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A CORRELATION OF PRE-FIG TREE ROCKS IN THE NORTHERN AND SOUTHERN PARTS OF THE BARBERTON MOUNTAIN LAND

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ABSTRACT

Detailed investigations of the pre-Fig Tree successions in both the northern and southern parts of the Mountain Land, have revealed striking stratigraphic similarities between the two areas.

In the south a huge pile of undeformed and only slightly thermally metamorphosed pillow lavas are grouped in the Onverwacht Series. The latter has been divided according to typical rock-types and associations into three major subdivisions.

In the north pre-Fig Tree rocks have been intensely dynamically and thermally metamorphosed. These rocks have previously been regarded as constituting part of the Jamestown Igneous Complex. Only traces of volcanic structures have been preserved, but distinctive rock-types and assemblages make it possible to correlate these rocks with the Onverwacht volcanic succession in the Komati River Valley. Unlike the southern area, however, mainly the Lower and Middle subdivisions of the Onverwacht Series are developed north of Barberton.

Extremely altered Onverwacht volcanics therefore constitute most of the northern part of the Mountain Land. Thus, rocks formerly regarded as belonging to the Jamestown Igneous Complex have now been reclassified into the Onverwacht Series at the base of the Swaziland System. Descriptions by other authors and recent reconnaissance work has facilitated a regrouping of similar rocks from other parts of the Mountain Land. Pre-Fig Tree rocks from these areas can also be subdivided into the Lower, Middle or Upper stages of the Onverwacht Series. It is suggested that these peripheral pre-Fig Tree basic rocks may constitute the pre-orogenic ophiolite assemblage of the Swaziland System.

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A CORRELATION OF PRE-FIG TREE ROCKS IN THE NORTHERN AND SOUTHERN PARTS OF THE BARBERTON MOUNTAIN LAND

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A CORRELATION OF PRE-FIG TREE ROCKS IN THE NORTHERN AND SOUTHERN PARTS OF THE BARBERTON MOUNTAIN LAND

INTRODUCTION

Recent detailed geological investigations as part of South Africa's contribution to the International Upper Mantle Project, have been carried out in the southern part of the Barberton Mountain Land. This work has been concerned primarily with a critical re-examination of the ancient Onverwacht lavas and associated ultrabasic rocks.

Reconnaissance investigations were undertaken in an attempt to locate an area where the Onverwacht sequence was best exposed. At the same time care was taken in the selection of an area where the latter succession attained its best development, was little altered or disturbed, and could be considered a type section. Field relationships were critically examined and the mapping supported by detailed petrological work. As a result of the study a better understanding of the Onverwacht Series was acquired, and it became clear that the latter consisted essentially of a thick pile of pillow basalts with subordinate ultrabasic bands, minor interlayered sedimentary horizons and more acid volcanic material. A detailed stratigraphic column was compiled in which three major subdivisions or stages, each characterized by a distinctive association of rock-types, were introduced. (Viljoen and Viljoen, 1965a).

During the last five years, and as part of an intensive geological investigation of the northwestern part of the Mountain Land, detailed mapping of a large region of pre-Fig Tree rocks was carried out. This work was done mainly by the Economic Geology Research Unit of the University of the Witwatersrand, together with mining companies operating in the area. The main aim of the undertaking was to obtain a better understanding of the controls of gold mineralization in the area. In so doing, however, a clearer insight into the stratigraphy, structure and metamorphism of the pre-Fig Tree suite of rocks in the northern part of the Mountain Land was also acquired.

The main fact that emerged from the latter investigations was that the pre-Fig Tree suite formed a regular, layered and stratiform sequence lying below the Fig Tree Series. These rocks were so strongly thermally and dynamically metamorphosed, however, that it was impossible to say with certainty what their original nature had been although it was suggested that lavas, together with altered, impure dolomitic sediments could have accounted for the assemblage.

It was only after the detailed investigation of the relatively unaltered volcanic suite of the Onverwacht Series in the southern part of the Mountain Land had been completed, however, that interest was stimulated in a reappraisal of the pre-Fig Tree rocks. Immediately it became apparent that striking stratigraphic and petrological similarities existed between the relatively unaltered pre-Fig Tree or Onverwacht volcanics in the south, and the array of altered pre-Fig Tree rocks in almost every other part of the Mountain Land. Previously, all of these thermally and for the most part, strongly dynamically metamorphosed rocks had been grouped by the Geological Survey (Visser, et. al., 1956) into the Jamestown Igneous Complex.

In the type locality chosen in the south, all three stages of the Onverwacht Series could be traced laterally for many miles. Extending westwards from the type area, the three stages, together with their interlayered sedimentary horizons, were found to grade into highly altered areas in which original volcanic structures were not clearly discernable. The Geological Survey (Visser, et. al., 1956), considered these extremely altered rocks to be part of the Jamestown Igneous Complex. It became clear, however, that the Onverwacht sequence extended laterally for many miles, and, in its position below the Fig Tree Series, actually encircled the entire Mountain Land. Dynamic, and to a lesser extent, thermal metamorphism had destroyed all original volcanic structures, but the typical rock-types and associations which characterized the three subdivisions of the Onverwacht Series to the south, were clearly recognizable in the remaining areas.

This paper deals with a description of the three main divisions of the Onverwacht Series, and indicates how the assemblage in the northern part of the Mountain Land can very clearly be correlated with the two lowermost divisions of the southern area. The paper shows further, how the remaining pre-Fig Tree rock-types and associations described from other parts of the Mountain Land, can be classed with confidence into one or more of the three subdivisions of the Onverwacht Series.

The proposed correlation thus reclassifies the pre-Fig Tree assemblages into the Onverwacht Series, thereby eliminating entirely the earlier held concept of the Jamestown Igneous Complex.

GENERAL GEOLOGY OF THE PRE-FIG TREE SUCCESSIONS

A. SOUTHERN AREA (KOMATI RIVER VALLEY)

Detailed mapping has recently been carried out in the Komati River Valley in the southwestern part of the Mountain Land and a preliminary report of the Onverwacht Series in the area has been prepared. (Viljoen and Viljoen, 1965a).

In this area the Series comprises a huge pile of essentially extrusive material in which volcanic structures such as pillows and amygdales have been observed throughout. The majority of lavas are basaltic in composition, but more acid varieties occur as well as interlayered ultrabasic zones and bands. In addition narrow, interlayered sedimentary horizons occur mainly in the form of siliceous sediments, calc-silicate rocks and banded chert horizons. This huge, steeply north-dipping and east-west-trending layered sequence reaches a thickness of over 35,000 feet in the region of maximum development on the farms Theespruit 156 IT and Hooggenoeg 731 JT. The volcanic pile is bounded in the south by an intrusive high-level granite pluton forming part of the complex granitic terrain of the Badplaas-Lochiel area, and in the north by banded cherts and greywackes of the Fig Tree Series.

