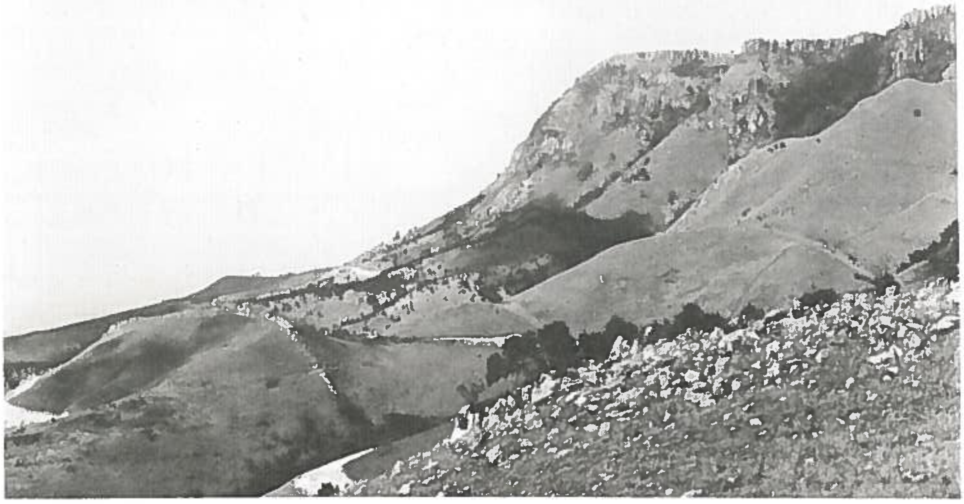
EXPLANATION: SHEET 2630 (1:250 000)
TOELIGTING: BLAD 2630 (1:250 000)



MBABANE

GEOLOGICAL SURVEY
GEOLOGIESE OPNAME

REPUBLIC OF SOUTH AFRICA

REPUBLIEK VAN SUID-AFRIKA

Cover—A view of the Drakensberg escarpment extending across the ages. Granites and gneisses of Swazian and Randian age form the lower and intermediate slopes while sediments of the Vaalian Transvaal Sequence disconformably overlie the older rocks near the top of the escarpment (photo by F. Walraven).

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Departement van Mineraal- en Energiesake

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THE GEOLOGY OF THE AREA WEST OF MBABANE

by/deur

F. WALRAVEN, Ph.D.

Explanation of Sheet 2630
Toeligting van Blad 2630
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CONTENTS

THE GEOLOGY OF THE AREA WEST OF MBABANE

by

F. WALRAVEN, Ph.D.

Abstract

The geological map of sheet area 2630 (Mbabane) includes rocks from a wide variety of lithological units ranging in age from Swazian to Recent. Included in these are the granite-gneiss and migmatite of the Swazian basement complex, the rocks of the Barberton and Pongola Sequences, the Usushwana Complex and the Amsterdam Formation, clastic and chemical sediments and volcanic rocks of the Transvaal Sequence, sedimentary rocks of the Karoo Sequence and Quaternary sediments.

The oldest rocks in the area have not yet been positively identified. Some consider the metavolcanic rocks and sediments of the Barberton Sequence to be the oldest, but others argue that they were preceded by the emplacement of the granite-gneiss and migmatite forming the basement rocks north and south of the Barberton Mountain Land. The Barberton rocks and the granite-gneiss and migmatite occur in the lowveld in the northeastern part of the map area. They are intruded by various granitic and basic rocks in the form of plutons, sills and dykes.

Most of the western part of the map area is underlain by sedimentary rocks of the Karoo Sequence and associated dolerite intrusions. Rocks of the Transvaal Sequence are present only along the northwestern margin of the map area.

The area is of economic significance primarily as a result of the mineralisation associated with the rocks of the Barberton Sequence.

Uittreksel

Die geologiese kaart van bladgebied 2630 (Mbabane) sluit gesteentes van 'n wye verskeidenheid litologiese eenhede in wat in ouderdom strek van Swazium tot Resent. Die granietgneis en migmatiet van die Swaziese vloerkompleks is hierby ingesluit asook die gesteentes van die Opeenvolgings Barberton en Pongola, die Kompleks Usushwana en die Formasie Amsterdam, klastiese en chemiese sedimente van die Opeenvolging Transvaal, sedimentêre gesteentes van die Opeenvolging Karoo en Kwaternêre sedimente.

Die oudste gesteentes in die gebied is tot dusver nog nie positief geïdentifiseer nie. Sommige beskou die metavulkaniese gesteentes en sedimente van die Opeenvolging Barberton as die oudste, maar ander redeneer dat dit voorafgegaan is deur die inplasing van die granietgneis en migmatiet wat die vloergesteentes suid en noord van die Barbertonse Bergland vorm. Die Barbertongesteentes en die granietgneis en migmatiet kom in die laeveld in die noordoostelike deel van die kaartgebied voor. Verskeie granitiese en basiese gesteentes het as plutone, plate en gange in die gesteentes ingedring.

Die grootste deel van die westelike helfte van die kaartgebied word deur sedimentêre gesteentes van die Opeenvolging Karoo en geassosieerde dolerietintrusies beslaan. Gesteentes van die Opeenvolging Transvaal is slegs in die noordwestelike gedeelte van die kaartgebied teenwoordig.

Die gebied is van ekonomiese belang hoofsaaklik vanweë die mineralisasie geassosieer met die gesteentes van die Opeenvolging Barberton.

1. INTRODUCTION

The map covers that part of the southeastern Transvaal between latitudes 26 and 27 degrees south and between longitudes 30 and 32 degrees east and includes rock types ranging in age from Swazian to the Recent. The area covered by the map is largely underlain by rocks of the Swazian basement complex, the Pongola Sequence, the Usushwana Complex and the Karoo Sequence, but also includes the southern part of the Barberton Mountain Land consisting of rocks of the Barberton Sequence, and a small area of rocks of the Transvaal Sequence.

