereas the lowest portion of the area around the Crocodile River north of Brits is approximately 1 030 m above sea-level.

The southern portion of the area approaches the Highveld in its characteristics, and forms undulating to hilly country. The western, central and eastern portions largely fall in the Middleveld and are also called "Bankeveld". This is characterized by roughly parallel hills, ridges and escarpments with longitudinal valleys between. The northern portion forms part of the Bushveld, which in this area is occupied by comparatively flat to undulating country, the monotony of which is relieved by ridges of granophyre and gabbro. The "Pyramid" line of hills increases in height above the surrounding flats from east to west, i.e. from 120 m at Bon Accord to 300 m at Kareepoortberg.

In the eastern portions the topography is less differentiated and there is a very gradual change from one type to another. In the north-eastern portion low-dipping resistant Waterberg sediments form a plateau-like landscape with steep valleys leading to wide flat sand-covered depressions.

The present topography is partly a fossil pre-Karoo one. The latter displays approximately the same direction and degree of slope as the present topography, which is reflected by the average altitudes above sea-level of erosion remnants of the Karoo System. Apart from local irregularities in the pre-Karoo topography, in particular in dolomite areas and around resistant quartzite ridges, the pre-Karoo land surface may have approached a peneplain. Although it has been dissected during and after denudation of the uplifted Karoo beds, its original outline is more or less preserved near or on the even crest lines of the Magaliesberg and Witwatersberg and also in areas between the ridges, which have not been affected by erosion by back-cutting longitudinal streams. On Hartebeesthoek 502 JQ, for instance, there is only 15 m difference in altitude between the crest of the Witwatersberg and the watershed between two longitudinal streams, which is on Ongeluk lava. The possible existence of a pre-Karoo valley or depression is indicated by a belt of intermittent occurrences of Karoo beds striking from Olifantsfontein to Tiegerpoort 371 JR.

B. DRAINAGE

All the main streams flow to the north in conformity with the general slope. They are the Crocodile, Magalies, Jukskei, Hennops, Apies and Pienaars Rivers and their tributaries. The main streams and some of their tributaries are frequently undeflected in their courses by prominent ridges and locally they have incised steep gorges or valleys in the resistant beds at right angles or oblique to the strike.

Some of the gaps in the ridges have been predetermined by faults, for instance on Zwavelpoort 373 JR, Tiegertpoort 371 JR and at Hartbeespoort Dam, but most of the steep valleys formed by the Crocodile, Hennops and Skeerpoort Rivers bear no relationship to pre-existing faults. The drainage has evidently been predetermined by the erosion pattern of the Karoo beds prior to denudation; in other words, the drainage is superimposed on the pre-Karoo structures. Subsequent younger drainage by longitudinal streams on less resistant shaly beds has given rise to the formation of broad valleys between the ridges. Resequent tributaries have incised the dip slopes on the northern side of the ridges, and the steeper slopes to escarpments on the southern side. Some of these streams have cut across the crest line and smaller catchment areas have been formed on the other side. The erosional power of these streams is evidently not caused by the supply of water from the catchment areas, but by cutting and lowering of their base levels. A more advanced stage is displayed by the Skeerpoort River and the upper course of the Magalies River, which during the process of back cutting have reached the dolomite. Sources of underground water in the dolomite were tapped, which increased the erosional power of the streams and their tributaries.

Stream capture may also have played a role; for instance the former course of the Magalies River probably more or less coincided with the Swartspruit, whereas its present course may have been originally a tributary, which cut backward on Zeekoehoek 509 JQ and Doornbosch 508 JQ until it captured the upper course of the Swartspruit north of Magaliesburg.

Rejuvenation of the entire stream pattern and a general lowering of the main base levels probably took place during uplift of the continent in late post-Karoo times. The formation of local base levels is rather exceptional, but well illustrated by the Hennops River. The gradient of the latter between Wierda Bridge and the upper chert zone in the dolomite is 1:277 and between the chert zone and the Crocodile River 1:181. The gradients of the Swartbooispruit and Rietspruit, however, decrease downstream in a normal way.

C. VEGETATION

In the central and southern portions of the area large tracts are built up or cultivated. In the remaining portions the natural vegetation consists of grass and trees, the latter growing mainly in valleys and on ridges. Small deciduous and evergreen trees and groups of aloes are typical of dolomite ridges and suikerbos (Protea abyssinica) of chert ridges, whereas the Camdeboo stinkwood (Celtis kraussiana) grows mainly on dolomite flats.