Thermal metamorphic effects have been produced by the intrusive granite along the contact zone in the south, but in general the lavas have not suffered a very high degree of metamorphism and original volcanic structures are frequently preserved. Dynamic metamorphism is confined to the environs of two strike faults which truncate several members of the Lower Onverwacht succession in the southern part of the area. No folding has taken place in the area and the whole sequence represents a regular, layered pile of almost vertically-dipping volcanic material.

The Onverwacht Series can conveniently be divided into three major subdivisions viz., the Lower Onverwacht or Theespruit Stage, the Middle Onverwacht or Komati River Stage, and the Upper Onverwacht or Hooggenoeg Stage.

The Lower Onverwacht succession consists essentially of a sequence of metamorphosed pillow basalts with interlayered siliceous sediments and occasional narrow chert horizons. Bands and lenses of serpentinized ultrabasic material are characteristic of the lower subdivision. The Middle Onverwacht differs from both the Lower and Upper divisions by its complete lack of interbedded siliceous or acid material. It consists entirely of a sequence of interlayered and alternating bands of amphibolitized pillow basalts and ultramafites. The Upper Onverwacht is comprised of basaltic to intermediate pillow lavas with interlayered acidic lava, the latter generally associated with banded chert, carbonate and slaty rocks. In addition it contains an upper massive, irregular zone consisting essentially of acidic volcanic material.

B. NORTHERN AREA (LOUW'S CREEK - CONSORT MINE - JAMESTOWN SCHIST BELT)

Mapping of the area north of Barberton has recently been undertaken and full accounts of the structure, stratigraphy, metamorphism and the mineralogy of this region can be referred to in reports by Anhaeusser (1964) and Viljoen (1964). In addition an account of the base of the Swaziland System in the Consort Mine - Louw's Creek area is available. (Anhaeusser and Viljoen, 1965).

A brief review of the essential features of the pre-Fig Tree formations is, however, necessary for a successful understanding of the attempted correlation of the northern area with that of the Komati River Valley area in the south. With the completion of the re-mapping of the Jamestown Schist Belt west of the Consort Mine additional correlative evidence has become available.

(a) Louw's Creek - Consort Mine

Between the Consort Mine and Louw's Creek the influence of the intrusion of the Nelspruit Granite along the contact with the rocks of the Mountain Land has been intense and there is developed in the area a wide variety of basic metamorphic rock-types.

In addition several metamorphosed siliceous horizons occur as intercalated bands within the basic rocks. These horizons are best developed in the area north of the Consort Mine but narrow towards Joe's Luck Siding. Further east from Eureka Siding to Louw's Creek identical siliceous schist horizons occur on both limbs of the tightly folded Lily Syncline.

The siliceous bands are generally the most resistant rocks in the area and stand out as distinct ridges in the basic schists. In places altered, silicified, shaly horizons often occur together with the quartz-sericite-schists or with purer quartzitic bands.

Serpentinites, of which the green variety predominates, occur as concordant bodies lying between siliceous schist horizons, particularly in the area north of Consort Mine. The remaining serpentinite bodies in the area invariably occur in the neighbourhood of major regional strike faults, e.g. the Kaap River Fault and the Lily Fault. Blue serpentinite bodies of smaller dimensions occur close to the granite contact also in the area north of Consort Mine.

The detailed structural history of the Consort Mine - Louw's Creek area can be referred to in the earlier mentioned reports. Briefly, however, it must be pointed out that the rocks in this locality have suffered several stages of intense deformation with the result that they have been subjected to considerable dynamic metamorphism. Large scale folding can be seen together with minor structures and a strongly developed foliation and schistosity is manifest throughout the area.

The combined effects of thermal metamorphism, coupled with the structural deformation of the successions, has created a prodigious variety of rock-types that were collectively grouped together in the Jamestown Igneous Complex by the Geological Survey (Visser, et. al., 1956). The detailed remapping and petrological study has resulted in a more rigorous classification of the rock-types into categories that enable regional correlation to be effected with confidence.

(b) The Jamestown Schist Belt

Adjoining the Consort Mine - Louw's Creek segment, and continuous with the latter, is the Jamestown Schist Belt, about which little has been written. Reference is made to the area by the Geological Survey (Visser, et. al., 1956) but no specific account of the Schist Belt has yet been presented.

Recently the area was remapped by C. R. Anhaeusser as part of the program of research currently being undertaken in the Barberton area by the Economic Geology Research Unit of the University of the Witwatersrand.

As the latter investigation is not complete no detailed account of the geology of this belt is yet available. The brief description of the Schist Belt in this paper, is, therefore, to be followed at a later date by a more comprehensive account of the structure, stratigraphy, metamorphism and economic mineral potential of the area.

The Jamestown Schist Belt occupies a narrow zone wedged between the Kaap Valley Granite in the south and the Nelspruit Granite in the north. It has a maximum width of about 4.5 miles immediately west of the Consort Mine from where it tapers rapidly to the northwest before disappearing beneath the younger cover of the escarpment formations (Figure 1).

The rocks of the Schist Belt, like those in the Louw's Creek - Consort Mine area, have also been deformed and metamorphosed to a considerable degree, again with the result that a wide variety of essentially basic rock-types is developed throughout. With a few exceptions the rocks have suffered the imprint of a strong regional foliation or schistosity that nearly everywhere parallels both the granite contacts and the trend of the Schist Belt itself.

Structurally the belt is a tight isoclinally folded syncline (the Jamestown Syncline), the axial plane of which strikes in a northwesterly direction. Best developed is the northern limb of the Syncline whose maximum thickness is approximately two miles. Only part of the southern limb of the Syncline is present, the remainder either having been faulted away or more probably stoped out and assimilated by the intrusion of the Kaap Valley Granite pluton.

A regional strike fault, the Albion Fault, occurs along the southern limb and in the area west of Clutha Siding acts as a detachment plane for a major disharmonic fold structure.

A boat-shaped synclinal core of basic and ultrabasic rocks occupies the centre of the Schist Belt between Noordkaap and the Barberton-Nelspruit road.

The axial plane of the Jamestown Syncline, which trends through the centre of this core, has been deflected to the north where it lies adjacent to the disharmonic fold mentioned earlier, with the result that it alters from a northwest-striking structure in the Worcester Mine area to an east-west-striking fold in the Noordkaap area.

The rocks underlying the central core of the Syncline consist of a variety of basic schists together with zones of serpentinite. A fundamental difference between this zone of rocks, as opposed to those of the central core, is the prevalence of a number of siliceous bands. These form conspicuous ridges which can be traced eastwards where they are continuous with the layered succession established in the area north and east of the Consort Mine.

At least six separate siliceous bands were noted on the northern limb of the Syncline whereas on the southern limb all but a few of the siliceous and cherty marker horizons have been truncated by the emplacement of the Kaap Valley Granite.