A general relationship exists between the underlying geology and the topographic expression in various parts of the map area. The Karoo rocks in the extreme western part form a moderately flat topography at a high elevation (up to 2 000 m) whereas a more rugged topography is developed on the Pongola Sequence, Usushwana Complex and the gneisses and granitoid rocks to the east as well as the Barberton Mountain Land.

Existing maps and published data were utilised to compile the geological map. A number of these maps were obtained from the Economic Geology Research Unit of the University of the Witwatersrand as well as from the Geological Department, Johannesburg Consolidated Investment Co. Ltd, and the assistance of both these organisations is hereby gratefully acknowledged.

2. BARBERTON SEQUENCE

Some of the oldest rocks present on Earth are found in the Barberton Mountain Land and constitute the Barberton Sequence. This sequence consists of a succession of volcanic rocks overlain by predominantly sedimentary rocks; an estimated total thickness in excess of 16 km is given by SACS (1980) for the Barberton Sequence and of this the lower two-thirds consist of volcanic rocks. As presently defined by SACS (1980) the Barberton Sequence consists of the Onverwacht, Fig Tree and Moodies Groups. Ultrabasic schist and related rocks, previously referred to as the Jamestown Series (Hall 1918) and Jamestown Igneous Complex (Visser 1956), were at one time grouped with the rocks of the Barberton Sequence but are now considered to represent sheared and thermally metamorphosed equivalents of the Onverwacht Group (Anhaeusser and Viljoen 1965), and a Jamestown unit is no longer recognised.

Only the most southwestern part of the Barberton Mountain Land falls within the map area; in this part rocks of all three of the groups of the Barberton Sequence are present. A small area of serpentinite (ex-Jamestown) correlated with other basic to ultrabasic intrusive rocks in the Barberton Sequence, is also present in the map area. The oldest rocks of the Barberton Sequence are the basic to ultrabasic volcanic rocks of the Onverwacht Group; these include basic to ultrabasic, highmagnesium lavas including peridotitic komatiite, intermediate to basaltic pillow-lavas as well as intermediate to acid volcanics with a wide variety of pyroclastic rocks. Chert-rich layers are present at various levels in the Onverwacht Group and a particularly prominent and presistent one, up to 9 m in thickness, forms the base of the upper subgroup of the Onverwacht Group.

A prominent feature of the upper subgroup, the Geluk, is its cyclic nature involving variations from tholeiitic lava upwards into andesite, dacite and rhyodacite, frequently terminated by chert horizons (Viljoen and Viljoen 1969b). The Fig Tree Group, a succession of predominantly pelitic rocks, conformably overlies the Onverwacht Group. Whereas the felsic volcanic rocks and interlayered chert of the Zwartkoppie Formation were formerly regarded as the base of the Fig Tree Group (Visser 1956), they are now considered part of the Onverwacht so that the Fig Tree Group commences with the appearance of greywackes with shale and interlayered cherts. Three formations are recognised in the Fig Tree Group and also in the overlying Moodies Group; in neither case has it been possible to show these formations individually on the map.

Available age determinations on the Onverwacht Group range from 3 290 ± 45 Ma on the Kromberg Formation to about 3 360 Ma on acid volcanic rocks of the Zwartkoppie Formation.

A prominent layer of chert and banded ferruginous chert, known as the Ulundi bar, occurs about halfway up to the Fig Tree Group and pyroclastic rocks, in the form of tuff and agglomerate, form the uppermost formation of the group. Some question exists with regard to the depositional environment in which the rocks of the Fig Tree Group were deposited. Deep-water environments were deduced by Kuenen (1963) on the basis of the rhythmically bedded nature of the sediments and sedimentary structures which suggest deposition by turbidity currents. Oolites in the Zwartkoppie Formation, on the other hand, would indicate deposition in shallow water. Possibly rapid deepening of the sedimentary basin at this time was involved.

The rocks of the Moodies Group are virtually exclusively sedimentary and overlie the Fig Tree Group conformably in some places and unconformably in others. A well-developed and persistent conglomerate marks the base of this unit and this is overlain by alternations of quartzite and shale that were interpreted by Anhaeusser et al. (1968) to represent cyclic sedimentation.

In the map area the rocks of the Barberton Sequence are seen to abut against gneisses and granitoids of the Swazian basement complex.

Numerous granite domes or diapirs were emplaced in the Barberton rocks and the latter on a regional scale appear draped around the acid rocks. Abundant inclusions of greenstone are present within the granitic rocks; these are presumed to be greenstone remnants of the Barberton Sequence, especially the Onverwacht Group.

Several bodies of basic intrusive rocks occur in and around the rocks of the Barberton Sequence. Within the map area one such body is located near the Swaziland border. It parallels the border and consists primarily of serpentinite.

3. GNEISSES, GRANITES AND SYENITE OF SWAZIAN AND RANDIAN AGE

Gneisses and granitic rocks occupy most of the map area east of the rocks of the Transvaal and Karoo Sequences and between the Barberton Mountain Land in the north and the rocks of the Usushwana Complex and the Pongola Sequence in the south. It was recognised at an early stage that a variety of acid rock types of various ages and geochemical affinities are present in the area (Hall 1918; Visser 1956; Van Eeden and Marshall 1975). A considerable amount of detailed work was carried out on them. It is inappropriate to discuss the various thoughts pertaining to the gneisses and granitoids in detail in these notes and the discussion on them is limited to the more recent views. It is also acknowledged that there are widely divergent views on the evolution of the primitive crust in this region and the author does not mean to prejudice any issue when mention is made of intrusive bodies, plutons, batholiths, and the like.