On acid soils, mainly on or along the quartzite ridges of the Pretoria Series and on the sandstone plateau of the Waterberg System, the following species are present: suikerbos (Protea abyssinica), witsering (Burkea africana), bergpruim (Pappea fulva), moepel (Mimusops zeyheri) and locally, on deeper soils, boekenhout (Faurea saligna) and wag-'n-bietjie (Acacia caffra). The kareeboom (Rhus), soetdoring (Acacia karroo) and Acacia arabica are found in the longitudinal valleys, mainly on sweeter soils de-

rived from basic rocks, lava, and argillaceous sediments.

In the Bushveld the black soil or "turf" is partly covered by the karee-boom (*Rhus*), cactus (*Euphorbia*) and different species of *Acacia*. Along the foot of the Magaliesberg the following species are present: wild fig (*Ficus* sp.), wild olive (*Olea* sp.), kiepersol (*Cussonia* sp.), maroela (*Sclerocarya caffra*), moepel (*Mimusops zeyheri*) and the different types characteristic of quartzite ridges mentioned above.

D. CLIMATE

The annual rainfall decreases slightly from east to west. Around Pretoria it varies between 625 and 750 mm and in the western portion of the area between 500 and 625 mm. Most of the rainfalls occur during thunderstorms between November and March.

At Pretoria the average maximum temperature varies between 23,1 °C and 32,0 °C and the average minimum temperature between -2,1 °C and 12,1 °C.

III. GEOLOGICAL FORMATIONS

The geological formations represented in the area are listed in Table 2.

TABLE 2

Tertiary and Quaternary Deposits			Alluvium, gravel, sand, scree, ferricrete, surface limestone	
Karoo System	{	Ecca Series	Grit, sandstone, conglomerate, shale, clay, and coal seams	
		Dwyka Series	Tillite, conglomerate, sandstone, shale	
Waterberg System	Nylstroom Series	Swaershoek Stage	Quartzitic sandstone with interbedded grit, conglomerate, breccia, shale	
Transvaal System	{	Pretoria Series	Smelterskop Stage ..	Shale, hornfels, quartzite (partly feldspathic), sub-graywacke, graywacke with layers of limestone, dolomite and lava (trachyandesite)
			Magaliesberg Stage	Quartzite Shale, hornfels with carbonaceous, calcareous, cherty and agglomeratic layers
			Daspoort Stage	Quartzite Shale with interbedded quartzitic and ferruginous layers. Amygdaloidal andesitic lava, agglomerate, tuff, shale. Shale with interbedded oolitic ironstone, calcareous layers, tilloid and quartzite

Transvaal System (contd)	Pretoria Series (contd)	Timeball Hill Stage	Quartzite, subgraywacke, magnetic quartzite, alternating with shale Shale, siltstone Conglomerate, quartzite, chert, shale
		Dolomite Series	Dolomite, chert, chert breccia, with interbedded shale, quartzite, grit, conglomerate
	Black Reef Series	Quartzite alternating with shale Quartzite, conglomerate, grit, arkose	
Ventersdorp System		Shaly sandstone with pebbles, shale, quartzite, grit, conglomerate, boulder conglomerate	
Witwatersrand System	Hospital Hill Series	Slate alternating with quartzite, Contorted Bed, Speckled Bed, Water Tower slate Orange Grove quartzite	
Dominion Reef System		Felsite, quartz porphyry	
Archaean Complex		Granite, granite-gneiss, including biotite-tonalite and trondjemite, gneiss, migmatite, migmatitic gneiss, granodiorite	
	Jamestown Igneous Suite	Amphibolite, serpentinite, talc schist, hornblendite, pyroxenite, gabbro, diorite, hybrid rocks	
	Swaziland System	Quartz-sericite schist, quartz-chlorite schist	
<u>Igneous Rocks</u>			
Post-Karoo		Dolerite	
Uncertain age		Pyroxenite, gabbro, dolerite, hybrid rocks Syenite, quartz diorite, gabbro, diabase	

Post-Waterberg	Pilanesberg Dyke System	Diabase, dolerite Syenite, foyaite, tinguaitite, bostonite, gauteite, granophyric gradiorite, granophyric gabbro, lamprophyre
	Leeuwfontein Igneous Complex ...	Trachyandesite, phonolite, syenodiorite, syenite, umptekite, syenite pegmatite, foyaite, urtite, pyroxenite, jacupirangite, syenite porphyry, syenodiorite porphyry, monchiquite
	Franspoort Igneous Complex	Trachyandesite, foyaite, syenodiorite, camptonite, ijolite, monchiquite
	Roodeplaat Igneous Complex	Diabase Tuff with interbedded shale. Trachyte, felsite, breccia, syenite, syenite porphyry, foyaite, foyaite porphyry, lamprophyre, monchiquite
	Derdepoort Diatreme	Breccia, carbonatite, alnoitic lamprophyre, syenite
	Basic and Hybrid Rocks	Diabase, granophyric quartz norite, gabbro and diorite Pseudofelsite
	Ultrabasic Rocks	Kimberlite
	Metamorphic Rocks	Hornfels, calc-silicate hornfels, metamorphic limestone, metasomatic rocks