The uppermost siliceous band has its fold hinge in the neighbourhood of the Worcester Mine while the remaining siliceous bands forming part of the lower succession in the area continue westwards, several of them forming further fold hinges.

The rocks of the central core of the Syncline contain no siliceous members although in many places quartz and felspar porphyries were recorded. These porphyritic rocks are not unlike tongues of Kaap Valley Granite that occur as cross-cutting veins and concordant lenses in the contact schists of the lower division.

DETAILED COMPARISON OF THE NORTHERN AND SOUTHERN AREAS

A. LOWER ONVERWACHT OR THEESPRUIT STAGE

(a) Southern Area

The Lower Onverwacht succession in the southern area consists predominantly of a sequence of metamorphosed basic lavas with interlayered siliceous sediments and occasional narrow carbonaceous chert horizons. Bands and lenses of serpentinized ultramafites are also typical of the lower division.

The thickness of the succession is variable, partly because of the transgressive nature of the intrusive granite body to the south, and partly because of a stratigraphic thinning to the west. Two large strike faults, viz., the Theespruit Fault and the Komati River Fault, have also influenced the true thickness and have truncated some horizons. The total thickness of the Theespruit Stage varies from 2,000 feet in the west to 9,000 feet in the east, the latter probably representing the true width of the Stage where best developed. The Theespruit Stage has been divided according to lithology into seven sub-stages (Viljoen and Viljoen, 1965a).

One of the main distinguishing features of the Theespruit Stage is the occurrence of numerous siliceous horizons. Up to 16 of these were recorded, but,due to the above-mentioned factors, do not all persist across the entire area. These horizons are confined to the Theespruit Stage and are unmistakable in the field, standing out clearly as low, white ridges often associated with black carbonaceous chert. Their thickness is variable, the narrower bands averaging from 10-20 feet but sometimes diminishing to only one foot in width. The larger bands average about 100 feet in width, but attain thicknesses of over 200 feet in places. They tend to be roughly grouped into zones separated by broad areas comprised solely of lava. The majority of these distinctive rocks are fine-grained and friable, consisting almost entirely of microcrystalline masses of quartz, together with small aligned sericite flakes. Other minerals occurring in lesser amounts include staurolite, andalusite and muscovite. Some of the horizons appear discoloured and greyish due to the presence of minute specks of black, opaque, possible organic material. Towards the middle of the Stage a siliceous horizon is developed that is subtly different from the majority of those described above. This horizon is generally rather massive without banding or bedding and has the appearance of a salic agglomerate or tuffaceous agglomerate mixed with siliceous material. The main minerals occurring in this rock are fine-grained quartz, sericite, biotite and sodic felspar, together with crystals of andalusite and staurolite.

A feature of most of the siliceous horizons is the frequent termination of upper contacts by bands of black carbonaceous chert. The latter average about six inches in width. Towards the middle of the Stage a zone is developed that contains black, somewhat dull, slaty, chert-like carbonaceous lenses and bands. In general, all the chert occurrences associated with the Lower Onverwacht tend to be of a carbonaceous, slaty type. Dense, fine-grained glassy-looking cherts are well developed only in the uppermost siliceous band of the Lower Onverwacht. A nine foot thick, well-banded, light greenish chert occurs near the centre of this band, and a six foot black banded chert at the top. In addition to the chert bands, narrow lenses of almost pure carbonate occur within this uppermost marker.

The lavas of the lower part of the Theespruit Stage have generally been converted into a variety of dark green to blackish amphibole rocks that represent the products of thermal metamorphism produced by the intrusion of the granite in the south. No dynamic metamorphism is evident and original structures such as pillows and amygdales can generally be discerned. The main amphibole is actinolite together with lesser amounts of hornblende, grunerite and cummingtonite. Quartz and sodic plagioclase also occur in small amounts. In the upper part of the Theespruit Stage, the lavas are less thermally metamorphosed than those near the base. The predominant minerals here are tremolite-actinolite with conspicuous, often abundant, chlorite and carbonate together with quartz and some sericitized felspar.

A number of narrow, apparently interlayered bodies of serpentinized ultrabasic are also typical of the lower part of the Theespruit Stage. Five such horizons are generally present and these vary in thickness from 30 feet to 650 feet. Antigorite, the most abundant mineral encountered in these rocks is clearly an alteration product of original olivine, relict crystals of which are often outlined by a secondary magnetite ring. Tremolite is frequently associated with the above minerals and it is concluded that these rocks must have had an original composition close to that of a dunite.

(b) Northern Area

In the Consort Mine - Louw's Creek area the entire succession of pre-Fig Tree rocks can be grouped into the Lower Onverwacht division. It is likely, however, as will be explained later, that some of the basic schists and serpentinites immediately north of the Consort Mine may also belong to part of the Middle Onverwacht group of rocks.

Further west, the maximum development of the Lower Onverwacht occurs on the northern limb of the Jamestown Syncline, with only partial development of some of the upper horizons on the southern limb.

The Lower Onverwacht consists for the most part of intercalated basic schists and siliceous horizons. In many cases the Nelspruit Granite is intrusive into dark "contact" amphibolites which consist mainly of green pleochroic hornblende together with plagioclase felspar and variable amounts of quartz. Locally along the contact, hornblende predominates and there is almost a complete exclusion of felsic constituents.

Frequently, a marked mineralogical banding is apparent with layers of pure hornblende adjacent to bands containing amphibole, quartz and felspar. The rocks are strongly foliated parallel to the granite contact and there is often a strong lineation due to the preferred orientation of hornblende crystals.

The lower portion of the succession has undergone thermal metamorphism due to the intrusion of the Nelspruit Granite along the northern contact of the Barberton Mountain Land. These rocks have been grouped into the hornblende-hornfels facies of contact metamorphism (Anhaeusser and Viljoen, 1965).

Further from the contact the grade of metamorphism decreases and green tremolite-actinolite schists become the dominant rock-type. These rocks consist mainly of pale green tremolite-actinolite together with smaller amounts of cummingtonite, zoisite, epidote, soda-plagioclase, chlorite, talc and quartz. In the Consort Mine area and in the Jamestown Schist Belt there are zones of serpentinite commonly separating the tremolite-actinolite schists from the contact amphibolites. Smaller serpentinite bodies frequently occur within the tremolite-actinolite zone and grade into almost pure tremolite. These pure tremolite rocks have apparently been derived from the alteration of serpentinite bodies and differ from the tremolite-actinolite schists described above in that they do not contain any other minerals.

The degree of mineralogical banding and mineral orientation here is distinctly less than that of the contact amphibolite zone but nevertheless there is invariably a schistosity. The mineral assemblage appears to be typical of the albite-epidote-hornfels facies as defined by Turner and Verhoogen (1960).