A proposal for the classification of the granitic rocks in the Barberton region was made by Viljoen and Viljoen (1969a). Their classification in broad terms resembles that of Hunter (1968), drawn up for granitic rocks in Swaziland. More recently Anhaeusser and Robb (1980) drew up a model of magmatic cycles for the granitic rocks and gneisses in the Barberton region. This model is compared with the classification of Viljoen and Viljoen (1969a) in Table 1.

Classification of the various types of gneissic and granitic rocks is based not only on the field evidence but to a large extent also on geochemical and geochronological data. The oldest rock bodies among the gneisses and granitoids appears to be a suite of biotite-bearing trondhjemitic gneiss bodies which border the Barberton Mountain Land to the south and west. Within the map area the Doornhoek, Theespruit, Stolzburg and Steynsdorp plutons are examples of such rock bodies. They are mostly elongated in shape and are bordered or surrounded by greenstones of the Barberton Sequence. The foliation in the gneiss bodies is generally parallel or subparallel to the margins of the bodies and although on a regional scale the greenstones appear to be draped around the gneiss bodies, the gneiss can be seen to transgress the layering in rocks of the Barberton Sequence locally. Such relations led Viljoen and Viljoen (1969a) and Anhaeusser and Robb (1980) to consider the gneiss bodies to be intrusive into the greenstones.

Table 1—COMPARISON OF CLASSIFICATIONS USED FOR GRANITES AND GNEISSES OF SWAZIAN AND RANDIAN AGE IN THE MAP AREA

1	2	3
Young plutons	Granite plutons	Magmatic cycle III A. Late granite plutons B. Older plutons C. Younger plutons
Nelspruit gneisses and migmatites	Homogeneous Granite	D. Na-rich pluton Magmatic cycle II A. Multicomponent K-rich batholiths
Homogeneous Hood Granite	Granodiorite Suite	B. Marginal K-rich migmatites and gneisses Magmatic cycle I A. Migmatites and bimodal gneisses
Ancient tonalitic gneisses	Ancient gneiss complex	B. Hornblende tonalites and leucocratic biotite trondhjemites

1. Viljoen and Viljoen (1969a)
2. Hunter (1968)
3. Anhaeusser and Robb (1980)

The gneiss bodies correspond to what is referred to as the Ancient Gneiss Complex by Hunter (1968) and also to the first of three magmatic cycles proposed by Anhaeusser and Robb (1980). Scattered greenstone remnants are present in the gneisses southwest of the Barberton Mountain Land; these are interpreted as fragments of Barberton Sequence rocks (Viljoen and Viljoen 1969a, 1969b) and are bordered by migmatite zones which were formed by interaction between the greenstone and the granitic rocks.

Age determinations carried out on the gneisses range between 3 430 and 2 900 Ma (Barton et al. 1983; Oosthuyzen 1970) and some specific recent determinations are as follows:

Doornhoek pluton— 3 191 ± 46 Ma, 3 176 ± 302 Ma (Barton et al. 1983)

Theespruit pluton—3 432 ± 125 Ma (Barton et al. 1983); 3 250 ± 80 Ma (Oosthuyzen 1970)

Stolzburg pluton—3 481 ± 92 Ma (Barton et al. 1983)

Possibly older than the above are gneissic rocks of the Ancient Gneiss Complex which adjoin the Usushwana Complex and the Pongola Sequence near the southern margin of the map area (Hammerbeck 1982). Barton et al. (1983) place these rocks in an age bracket of between 3 560 and 3 430 Ma. Hammerbeck describes them as medium- to dark-coloured gneiss with strong foliation and containing parallel to subparallel light and dark layers which indicate an advanced stage of granitisation.

The second magmatic cycle, recognised by Anhaeusser and Robb (1980), started at about 3 200 Ma and is represented by batholithic bodies of K-rich granite emplaced both north and south of the Barberton Mountain Land. This cycle corresponds to the Homogeneous Hood Granite as well as the Nelspruit Gneisses and Migmatites of Viljoen and Viljoen (1969b) (see Table 1). In the map area these rocks are represented by the granite of the Mpuluzi batholith and other, rather coarse-grained, homogeneous, porphyritic granites of adamellitic composition. The granite of the Mpuluzi batholith is characterised by microcline megacrysts, the abundance of which shows strong local variations. Dyke-like linear bodies of homogeneous, medium-grained, pinkish-grey adamellite in many places cut across the prophyritic granite.

The porphyritic granites are separated from the trondhjemitic gneisses to the north by a selvage of K-rich migmatite and gneiss which is interpreted as having resulted from interaction between the granites of the second cycle and the pre-existing gneiss and greenstones (Anhaeusser and Robb 1980, p.7). The second magmatic cycle is considered to extend from about 3 200 Ma to about 2 900 Ma and Rb–Sr isochron ages of granite of the Mpuluzi batholith range from 3 028 ± 14 Ma to 2 986 ± 69 Ma (Barton et al. 1983; Davies et al. 1970).

The third and final magmatic cycle recognised by Anhaeusser and Robb (1980) is represented by a number of homogeneous, coarse-grained, commonly porphyritic, K-rich plutons which range from adamellite to syenite in composition. Two such plutons are present in the map area. They are the Dalmein and Sicunusa Granites*. The former is an oval pluton adjoining the Barberton Mountain Land to the south where it intrudes rocks of the Barberton Sequence. Petrographically it is similar to both the K-rich granites of the second magmatic cycle and those of the third cycle of Anhaeusser and Robb (1980). However, the Dalmein Granite has an Rb–Sr whole-rock isochron age of 3 201 ± 43 Ma (Barton et al. 1983) which is corroborated by a U/Pb zircon age of 3 170 ± 190 Ma (Oosthuyzen 1970). It is therefore more likely to belong to the second magmatic cycle than the third.