Post-Transvaal Bushveld Igneous Complex	Acid portion of complex	Granite, granophyre	
	Basic portion of complex	Ultrabasic pegmatoids ...	Dunite, serpentinite, harzburgite, olivine gabbro, diallage pegmatite, magnetitite
		Ferrogabbro unit ..	Ferrogabbro with magnetitite bands, troctolite, anorthositic and pyroxenitic ferrogabbro, anorthosite, ferrodiorite, syenite

Post-Transvaal Bushveld Ig- neous Complex (contd)	Basic portion of complex (contd)	Gabbro unit	Gabbro, norite, hyperite, anorthosite, pyroxenite
		Porphyritic pyroxenite ..	Porphyritic pyroxenite, pegmatitic pyroxenite (Merensky Reef)
		Norite unit	Norite
		Anorthosite ..	Anorthosite, anorthositic norite, locally with chromitite seams
		Pyroxenite unit ...	Pyroxenite (bronzitite) with chromitite seams, melanorite
	Basal norite	Marginal norite sub-unit: norite. Quartz norite sub- unit: quartz norite, hy- brid and migmatitic rocks	
	Sill-phase of complex	Diabase, norite, pyroxene, harzburgite	
	Extrusive phase of complex	Felsite	
	Metamorphic rocks	Andalusite slate, cordierite, hornfels, calc-silicate hornfels, feldspathized quartzite	
Pre-Transvaal		Lamprophyre, diabase, quartz felsite.	

Most of these formations are indicated on the accompanying geological map. This was compiled by following certain rules which, however, have not always been strictly adhered to. In areas where outcrops are scarce and where the overburden does not attain considerable thickness, only one formation is indicated if its continuity underneath the overburden has been proved by the existing outcrops and (or) borehole data. This method mainly concerns the areas occupied by the Archaean granite and the basic and acid rocks of the Bushveld Igneous Complex. In other cases, for instance in the north-eastern portion of the area, where scattered outcrops belong to different formations, the outcrops and the overburden are indicated separately, so that the map is actually an outcrop map. This method is preferred, in particular where irregular intrusive contacts predominate.

Occurrences of the Karoo System indicated on the map do not always crop out, for instance those on the air-fields south of Pretoria and vicinity. However, some of the occurrences are well established in outline by gravity and borehole data. Similarly, the position of the Merensky Reef and the band of anorthosite in which it occurs were determined mainly from data obtained from prospecting pits and boreholes. The positions of some dykes and sills, in particular the Pretoria dyke, were largely established by magnetic surveys, borehole data and excavations. A separate symbol has

2. Rock aggregate

The Archaean granite, gabbro and norite of the Bushveld Complex as well as dolomite and quartzites of the Transvaal System provide aggregate material of good quality suitable for all construction purposes.

The more important quarries are on:

- Olievenhoutbosch 389 JR (granite)
- De Onderstepoort 300 JR
- Mamagalieskraal 420 JQ (norite)
- Elandsfontein 440 JQ
- Sterkfontein 401 JR (dolomite)
- East Lynne (quartzite)

Usually a full range of concrete and road aggregates, crusher run, sometimes railway ballast, is produced from these quarries.

U. UNDERGROUND WATER RESOURCES

Pretoria owes its initial development to the so-called "fountains" or springs that rise in the dolomite south of the city. Even today about 20% of the city's water requirements of some 200 000 m³/day are obtained from dolomite springs in the Fountains, Kafferspruit and Sterkspruit valleys. The rest is supplied by the Rand Water Board from the Vaal River catchment on the other side of the continental divide.

Because of the duplication of outcrops by a strike overthrust there are two bodies of dolomite south of Pretoria separated by rocks of the Pretoria Series. The lowest part of the outcrop of the eastern body of dolomite lies in the Kafferspruit valley upstream of the Rietvlei Dam and there groundwater overflows from the dolomite at several widely separated springs. The exact position of each spring is probably determined by the disposition of the various dykes that occur there in relation to the topographical relief.