Talc carbonate, talc-chlorite and chlorite schists are developed still further from the influence of the intrusive granite contact and occur south of the Lily quartzite horizon between the Consort Mine and Louw's Creek. They are also well developed in the Jamestown Schist Belt. Fresh outcrops of talc-carbonate schist are greenish-grey, but where weathered may have a dirty pinkish-brown colouration. The schists often contain amygdale-like patches that consist either of pure white carbonate or a pinkish-brown carbonate which is possibly siderite. Where weathered the rock develops a 'pocked' surface consisting of hollows, either empty or partially filled with limonitic material.

The chloritic schists contain long bladed crystals arranged parallel or sub-parallel to one another and often display a marked lineation. The majority of the basic rocks in the lower sequence of the Jamestown Schist Belt consist of chlorite schists together with some carbonate, quartz, magnetite and actinolite.

These schists are usually strongly sheared and may display a development of intense minor folds and lineation. The mineral assemblage has been grouped into the greenschist facies (Anhaeusser and Viljoen, 1965).

Green and blue varieties of serpentinite also occur in the lower sequence as concordant strips lying between the contact-type amphibolites and the tremolite-actinolite schists. In addition serpentinites occur between bands of siliceous schists and quartzites north of the Consort Mine and in places along both limbs of the Jamestown Syncline. Near the Kaap Valley Granite contact secondary dolomitic masses, thought to be "sweats" from the alteration of serpentinites and basic schists, are also developed.

Green serpentinite masses also occur as discordant, apparently intrusive, masses confined to zones of faulting. An example of this is the mass of serpentinite tectonically intruded into the Lily Syncline quartzite horizon near Sheba Siding. This serpentinite was introduced along the Kaap River Fault. The Lily Fault further south also provided a suitable environment for the tectonic intrusion of serpentinite masses.

Occurring concordantly within the variety of basic rock-types enumerated above are a number of siliceous bands composed essentially of quartz with smaller amounts of fine sericite flakes. In addition these rocks may contain local developments of sillimanite, andalusite, staurolite and chloritoid. Smaller amounts of garnet, fuchsite (chrome muscovite) biotite, tourmaline, clino-zoisite, magnetite, ilmenite, leucoxene, pyroxene (diopside-diallage) and twinned and untwinned felspar (albite or microcline) have also been observed. Often the siliceous horizons contain various types of chert (green, white, black in colour) together with shaly and slaty material, carbonate bands and lenses as well as dark carbonaceous shales and slates.

The distance of these horizons from the intrusive granite contacts is manifested by mineralogical, petrological and textural changes. Aluminous siliceous horizons occurring near the contact north of the Consort Mine contain the fibrous, high temperature metamorphic mineral sillimanite. Similar rocks further from the contact contain poeiciloblastic porphyroblasts of andalusite. These last mentioned siliceous schists occur in the field as nodular highly sheared bands and were formerly regarded by the Geological Survey as tongues of altered Nelspruit Granite, intruded into the Jamestown Schist Belt (Visser, et. al., 1956).

Invariably the siliceous horizons are intensely deformed, sheared and sometimes mylonitic in character. Their brittle nature has facilitated the imprint of minor structures such as conjugate and "kink band" folds and associated lineations.

(c) <u>Discussion</u>

The problem involved in equating the rocks of the Lower Onverwacht succession in the Komati River Valley with those of the northern portion of the Mountain Land is essentially one of correlating relatively unmetamorphosed rocks with other more strongly metamorphosed and sheared rocks. The main criteria used for the recognition of the original nature of the rocks in the Komati River Valley were primary structures such as pillows, amygdales and bedding. Correlation with rocks of the northern area was made difficult because most of the primary structures in the latter region have been effectively obliterated by thermal and dynamic metamorphism. These metamorphic alterations have also destroyed many of the significant field relationships. There remained as an instrument of correlation the chemical, petrological and mineralogical composition of the rocks, in addition to the position stratigraphically of distinct rock assemblages.

From a correlative viewpoint all the component rock-types recognized in the southern area are recognizable in the northern part of the Mountain Land. The main varieties encountered in both areas comprise basic schists (or meta-basalts) together with a number of siliceous horizons and ultrabasic zones.

In the Komati River Valley, most of the rocks show signs of original pillow structures and amygdales. The main minerals present were found to be tremolite-actinolite and lesser amounts of quartz and felspar. This mineral assemblage indicates metamorphism of the albite-epidote-hornfels facies. The almost entire absence of dynamic metamorphism was of importance because it assurred the preservation of original structures, irrespective of thermal metamorphic effects.

In the northern area, however, thermal metamorphism near the granite contact produced black "contact" amphibolites consisting mainly of hornblende together with lesser amounts of felspar and quartz. This suite of minerals was produced by metamorphism characteristic of the hornblende-hornfels facies, which is of a higher grade than the majority of thermally metamorphosed rocks in the Komati River Valley. Felspar and quartz appear to have migrated into small bands and lenses by a process of metamorphic differentiation giving the rock a banded appearance. This banding has been accentuated by strong shearing, and in their present form the rocks do not resemble basalts in the field although petrologically they are similar. This has led some previous investigators to the spurious conclusion that the contact amphibolites were partly derived from impure dolomitic sediments, the banding being strongly suggestive of bedding. Further from the contact, the metamorphic grade and mineralogical banding decreases, giving rise at first, to tremolite-actinolite schists (comparable in composition to the meta-basalts of the Komati River area), and finally to talc-carbonate, talc-chlorite and chlorite schists. These rocks are, however, partially sheared and most primary structures have been obliterated. Unequivocal sheared amygdales have, nevertheless, been observed in some localities.

Ignoring the metamorphic overprints outlined above the petrological similarity of the rock-types is too marked to be fortuitous. In addition to the basalts, zones of ultrabasic, now predominantly serpentinized, are common to both areas. In the south they generally occur as stratiform sheets interlayered with amphibolitized pillow basalts and can be traced for several miles along strike. In the north, bodies of serpentinite occur interlayered with amphibolites. Although occurring more abundantly than in the south these serpentinites are not as continuous along strike and tend to form discontinuous lenses. The lensoid nature of the serpentinites is interpreted as a manifestation of the greater stress field that was operative in the northern area. The formation of lensoid bodies of serpentinite from a presumably continuous band is characteristic of serpentinized ultrabasics which have been subjected to stress. Despite the rather irregular nature of the ultrabasic bodies in the north the similarity in stratigraphic positions of this rock-type in both areas is compelling evidence in support of the suggested correlation.

The most diagnostic rocks and those which provide strong evidence for correlation are the siliceous- sericite-bearing sediments and associated slaty cherts which are only developed in the Theespruit Stage of the southern area. Here they have been little affected by thermal and dynamic metamorphism and outcrop as distinctive narrow white ridges within the black amphibolites. The stratigraphic continuity of identical rocks in the northern area was also described. These horizons have previously been classified either, as Fig Tree cherts or sheared veins of Nelspruit Granite, and were shown to be totally unlike the latter rock-types. Distinctive quartz-sericite rocks as well as their associated discontinuous slaty chert lenses and bands are unknown in either the Fig Tree or Moodies Series.