The Sicunusa Granite, located on the Swazian border, intrudes the Usushwana Complex in Swaziland and is a coarse-grained granite containing euhedral

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* Name not yet approved by SACS

K-feldspar megacrysts. A fine-grained variety of the granite is also recognised. The Sicunusa Granite can be distinguished from other potassic granites in the area on the basis of its high K20/Na20 ratio (Condie and Hunter 1976).

An intrusion of coarse-grained syenite and quartz-syenite is located within the gneisses and granitoids southwest of the Barberton Mountain Land. This intrusion is known as the Bosmanskop Syenite and displays intrusive relations with the granitic rocks as well as with greenstone fragments therein. A "tail" of medium-grained syenite extends to the southeast for a distance of some 10 km and a margin of very coarse-grained porphyritic syenite forms part of the Bosmanskop Syenite on the north and west. An elongated body of quartz-syenite, informally known as the Kees-Zyn-Doorns syeno-granite, striking parallel to the Bosmanskop tail, is located just outside the map area to the north and a much smaller occurrence of syenite, informally known as the Welverdiende Syenite, is located directly to the south of the Bosmanskop pluton.

Lithologically these rocks, which are considered to be co-genetic (Anhaeusser et al. 1979), range from very coarse-grained syenite with euhedral, zoned perthite crystals through medium- and fine-grained syenite to syeno-granite. Mafic inclusions are common and generally consist of amphibolite; they show various degrees of assimilation. Inclusions of coarse-grained syenite and the presence of thin syenite and aplitic dykelets suggest that the magma underwent a complicated cooling history. The syenite is foliated, especially near its margins and also where ferromagnesian minerals are present.

Geochronological data indicate that the Bosmanskop Syenite has an age of about 3 130 Ma. This age is considered to represent the age of the source rocks, intermediate to acid rocks from which the syenite magma was formed by partial melting, and a younger Rb–Sr age (2 850 Ma) is regarded as indicating the age of emplacement (Anhaeusser et al. 1979). The shape of the intrusion suggests that it was emplaced along fractures trending northwest–southeast.

4. PONGOLA SEQUENCE

Rocks forming the Pongola Sequence are present in the south-central part of the map area where, in association with rocks of the Usushwana Complex, they extent from the Amsterdam area to the southeast into Swaziland and beyond the map area. In general the strata thicken towards the southeast. The Pongola Sequence forms the oldest named succession, overlying the gneissic and granitoid rocks of the Swazian basement in the area unconformably.

The South African Committee for Stratigraphy selected the Bivane Formation as the boundary between the Swazian and Randian erathems and consequently the rocks of the Pongola Sequence straddle this time boundary. SACS (1980) recognised four formations in the Pongola Sequence in the Amsterdam area. Hammerbeck (1982) mapped most of these rocks in the area north of 27 degrees south and his subdivision forms the basis of the present classification. Two groups make up the Pongola Sequence. The lower Nsuze Group consists of a lower part of quartzite alternating with ferruginous quartzite and basaltic lava and is in the order of 300 m thick (the Mantonga Formation) while the upper part, the Bivane Formation, is about 2 000 m thick and consists of basalt and andesite with interlayered amygdaloidal zones (Hammerbeck 1982). A thin layer of ferruginous quartzite, the Wolvenkop Bed, occurs near the base of the Mantonga Formation; it is not distinguished on the map. Below this the basal quartzite of the Mantonga Formation rests with a sedimentary contact on the basement rocks. An andesitic lava horizon, the Mpama Member, higher up in this formation is shown on the map where possible.

The overlying Mozaan Group has an estimated thickness of more than 2 300 m. It is exclusively sedimentary in origin and consists of quartzite, ferruginous quartzite and ferruginous shale. Two named members not shown on the map are recognised in the two formations, namely the Skurwerant and Redcliff which constitute this group. They are the Madola Member, a persistent horizon of ferruginous shale which separates an upper and a lower quartzite unit of the Skurwerant Formation, and the Cascade Member in the Redcliff Formation. The former is very prominent and readily recognisable in the field. The Cascade Member consists of two beds of iron formation which in places display typical banding and are composed of alternating layers of iron oxide and chert. Elsewhere they are massive or grade into an oölitic iron formation. On the basis of the presence of both chert and oölites Hammerbeck (1982) considers these rocks to be of the Lake Superior type of iron formation.

Two quartzite units and a shale unit occurring in the southeastern corner of the map were erroneously correlated with the Skurwerant and Redcliff Formations respectively. The structural attitude of the succession is normal and the above correlation therefore implies that the Skurwerant (main quartzite) overlies the Redcliff Formation which is stratigraphically wrong. On the adjacent map (2730, Vryheid) this succession of the Pongola Sequence was subdivided due to uncertainty of correlation of the different lithological units with existing formations.

The rocks of the Pongola Sequence were subjected to regional metamorphism, the intensity of which increases north-northeastwards to reach amphibolite facies beyond the border with Swaziland (SACS 1980, p.73). Contact metamorphic effects are found in the Pongola rocks in aureoles surrounding granitoid bodies and the emplacement of the Usushwana Complex also left thermal imprints on the Pongola Sequence.

5. USUSHWANA COMPLEX, AMSTERDAM FORMATION AND THOLE SUITE

The Usushwana Complex is located in the southeastern part of the map area where it overlies granites and gneisses of the basement complex. Together with the rocks of the Pongola Sequence it forms a northwest–southeast elongated belt about 20 km wide which to the northeast is obscured by a cover of Karoo rocks and to the southwest extends into Swaziland. The complex was apparently emplaced along a major northwest–southeast-striking lineament and at present has an outcrop pattern resembling an inverted 'h'.

The Usushwana Complex as defined by SACS (1980) includes only intrusive igneous rocks and is subdivided into a basic portion, the Piet Retief Suite, and an acid portion, the Hlelo Suite. The Amsterdam Formation, which consists primarily of volcanic rocks, and the ultramafic rocks of the Thole Suite* are regarded as separate units and although genetically related to the Usushwana Complex, are not subdivisions thereof.