The western body of dolomite is divided by the Pretoria dyke into an eastern and a western part and, as this dyke is the locus of the deep Fountains valley drained by the headwater of the Apies River, the lowest points of the outcrops of both parts of the dolomite are on either side of the Pretoria dyke in this valley as indicated by the geological map after Cilliers (1953), figure 5. Overflow of groundwater from the eastern part of the western dolomite body at the Sterkfontein springs near Olifantsfontein also contributes to the Pretoria city's supply.

Available data on groundwater in the Pretoria area are presently (1975) being assembled and processed (and will form the subject of a proposed separate Geological Survey publication).

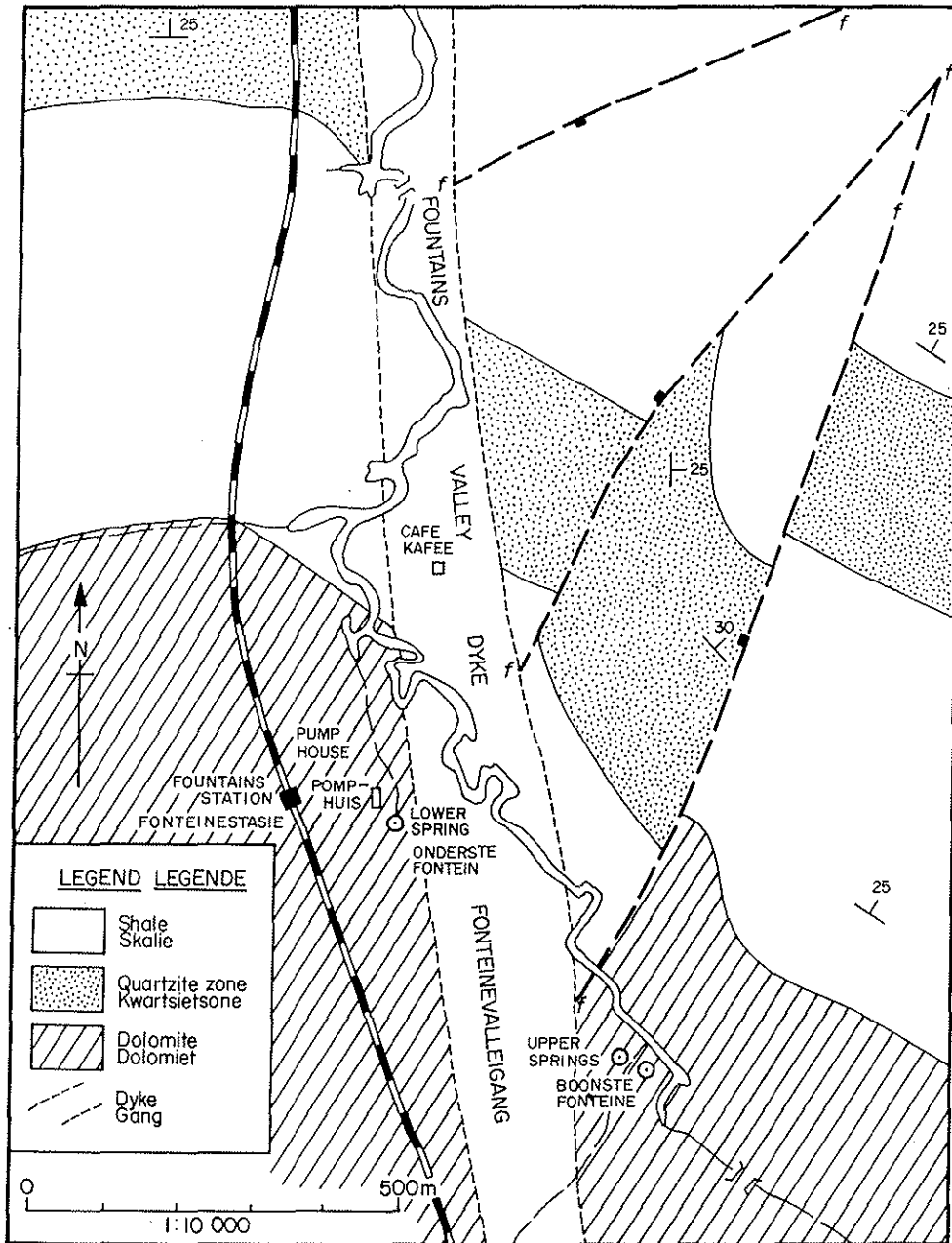


Fig. 5 - Geological map of the Fountains Valley locality (after Cilliers 1953).
 Geologiese kaart en lokaliteit van die Fonteinvallei (volgens Cilliers 1953).