One of the most characteristic and diagnostic features of these predominantly quartz-bearing rocks is their aluminous composition. This is manifested by the formation of typical metamorphic aluminous minerals such as andalusite, sillimanite and staurolite, besides the constant presence of sericite. In the south, andalusite and staurolite are frequently encountered but in the northern area the siliceous horizons are characterized by a greater variety of aluminous minerals including andalusite, staurolite, chloritoid and sillimanite, the latter mineral indicating a higher grade of metamorphism. Besides the frequent occurrence of aluminous minerals these siliceous rocks are often overlain by narrow black carbonaceous cherts. The close association of the cherts with the aluminous siliceous horizons in both areas under consideration leaves little doubt as to the validity of the proposed correlation. This, taken together with the other stratigraphic similarities outlined above, is regarded as conclusive evidence that the rocks of the Theespruit Stage in the south can be correlated with similar rocks from the northern portion of the Mountain Land as indicated on the map (Figure 1).

B. MIDDLE ONVERWACHT OR KOMATI RIVER STAGE

(a) Southern Area

Rocks of the Middle Onverwacht succession in the southern part of the Barberton Mountain Land form a continuous zone of outcrop some 12 miles long in the Komati River Valley from the eastern portion of the farm Boekenhoutrand 722 JT in the west to the eastern portion of Laaggenoeg 158 IT in the east.

As the detailed stratigraphy of this zone has been described elsewhere (Viljoen and Viljoen, 1965a) only the more important features pertaining to the correlation of similar rock-types in the northern portion of the Mountain Land are included in this section.

The rocks of the Middle Onverwacht sequence consist of a large pile of interlayered pillow basalts and ultrabasic horizons some 11,500 feet thick in the area of maximum development. The basalts which in some areas display well-developed pillow structures and amygdales are interlayered with ultrabasic bands that are considered to represent interlayered ultrabasic lavas (Viljoen and Viljoen, 1965b). The entire succession is comprised of distinctive bands and ridges that constitute a continuous layered sequence.

Partial serpentinization of the ultrabasics and alteration of the basalts produced locally some basic schists in which original structures such as amygdales and pillows (in the basalts) were not clearly discernable. Carbonation of both the basalts and the ultrabasics on weathering, or where subjected to shearing, is a common characteristic of this zone. The basalts were altered to various types of amphibole-talc-chlorite schists with carbonate, whereas the ultrabasics gave rise firstly to serpentinite and finally to talc schists and talc-carbonate schists. In many cases it was difficult to decipher the original nature of these altered rocks.

Local shearing has often caused the development of cross-fibre seams of chrysotile asbestos in the ultrabasic bands. The fibre is generally found to be brittle and short with individual deposits of limited extent. Some mining, mainly on a prospecting basis, has taken place in the area.

One of the most notable features of the Middle Onverwacht is the complete lack of any siliceous sediment or chert horizon. The absence of these siliceous interlayers was found to be a critical factor in the recognition of the Middle Onverwacht sequence. Also of importance is the occurrence of numerous intrusive bodies of quartz and felspar porphyry. These bodies were intruded parallel to the general foliation of the rocks and are largely confined to the Middle Onverwacht succession.

Faulting and shearing is a common characteristic of the sequence which is bounded by a longitudinal strike fault in the south (the Komati River Fault) and another probable fault (the Violet Fault), on the northern contact. Cross-faulting, due to a shearing couple, is well-developed in the Middle Onverwacht succession (Viljoen and Viljoen, 1965a).

In the upper portion of the sequence intense shearing (in the vicinity of the Violet Fault) has produced isolated lenses and pods of ultrabasic rock within the main mass of sheared basalt. Originally continuous ultrabasic bands have thus given rise to a number of disconnected serpentinized lenses which may be interpreted as intrusive ultrabasic bodies.

(b) <u>Northern Area</u>

Rock-types now considered to be representatives of the Middle Onverwacht succession in the northern area of the Barberton Mountain Land are practically confined to the central synclinal core of the Jamestown Schist Belt. Some development of these rocks probably also occurs in the neighbourhood of the escarpment near Kaapsehoop and in the region immediately north and west of the Consort Contact in the Consort Mine area.

In the Jamestown Schist Belt the core of the Jamestown Syncline consists of a variety of basic rock assemblages with the total exclusion of any siliceous or cherty horizons. Maximum development of the middle division occurs in the area due west of Noordkaap where the predominantly basic core of the Jamestown Syncline approaches two miles in width.

The various basic assemblages occupy a position above the upper siliceous marker horizon of the Lower Onverwacht Series. This horizon closes and folds around in the neighbourhood of the Barberton-Nelspruit road near the Worcester Mine.

The rocks of the middle division comprise a variety of generally serpentinized ultramafics, tremolite-actinolite schists, tremolite-chlorite-talc schists, talc-chlorite-carbonate schists, amygdaloidal talc schists and talc-carbonate rocks.

In addition the zone contains some dolomite and deposits of economically recoverable talc and asbestos. The semi-precious ornamental stones, verdite and buddstone have also been mined in the area. Massive lava or dyke-like rocks, now mainly amphibolitized, lie concordantly with the basic assemblages described above. Several of these bodies are concentrically folded in the disharmonic fold structure north of Caledonian Siding. If these rocks were originally dykes they are the only folded hypabyssal rocks yet recorded in the Barberton Mountain Land.

The serpentinites occur as distinctive bands and ridges, interlayered with amphibolitized basaltic lava horizons and although often disconnected and lensoid they do, nevertheless, appear to be part of a layered succession. The mass of serpentinite on Mundt's Concession west of Noordkaap forms the eastern fold hinge of part of the Jamestown Syncline. Photogeological interpretation clearly demonstrates the continuous nature of the serpentinite bands and their folded nature. This obvious layering within the serpentinites as well as the folded disposition of the units is additional strong evidence for the contention that these rocks formerly comprised a continuous layered or stratigraphic succession.

A characteristic of the serpentinite bands in the western part of the area is their lensoid nature. The serpentinites give way along strike to zones of tremolite or talc, reappearing again as further lensoid ridges. Frequently tremolite or talcose rocks envelop the serpentinites and are clearly a result of steatization.

Invariably the serpentinite bands are separated from each other by zones of chloritic schist. Carbonate, chlorite, magnetite, quartz, and plagioclase felspar (often altered to sericite), are found in these rocks. In addition there are zones where flattened amygdales were also recorded. As the rocks are strongly deformed and schistose the original textures and structures have been obliterated, yet, at times, there are outcrops displaying phenomena suggestive of deformed pillow structures.

It is suggested that the serpentinite bodies together with their alteration products are the direct result of transformation of ultramafic horizons and that the essentially chloritic schistose rocks represent original interlayered basaltic lavas.

The picture has, however, been obscured by metamorphism and deformation coupled with the widespread effects of carbon-dioxide metasomatism.