No volcanic rocks equivalent in stratigraphic position to the Amsterdam Formation was identified in the adjacent sheet area 2730 (Vryheid). Only granophyre and subordinate microgranite belonging to the Hlelo Suite (both intrusive into the Pongola Sequence) occur in this stratigraphic position. It is therefore uncertain how far south the Amsterdam Formation extends on sheet 2630 (Mbabane).

The rocks of the Usushwana Complex in the Republic of South Africa were mapped by Van Vuuren (1965) and later by Hammerbeck (1982) who proposed the lithostratigraphic subdivision upon which the present classification is based. Hammerbeck recognised an early phase of magmatism during which ultrabasic to basic sheets and sills were emplaced, primarily in the strata of the Mozaan Group. These intrusives consist of harzburgite, pyroxenite and gabbronorite and constitute the Thole Suite; they attain their maximum development west of Amsterdam. They were emplaced more or less concordantly into the upper part of the Mozaan Group and northeast of Amsterdam they rest directly on basement granitoids. Geochemically they can be regarded as basaltic komatiite. Some of the thicker sills and sheets are differentiated and grade from harzburgite at the base to pyroxenite and/or norite and gabbro at the top.

This initial phase was followed by an extrusive phase during which intermediate to acid volcanic rocks of the Amsterdam Formation were poured out. Hammerbeck (1982) divided the volcanic rocks into a lower unit primarily of dacitic composition overlain, with an apparent conformity, by a rhyolitic upper unit. The lower unit, the Gobosha Dacite Member, has a minimum thickness of some 250 m

* Name not yet approved by SACS.

and includes a basal rhyolite layer (Hammerbeck's Athole Member). It consists primarily of massive, fine-grained ash-flow tuffs of dacitic composition in which angular ejecta are present, locally in great abundance.

The overlying Vaalkop Member consists of massive rhyolite without any bedding or flow structures and containing few volcanic fragments. It occurs in the area mainly as erosional remnants of a formerly more extensive blanket of volcanic rock. Quartz, plagioclase, K-feldspar and hornblende make up the larger part of these rocks and are accompanied by magnetite, ilmenite, pyrite and sphene. Chlorite, epidote and stilpnomelane are present as alteration products. Compared to the rhyolite of the Gobosha Member these rocks are generally somewhat coarser grained: They contain scattered phenocrysts of quartz and feldspar and locally become noticably porphyritic. Micrographic intergrowths are present in the groundmass in places and Humphrey and Krige (1931), who considered these rocks to be intrusive and to be related to a "gabbro-granophyre magma", distinguished a variety of rock types ranging from granophyre to quartz porphyry. Hammerbeck (1982) recognised no intrusive rocks in this unit but noted local transitions into porphyritic varieties and a degree of recrystallisation to produce spherulites.

The third and final phase consists of the acid and basic plutonic rocks of the Usushwana Complex as defined by SACS (1980). The rocks of the Piet Retief Suite, which include pyroxenite, quartz gabbro, magnetite gabbro, gabbro and hyperite, occur as more or less isolated massifs intruded into the basement rocks. Clear-cut intrusive relations with the country rocks are to be found in places. These include discordant relations and intrusion breccias as well as xenoliths of country rock in the gabbro. The gabbro is preferentially emplaced along the contact between the Vaalkop Formation and the basement but is in places intrusive into the Pongola Sequence. Granodiorite and micrograrite make up the bulk of the Hlelo Granite Suite and appear to have been intruded by the basic rocks of the Piet Retief Suite (Hammerbeck 1982). However, Hammerbeck (1982) considered the acid rocks to be genetically related to the Piet Retief Suite and formed by magmatic differentiation (the granodiorite) and by remelting of the rhyolite of the Vaalkop Formation (the microgranite).

6. TRANSVAAL SEQUENCE

Rocks of the Transvaal Sequence are restricted to the northwestern corner of the map area where they form the southward continuation of the eastern margin of the Transvaal Basin. To the south they are obscured by Karoo rocks. Owing to the absence of any significant deformation other than local block faulting, the strata of the Transvaal Sequence display a regular undisturbed attitude, dipping at shallow angles of between ten and twenty-five degrees towards the northwest. The Black Reef Formation and the overlying Chuniespoort and Pretoria Groups are represented within the map area.

6.1 BLACK REEF FORMATION AND CHUNIESPOORT GROUP

The Black Reef Formation is the lowermost unit of the Transvaal Sequence present in the map area. It rests unconformably on older gneisses and granitoids of the Swazian basement complex but within the map area it is only sporadically developed. Thickly bedded, clear orthoquartzite is the predominant lithology of the Black Reef Formation and well-developed cross-bedding, quite often trough shaped, is present in many places. The formation is characterised by the presence of abundant pebble beds, especially in its upper part which is rather coarse grained and gritty in places. The pebbles are six to twelve millimetres in diameter. At its base, especially on Barneveld 161T, the formation is micaceous and feldspathic and also finer grained than higher up. On Uitkyk 371T the quartzite is overlain by bluish-coloured shale. This is taken to represent the so-called transition zone between the Black Reef and the overlying dolomite and chert of the overlying Chuniespoort Group and is included in the latter.

Outcrops of rocks belonging to the Chuniespoort Group are poorly developed in the area covered by the map and are furthermore obscured by extensive forested areas. As a consequence it is not possible to apply the subdivision of the group into chert-rich and chert-poor formations to this area. On Barneveld 161T fine-grained, bluish dolomite without visible algal structures is present in outcrop.

6.2 PRETORIA GROUP

6.2.1 Rooihoogte Formation

In the map area the Rooihoogte Formation is principally represented by the Bevet's Conglomerate Member which is prominently developed in its outcrop area. This member consists of a breccia comprising angular to slightly rounded chert fragments set in a fine-grained cherty matrix. White to grey chert is present on Rietfontein 191T. This rock probably represents the lowermost part of the Rooihoogte Formation and corresponds to what is known as the giant chert. Elsewhere in the Eastern Transvaal the upper part of the Rooihoogte Formation consists of more arenaceous material; this is not exposed in the map area.

Evidence from eslewhere in the Transvaal Basin indicates that the base of the Rooihoogte Formation represents a regional unconformity and the Bevet's Member can be regarded as a basal residual deposit that formed prior to the sedimentation of the overlying shales and quartzites of the Pretoria Group.

6.2.2 Timeball Hill Formation

The Timeball Hill Formation consists of an upper and a lower shale portion separated by a quartzite horizon; all three these units are present in the map area.

Although elsewhere the shale of the Timeball Hill Formation is laminated and fissile, in the map area it is predominantly a massive, featureless rock more akin to a mudstone than a shale. It is very fine grained and dark in colour.

The quartzite separating the upper and lower shale members is called the Klapperkop Quartzite Member by SACS (1980) and corresponds to what was formerly known as the Nooitgedacht Quartzite. It is essentially a mature, medium- to fine-grained quartzite locally containing cross-bedding. Shale beds are interlayered in the quartzite. The transition from the lower shale into the quartzite is somewhat gradual and involves sandy shale horizons, while the transition from the quartzite into the upper shale member involves variations between pure quartzite and pure shale.

In the area north of the map area the quartzite member is composite and consists of two separate quartzite horizons, separated by a shale horizon, between 60 and 90 m in thickness, which incorporates a ferruginous quartzite horizon at its base. In the map area only one quartzite horizon is recognised although locally block faulting leads to duplication of the strata and creates the impression that two quartzite horizons are present.

6.2.3 Boshoek Formation

Quartzite of the Boshoek Formation, formerly known as the lower Ongeluk Quartzite, overlies the Timeball Hill Formation. Exposure is limited to a small area south of Carolina on Goedehoop 451T. Here the basal conglomerate, present in this formation in other areas, is not exposed and is probably absent. The formation is represented by thick, medium-grained, relatively clean quartzite in which cross-bedding and grit layers are present.

6.2.4 Hekpoort Andesite Formation

Thick, prominent layers of andesitic and basaltic lava represent the Hekpoort Andesite Formation (formerly known as the Ongeluk Lava) in the map area. The lava has a thickness of over 200 m and is fine to medium grained; in places abundant amygdales and flow-structures are present. Although prominent pillow structures occur in the formation in the area north of the map area, they are absent here. A sedimentary interlayer in the lava is present on Leeuwpoort 131T.

At the top of the formation a moderately persistent light-coloured sericite schist separates the lava from the overlying formation. The schist varies between 80 and 120 cm in thickness and, according to Button (1973), represents a soil formed on the Hekpoort Andesite, which was subsequently lithified and converted into a schist by intrastratal movement.

6.2.5 Dwaalheuwel Quartzite Formation

The Dwaalheuwel Quartzite Formation, consisting mainly of white to brown quartzite with abundant grit layers and local secondary iron enrichment, is poorly exposed in the map area.

6.2.6 Strubenkop Shale Formation

Overlying the Dwaalheuwel Formation is the Strubenkop Shale Formation, represented by a pale-yellow to brown sandy-shale horizon which is comparatively thin and rather poorly exposed. This was formerly known as the Daspoort Shale and reaches a much greater thickness elsewhere in the Transvaal Basin.

6.2.7 Daspoort Quartzite Formation

The Daspoort Formation consists of a clean, medium-grained quartzite characterised by a friable, sugary texture. Horizontal bedding is prominent in this formation but planar cross-bedding and ripple marks are also present.

6.2.8 Silverton Shale Formation

In the map area the Silverton Shale Formation (formerly known as the Magaliesberg Shale) can be divided into an upper Lydenburg Shale Member and a lower Boven Shale Member which are separated by the Machadodorp Member consisting of volcanic rocks. The Boven Shale outcrops poorly and consists of laminated and well-bedded shale together with some blue-grey mudstone.

The overlying Machadodorp Member is predominantly a volcaniclastic unit of basaltic composition and includes tuff and agglomerate together with some pillow lava near its top. Two agglomerate horizons are recognised of which the upper one pinches out to the southwest. The pillow lava is a very fine-grained, dark-grey basalt and is in many places intruded by diabase. This has led to misidentification of the lava as diabase in the past. Due to the poor quality of the outcrop it is not possible to accurately locate the contact between the Machadodorp Member and the overlying shale.

Reasonably good outcrops are found on the Lydenburg Shale Member. The shale is comparatively well laminated but shows no other sedimentary features. The shale members of the Silverton Formation lack cross-bedding, ripple marks or dessication features and were probably deposited in moderately deep water.

7. KAROO SEQUENCE AND DOLERITE

A large portion of the map area is underlain by rocks of the Karoo Sequence, principally the Vryheid Formation. A small exposure of the underlying Pietermaritzburg Formation is present along the southern margin of the map area and the basal unit. The Dwyka Formation is exposed along the lower parts of river channels in the northwestern part of the map area and in the Amsterdam area. Karoo formations overlying the Vryheid Formation are restricted to the Volksrust and Estcourt Formations. Abundant dolerite intrusions, principally as sills, are present throughout the Karoo Sequence. They are possibly more abundant towards the southwestern corner of the map area.

7.1 DWYKA FORMATION

The Dwyka Formation is generally poorly exposed in the map area. Where observed it consists of pebbles and boulders in a groundmass of yellowish-green, argillaceous material and quartz grains. The pebbles and boulders range in size from centimetres to metres and include granite, vein quartz, pegmatite, schist, lava and sandy shale. They appear to represent most of the pre-Karoo rocks present in the general vicinity.