The basic and ultramafic rocks are also intruded by bodies of quartz and felspar porphyry which resemble the intrusive tongues and concordant lenses of Kaap Valley Granite found along the southern contact of the Jamestown Schist Belt. Porphyritic rocks of this type were not observed in the northern limb of the Jamestown Syncline, and apart from the local occurrences of porphyritic material along the Kaap Valley Granite contact, the major development of these bodies occurs in the Middle Onverwacht succession.

(c) Discussion

In both the northern and southern areas of the Mountain Land discussed, the Middle Onverwacht or Komati River Stage is characterized firstly, by the development of basic and ultrabasic rocks together with minor intrusive bodies of quartz and felspar porphyry and secondly, by the entire absence of siliceous sedimentary or cherty horizons. Further testimony as to the similarity of the basic and ultrabasic assemblages in the two separate localities lies in a critical examination of the rock-types and their various alteration products. It must be realized and stressed that the areas were subjected to entirely different conditions of deformation and metamorphism with the result that the variations of rock-types is considerable. A critical examination of the stratigraphy in both areas, however, strongly suggests that the rock-types were derived from identical source rocks.

The southern area has proved critical for a complete understanding of the varied problems relating to the disparity of rock-types particularly prevalent in the area north of Barberton. A classic section of the Middle Onverwacht succession in the Komati River Valley has illustrated the indisputable interlayered nature of basaltic lavas, containing pillow structures and amygdales, and ultramafic horizons that thin sympathetically with the lava horizons. It has been shown that even in this area where the continuous nature of the horizons is irrefutable, serpentinization and other forms of alteration of the ultrabasics and basalts takes place very readily resulting in a variety of basic schists in which original structures are not easily discernable. With this knowledge, the once bewildering array of basic schists can now more readily be categorized.

Original structures in the basic and ultrabasic rocks such as pillows and amygdales are unfortunately, very easily destroyed by even mild alteration and deformation. The absence of these structures which would normally provide incontestable proof of correlation is thus no criteria for rejection of the observed stratigraphic relationships. Although no unequivocal proof exists of pillow structures in the northern region there have locally been preserved a number of flattened, yet unmistakable, amygdales.

Finally, a broad basis of classification that can be applied to most regions around the Mountain Land where basic rocks are present can be summed up briefly as follows :- (1) serpentinites and their steatized derivatives consisting of tremolite and talcose rocks were probably derived from primary ultrabasic rocks, and (2) amphibolites (hornblende, actinolite rocks) and chloritic schists as well as some talc-chlorite-carbonate rocks were probably derived from original basaltic to intermediate lavas.

C. UPPER ONVERWACHT OR HOOGGENOEG STAGE

(a) Southern Area

Overlying the Middle Onverwacht sequence is a well developed succession of pillow basalts with numerous interlayered zones of andesitic to acid lavas. This succession constitutes the lower part of the Hooggenoeg Stage and is unconformably overlain by a broad, irregular zone of probable acid lavas. These rocks constitute the upper part of the Hooggenoeg Stage.

Where best developed in the eastern part of the area the entire succession reaches a maximum thickness of 15,500 feet but in the west diminishes to 10,000 feet.

The lower succession comprises a number of cycles, each commencing with a broad zone of basaltic pillow lavas. These are followed by narrower, intermediate to acid lavas and the cycle is frequently terminated by narrow, persistent, well-banded and often carbonaceous chert horizons. Various calc-silicate and carbonate rocks are usually associated with these chert horizons.

Seven cycles can be recognized, four of which form distinct and persistent units in the type area. These units vary in thickness from 1000 feet to 4,600 feet.

The Upper Onverwacht or Hooggenoeg Stage is overlain by basal chert horizons of the Fig Tree Series.

Although similar to both the Lower and Middle Onverwacht sequences in that it consists essentially of lavas, the Hooggenoeg Stage is characterized by features which make it distinctly different from the former two subdivisions. Being further from the granite contact the degree of thermal metamorphism is much less, and many of the rocks are often strongly carbonitized. The predominant mineral in the more basic lavas is chlorite, together with sodic plagioclase and carbonate. Characteristic of the Stage, however, is the occurrence of intermediate to acid lavas. The main minerals encountered in these volcanic rocks are sodic plagioclase, quartz, chlorite, sericite and some carbonate.

(b) Discussion

As the various rock-types and associations of the Upper Onverwacht succession do not occur in the northern part of the Mountain Land, only a brief account of the subdivision has been given. A more detailed description can be referred to elsewhere (Viljoen and Viljoen, 1965a).

The absence of the Upper Onverwacht succession in the north was probably due to non-deposition of these rocks in the area, together possibly with some faulting. As will be shown later, however, horst blocks consisting of Upper Onverwacht rocks, have been noted well within the Mountain Land.

The main features of the Upper Onverwacht, and those which made it distinctly different from the Lower and Middle Onverwacht successions, are listed below.

1. Being the furthest away from the granite contact, the degree of thermal metamorphism was found to be generally less than that of the Lower and Middle Onverwacht sequences. Thus, instead of amphibole, the main mineral encountered was chlorite, together with some altered sodic plagioclase and carbonate.

2. White-weathering, intermediate to acid lavas are confined to this stage.

3. Unlike the Lower Onverwacht with its siliceous, sedimentary horizons and sporadically developed, narrow, slaty chert bands, the Upper Onverwacht contains well-developed, interlayered and persistent banded chert horizons.

4. It differs from both the Lower and Middle Onverwacht Stages in that it contains very little, if any, interlayered ultrabasic material, although a number of ultrabasic dykes do occur.

POSSIBLE CORRELATION WITH OTHER AREAS OF THE BARBERTON MOUNTAIN LAND

A. NORTHERN AREA

Apart from the Jamestown Schist Belt and the Consort Mine - Louw's Creek area which has been discussed at length in this paper, there are four other regions on the northern side of the Barberton Mountain Land that can very briefly be mentioned as possible further correlatives of the Onverwacht Series. These are :

1. The narrow belt of basic rocks occurring between Barberton and Caledonian Siding.

2. The more extensive zone of basic rocks southwest of Barberton

3. The area from Louw's Creek northeast to Kaapmuiden, Malelane and Hectorspruit.

4. Remnants of basic rocks occurring mainly as xenoliths in the Nelspruit Granite north of the Mountain Land.

(a) Barberton-Caledonian Siding Area

A narrow belt of essentially basic schists occurs between the Kaap Valley Granite and the Eureka Syncline (Figure 1). Also included in this zone are lenses of serpentinite, dolomitic rocks, a narrow chert and shaly horizon and some quartz and felspar porphyries. The majority of the rocks consist of tremolite-actinolite schists, chlorite-talc schists and talc-carbonate schists. Outcrops are poor but it is tentatively suggested that a narrow portion of the western edge of this schist belt be grouped with the Lower Onverwacht, while the rocks immediately overlying the narrow siliceous, cherty marker horizon mentioned above, be grouped with the Middle Onverwacht Stage. The siliceous marker can be traced northwest of Caledonian Siding where it forms the upper siliceous horizon in the Jamestown Schist Belt. The Middle Onverwacht between Barberton and Caledonian Siding, like the latter stage in the Jamestown Schist Belt, contains lenses of quartz and felspar porphyry but is otherwise solely comprised of basic schists and serpentinite. These rocks are overlain by Fig Tree shales, cherts and banded ironstones. The Upper Onverwahct is not developed in this locality.