A glacial pavement developed on the quartzite member of the Timeball Hill Formation is present on Goedehoop 451T; chattermarks and star-like pressure cracks are found here. Ice movement is indicated to have been in a north-northeasterly direction. Small roches moutonnees and striated floors carved into quartzite of the Skurwerant Formation and the pyroclastic rocks of the Amsterdam Formation are exposed northwest of Amsterdam on Athole 392IT and Forbes Athole 393IT. A small striated pavement is also located on Amsterdam Townlands. The direction of ice movement in this area was south-southeast (Hammerbeck 1982).

7.2 ECCA GROUP

In the map area three formations, the Pietermaritzburg, Vryheid and Volksrust Formations represent the Ecca Group. Some very poorly outcropping brown, micaceous shale exposed near the southern margin of the map area is considered to form part of the Pietermaritzburg Shale Formation. Bluish-black to buff-coloured shale of this formation is also encountered in holes drilled through the overlying Vryheid Formation in the same general area. It is doubted whether this formation ever extended further north in the map area.

The overlying Vryheid Formation is also generally poorly exposed but covers a large part of the map area. It consists of grit, sandstone and shale and contains a number of coal seams. In addition, pebble beds and intraformational conglomerate are locally developed and intercalations of siltstone and mudstone are common in the sandstone, especially in the upper part of the formation. Lenses of calcareous sandstone and sandy limestone are relatively common. The sandstone is generally feldspathic and weakly cemented, especially the coarser varieties. Ripple marks are occasionally present but trough cross-bedding is quite common.

A cyclicity is apparent in the coal-bearing part of the Vryheid Formation (Du Plessis 1979) in the form of upward-fining cycles starting at the bottom with conglomerate and grit followed by sandstone, shale and eventually coal seams. These lithologies are interpreted to represent respectively the channel-lag deposit, the point-bar deposit and the overbank deposit of a meandering stream.

Plant fossils are relatively common in the Vryheid Formation although the degree of preservation is highly variable. Plants that were identified in the map area include Glossopteris, Gangamopteris, Equisetales, Phylotheca and Schizoneura.

Blue shale, mudstone and argillaceous sandstone represent the Volksrust Formation overlying the Vryheid Formation in the southwestern corner of the map area. These sediments are usually deeply weathered and in places form discoidal fragments.

7.3 ESTCOURT FORMATION

Sandstone, shale, mudstone and subordinate coal representing the Estcourt Formation occur in the extreme southwestern corner of the map area where together with intruded dolerite sills they form the Elandsberg. The sandstone layers generally stand out prominently but the other lithologies are poorly exposed.

8. QUATERNARY DEPOSITS

Quaternary deposits in the map area include residual soils, alluvial deposits and scree deposits. Outcrop in the map area, especially on the granites and gneisses of the lowveld and also on the rocks of the Karoo Sequence, is very poor and much of these areas are covered by residual soils. On the granites and gneisses the residual soils are predominantly sandy and consist of quartz and feldspar. In other parts of the map area silty and clayey soils are more abundant.

Alluvial deposits are found along most of the streams in the map area. The actual deposits vary according to the geology of the region and in the lowveld many of the streambeds consist of sand and pebbles. Prominent scree deposits and very thick alluvial fans adjoin the Drakensberg escarpment. The material in these deposits varies from very coarse and conglomeratic to fine grained and clayey.

9. STRUCTURE AND METAMORPHISM

The area covered by this map sheet can be divided into two structurally distinct regions. The western region consists of rocks of the Transvaal Sequence and is structurally very simple. The other region is underlain by rocks of the basement complex and the Barberton Sequence and has a complex structure.

The rocks of the Transvaal Sequence have a regional westward dip of between seven and ten degrees. Local disturbances resulted in increased dips in places. The emplacement of the Bushveld Complex gave rise to the formation of domal structures in the floor rocks; the Dwars River fragment is an example of such a structure. Local steeper dips of the contact between the Bushveld Complex and the Transvaal strata are probably due to isostatic equilibration.

Metamorphic effects in the rocks of the Transvaal Sequence are due to the intrusion of the Bushveld Complex and the emplacement of basic sills of various ages. The effects of the former are probably much more significant than those of the latter which appear to be restricted to the formation of narrow zones of hornfels in the shales into which they were emplaced. The ubiquitous alteration to hornfels of all the shale horizons above a certain stratigraphic level [the so-called hornfels line of Button (1976)] is most likely due to the Bushveld Complex as is the presence of andalusite in the Lydenburg Shale Member and the recrystallisation of quartzite of the Steenkampsberg and Magaliesberg Formations (which are located above Button's quartzite line—not present in area 2630).

Considerable structural deformation can be seen in the rocks of the Barberton Sequence. Although investigators differ in their detailed structural interpretations, large-scale upright folds and structural dislocations appear to dominate the mountain land (De Wit et al. 1983). Horizontal shortening and vertical extension, possibly contemporaneous with granitoid emplacement (De Wit et al. 1983) were preceded by thrust and nappe tectonics. Up to four generations of folding are recognised by Jackson and Robertson (1983), the second and third of which were of greatest importance. Following the development of a tilted pre-deformation surface the next two deformations involve a period of horizontal translation with associated thrusts and nappes followed by intense shortening in a northwest–southeast direction. The fourth and final phase involved warping about upright axial surfaces striking southeast (Jackson and Robertson 1983).

10. ECONOMIC GEOLOGY

A number of mineral occurrences of economic interest are present in the area covered by the Mbabane map. Not all are economically significant, however, and only the more prominent occurrences are listed below.

10.1 COAL AND OIL SHALE

Virtually the entire area underlain by the Vryheid Formation (middle Ecca) can be considered as potentially coal bearing. It represents the northernmost portion of the eastern Transvaal coal field. Six coal seams are present but at least two of these are generally too thin to be of economic significance. Most of the reserves can be classified as high-grade steam coal.

Oil shale is frequently associated with the coal seams around Ermelo where some of the most promising deposits of torbanite in the country were found. The only commercial exploitation of torbanite in South Africa took place within the map area on the farm Mooifontein 109IT.

10.2 IRON AND MANGANESE

A number of horizons of ferruginous shale and quartzite are present in the Pongola Sequence in addition to the iron formation in the Rėdcliff Formation. Hammerbeck (1982) estimated the near-surface resources to a depth of 100 m to be in the order of 75 million tons, but noted that the metallic iron content of these rocks is limited to between 30 and 35 per cent. These rocks have MnO concentrations of between three and seven per cent and local supergene enrichment was sufficient to warrant exploitation on a limited scale in the past.

Magnetite layers in the Usushwana Complex are of very limited extent and their low V205-content renders them economically unimportant.

10.3 GOLD

The Barberton Mountain Land was and still is an important gold producer. In the past the gold mineralisation in this area was responsible for one of the biggest mining booms in South Africa. The gold mineralisation appears to be structuraly controlled; the more important deposits being largely controlled by large faults and related second-order features (Visser 1956). In some instances chert layers appear to have acted as barriers or "bars" in which loci for gold mineralisation were present. The gold is generally present as native gold and is accompanied by native silver, pyrite, arsenopyrite, pyrrhotite and lesser chalcopyrite, stibnite, galena, sphalerite and marcasite. Although it was generally accepted that granitic magmas were the source of the gold, Viljoen et al. (1969) considered the origin of the gold to lie in the Onverwacht Group and to have been concentrated into economic deposits by repeated mobilisation processes.

A number of gold fields are recognised in the Barberton Mountain Land but of these only one, the Komati–Steynsdorp gold field, lies within the map area. Although some twenty mines were operative in this gold field in the past, their total production amounted to only about 0,1 per cent of the region and none are producing at the moment. Among the more important gold mines that were operating in the map area are the Comstock Mine, Conqueror's Way, Contractus, Gipsy Queen, Golden Snake, Independent, Onverwacht, Sheba Queen and Swans. In each case the gold mineralisation is in rocks of the Onverwacht Group. None of the mines produced more than 100 kg of gold.

10.4 KIESELGUHR

Deposits of diatomaceous earth and peat (kieselguhr) are found at three localities in the map area. A deposit on Athole 392IT is estimated to have reserves of 600 tons only and another, on Bankplaats 279IT, is of economic importance and was until 1943 virtually the only producer in South Africa. It is still operating today.

11. SITES OF GEOLOGICAL INTEREST

At the time of deposition of the Dwyka Formation of the Karoo Sequence extensive areas in South Africa were covered by ice sheets and glaciers. Two examples of features resulting from glacier action are present within the map area. The first of these is a striated floor (Fig. 1) formed on quartzite of the Mozaan Group located on the farm Amsterdam 408IT (locality 1 on the geological map), while the second is an example of "roches moutonnees" (Fig. 2), also striated, which formed on pyroclastic rocks of the Gobosha Member of the Amsterdam Formation (locality 2 on the map).

Intrusive relations between trondhjemitic granite (now gneiss) and komatiitic basalts with pillow structures can be seen in the bed of the Theespruit along the southern margin of the Barberton Mountain Land (locally 3 on the map). Figure 3 shows spectacularly deformed gneiss and greenstone which form part of the various contact relations to be seen. The basalts intruded are part of the Barberton Sequence.

Along the road between Badplaas and Diepgezet (locality 4, near the Msauli Asbestos Mine) a clear impression can be obtained of the intrusive relations between the Dalmein pluton and the metavolcanic strata of the Barberton Sequence. The Dalmein Granite, characterised by its typical rough surface expression, can here be seen to discordantly cut across the rocks of the Onverwacht Group.

Fig. 1 – A striated floor of quartzite of the Mozaan Group on the farm Amsterdam 408 IT.
(Photo by E.C.I. Hammerbeck.)

Fig. 2 – A striated "roches moutonnees" of Gobosha pyroclastics on the farm Athole 392 IT.
(Photo by E.C.I. Hammerbeck.)

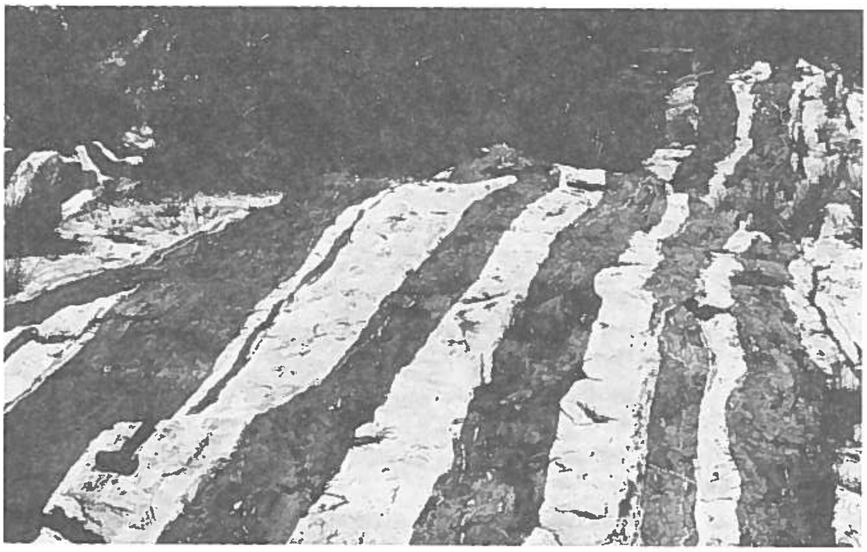

Fig. 3 — Interlayered trondhjemitic gneiss and greenstone in the Theespruit, south of the Barberton Mountain Land.
(Photo by F. Walraven.)

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