East of here between the Eureka and Ulundi Synclines, serpentinites and carbonate-chlorite-talc rocks apparently occupy the lowest stratigraphic position and occur in the cores of anticlines. Van Vuuren (1964) believed these rocks to be metamorphic derivatives of ultrabasic igneous rocks as they were found to contain high trace element percentages of chromium and nickel. It is thus contended that this basic rock assemblage belongs to a tectonically folded and faulted Middle Onverwacht sequence which presumably underlies the sedimentary successions of the Fig Tree and Moodies Series. The Upper Onverwacht is not developed in this strip.

Between the Barbrook and the Saddleback Faults there is a narrow belt of rocks correlated with the Onverwacht Series by the Geological Survey (Visser, et. al., 1956). Steyn (1965) compared these rocks to the Onverwacht successions in the lower reaches of the Komati River between the Msauli Asbestos Mine and Steynsdorp. He described fine-grained sheared andesitic to basaltic lavas with interlayered massive banded cherts, shales, greenschists, dolomite and lime-silicate rocks in the Belt between the Barbrook and Saddle-back Faults. The Msauli Asbestos Mine area has been classed as Upper Onverwacht or

Hooggenoeg Stage (Viljoen and Viljoen, 1965b). They found the factors supporting this contention to be the presence of basic lavas, some resembling andesites, the massive banded cherts, the silicified, ferruginous shales and calc-silicate rocks. This assemblage is similar to that reported by Steyn (1965) in the area east of the Florence Mine in the Barbrook Fault area. It would thus appear that faulting has elevated a portion of the Upper Onverwacht sequence to a position where it occurs in juxtaposition with Moodies rocks in the south and Fig Tree rocks in the north.

(b) Area Immediately Southwest of Barberton

An account of this region has been presented by Cooke (1965) who showed that a wide variety of basic rock-types, together with interlayered sedimentary horizons, occurred in a zone formerly regarded as belonging to the Jamestown Igneous Complex by the Geological Survey (Visser, et. al., 1956).

Hornblende and actinolite-tremolite amphibolites were found close to the Kaap Valley Granite. These rocks also contained altered plagioclase, felspar, talc, calcite, biotite, magnetite and some quartz. Shales and phyllites in close association with the amphibolites and talcose rocks occurred as interlayered bands.

A few thin intercalated horizons of chert and quartz-sericite were recorded mainly in the northwestern corner of the area where they occur within the amphibolites. Cooke (1965) also reported the occurrence of quartz and felspar porphyries enveloped in shales and talcose rocks.

Green and blue serpentinites occur as elongated bodies parallel to the regional trend in the area and dolomitic and carbonate rocks, frequently altered from the serpentinites, were found adjacent to post-Moodies strike faults. Talc-carbonate-chlorite rocks are extensively developed immediately southwest of Barberton where they usually enclose serpentinite bodies and were probably formed from the alteration of primary ultrabasic and basaltic material.

It is suggested that the area comprises essentially rock-types of the Middle Onverwacht succession manifested by the serpentinites and amphibolites. In addition it seems likely that the intercalated bands of chert and quartz-sericite rocks entirely surrounded by amphibolites in the northwest corner of the area possibly represent the Lower Onverwacht group.

(c) Louw's Creek - Kaapmuiden - Hectorspruit Area

Detailed remapping of this area has recently been completed by M. and R. Viljoen, but as yet no description of the area is available. The views expressed here on correlation were formulated prior to the remapping of the area and were based essentially on existing descriptions by the Geological Survey (Visser, et. al., 1956), and from personal reconnaissance trips by the writers.

East of Louw's Creek, outcrops are poor and the area consists essentially of arable farmlands. A few isolated, highly sheared and altered zones of siliceous material, were, however, found. These corresponded to the interlayered sedimentary quartz-sericite-schist horizons found in the Lily Syncline to the west (Anhaeusser, 1964). It is considered that this altered siliceous material occurs in much the same manner as in the area between the Consort Mine and Louw's Creek where the siliceous bands were found intercalated with basic schists. This section is, therefore, regarded as the easterly continuation of the Consort Mine - Louw's Creek schist belt mentioned above, and is correlated with the Lower Onverwacht succession.

South of the Crocodile River, between Kaapmuiden and Malelane there is developed a four mile wide belt of rocks grouped with the Jamestown Complex by the Geological Survey (Visser, et. al., 1956). A variety of basic schists are interlayered with several well-defined bands and ridges of blue and green serpentinite. The Geological Survey also reported from the southern part of this belt, "several narrow bands of banded, siliceous rock and acid lava".

Many of the basic schists are identical to the dark hornblende types found along the northern contact near the Consort Mine. The massive serpentinite occurrences have yielded chrysotile asbestos. Magnesite has also been mined. Furthermore, Hall (1918) recorded quartz porphyry in the area south of Hectorspruit and considered it to be fundamentally similar to outcrops of quartz porphyry he had observed near the Violet Mine on the farm Hooggenoeg 731 JT in the Komati River Valley and in the area south of Barberton.

The rocks of this belt can clearly be equated with the Onverwacht Series as defined elsewhere in the Barberton Mountain Land, but a precise breakdown into a lower, middle or upper division at this stage is not possible although it is suggested that only the Lower and Middle Onverwacht divisions occupy this area.

<u>NOTE</u>: The recently completed mapping of the Kaapmuiden - Hectorspruit area by M. and R. Viljoen has verified that the rocks in this area need be included in the Onverwacht Series. Much additional supporting evidence has become available including the occurrence in many places of pillow and amygdaloidal basalts.

(d) <u>Remnants in the Nelspruit Granite</u>

Numerous large bodies of basic schist occur in the area north of the Consort Mine from where they can be traced well into the granite in an easterly direction and give the impression of having been formerly connected with the basic schists in the Kaapmuiden region. Further large- and small-scale xenoliths of this type occur north of the Crocodile River in the southern section of the Kruger National Park. These rocks, essentially composed of hornblende amphibolite, are regarded by the writers as being down-folded remnants of the once extensive Lower Onverwacht succession. Careful examination of these occurrences may reveal the presence of isolated siliceous horizons of the type described from the Consort Mine area.

B. <u>SOUTHERN AREA</u>

(a) <u>The Komati River Valley</u>

In the Komati River Valley in the southwestern part of the Mountain Land, a four mile wide section across the pre-Fig Tree successions has been classed as the type area of the Onverwacht Series. As described elsewhere however, (Viljoen and Viljoen, 1965b), the three main stages of the Onverwacht Series can be traced laterally for many miles, both to the east and to the west of the type locality.

Proceeding westwards, all three stages of the Onverwacht Series thin out appreciably. This is due to a number of combined factors, viz.,

1. a definite stratigraphic thinning of all horizons and zones in a westerly direction.

2. elimination of parts of the succession by faulting, particularly in the Middle Onverwacht sequence.

3. intrusion and transgression of the granite in the south erradicating an unknown amount of the Lower Onverwacht sequence.

The Upper and Lower Onverwacht Stages persist, although greatly reduced in thickness, for six miles to the west of the type area before the Upper Stage is wedged out. The Lower Onverwacht succession continues for another three miles towards the extreme southwestern part of the Mountain Land. About 2.5 miles west of the type locality, the Middle Onverwacht tapers and disappears completely. This wedging out as mentioned above, is mainly due to faulting.

All three stages extend east of the type locality for about four miles before being strongly folded about a northeast-trending fold axis. All the horizons then swing abruptly to the south and trend approximately at right angles to the east-southeast trend of the type locality. This major fold, probably also accompanied by faulting, has caused the almost complete erradication of both the Lower and Middle Onverwacht Stages in this area. To the east of the fold axis only the Upper Onverwacht sequence is present. These rocks were found to extend to the Msauli Asbestos Mine and to the Ingwenya Range on the Swaziland border.

(b) <u>The Nelshoogte Schist Belt</u>

Occurring to the south of the Kaap Valley Granite and almost completely separating the latter pluton from the granitic terrain north of Badplaas, is an elongated, wedge-shaped mass of basic rocks termed the Nelshoogte Schist Belt. In many ways this belt is analogous to the Jamestown Schist Belt which separates the Kaap Valley Granite pluton from the Nelspruit Granite to the north.

The Nelshoogte Schist Belt is comprised mainly of a variety of basic schists and layered ultrabasic bodies with little siliceous or sedimentary material other than that found along its northeastern contact. Deformed pillow structures and amygdales were encountered in the basic schists and it is clear that the latter were derived essentially from basalts. The assemblage is thus similar to the Middle Onverwacht sequence with its alternating pillow basalts and ultrabasic horizons, and most of the Nelshoogte Belt has for this reason, been correlated with the latter. A narrow strip along the northeastern contact contains, in addition to basic schists and ultrabasic bodies, bands of chert together with siliceous horizons and slaty sediments. The latter assemblage is, by analogy, grouped with the Lower Onverwacht sequence of rocks (Figure 1).

Forming the base of the triangular Nelshoogte Schist Belt, and abutting against folded Moodies sediments of the Stolzburg Syncline to the southeast, is a 3,500 feet wide northeast-trending ultrabasic mass known as the Stolzburg serpentinite body. It is well-layered, steeply-dipping and has been completely serpentinized. The body is also fault-bounded along its southeastern as well as its northern contact. In view of its well layered nature and close petrological similarity to the Middle Onverwacht sequence, it is suggested that this body may represent part of the latter succession which was tectonically moved from its original stratigraphic position in the layered sequence to its present position, becoming completely serpentinized in the process.

C. OTHER AREAS

(a) Northwestern Swaziland

Flanking the eastern part of the Mountain Land along the northwestern border of Swaziland, is a strip of basic rocks which trends in a northeasterly direction and separates the central granitic terrain of the latter territory from Fig Tree and Moodies rocks to the west. A detailed petrological account of the Forbes Reef area in the southern part of this belt, has been given by Urie and Jones (1965). A reconnaissance structural investigation of the same area has also been presented (Urie, 1965).

Most of this belt is regarded by the Swaziland Geological Survey (Hunter, 1961) as also belonging to the Jamestown Igneous Complex. Urie and Jones (1965) subdivided the southern part of the belt into two groups viz., the metasedimentary group and the magnesia-rich group. The former is included in the Jamestown Complex and the latter in the lower Fig Tree Series.

The metasedimentary group, occurring at the base of the sequence in contact with the granite, consists essentially of dark greenish-grey amphibolites. The main minerals are actinolite or hornblende together with smaller amounts of quartz, chlorite, biotite and rarely some sodic plagioclase and diopside. Occurring as interlayered horizons within these basic schists are a variety of siliceous rocks. These rocks are light in colour and are composed dominantly of fine-grained quartz and sericite. Other minerals encountered include andalusite, biotite and muscovite with amphibole, felspar, chlorite, epidote and sphene occurring less frequently.

The association of andalusite-bearing, quartz-sericite schist horizons within actinolitic schists, is considered strong evidence for classifying the so-called metasedimentary rocks into the Lower Onverwacht sequence. The basic rocks of the metasedimentary group have probably been derived from original basaltic lavas whereas the interlayered siliceous schists so characteristic of the Lower Onverwacht sequence from other parts of the Mountain Land comprise original primitive sediments. In view of the above evidence it is considered improbable that the metasedimentary rocks constitute the basal part of the Fig Tree Series.

The magnesia-rich schists are represented by a wide variety of serpentinous, amphibolitic and talcose rocks which appear to be largely, if not entirely derived from original ultrabasic and basic rocks. Siliceous horizons are virtually absent, although a few very minor and narrow chert bands have been recorded. This zone, therefore, has much in common with the Middle Onverwacht sequence. It seems likely however, that more ultramafic material is represented in this area and the well-banded, alternating sequence, found in other parts of the Mountain Land, is not as apparent. The similarity with the Middle Onverwacht succession is, however, evident and most of the magnesia-rich schists can be classed in this subdivision.

No detailed account of the basic schists in the far northwestern part of Swaziland is available, but the latter probably represent an extension of the basic schists of the Forbes Reef area. This, together with the available literature suggests that these rocks can also be correlated with the Lower and Middle Onverwacht sequences.

It might be noted in passing that amphibolitic and quartzitic rocks occur within the so-called Ancient Gneiss Complex of Swaziland (Hunter, 1965). Some of these rocks are very similar in composition to the amphibolites and siliceous horizons of the Lower Onverwacht. It is suggested that as in the case of the amphibolitic xenoliths within the Nelspruit migmatite north of Consort Mine, some of these bodies also represent isolated remnants of Lower Onverwacht material.

From the northern tip of Swaziland and trending in a northeasterly direction towards Komatipoort is a further belt of basic rocks about which little is known. The writers consider that this belt represents an extension of the basic assemblages in northwestern Swaziland. They further contend that these rocks represent one or more of the stages of the Onverwacht Series.

(b) Occurrences within the Mountain Land

Four main occurrences of Onverwacht rocks situated within the Mountain Land have been noted. Two of these have been referred to previously, viz., the rocks in the cores of anticlines associated with the Ulundi Syncline and the horst block between the Barbrook and Saddleback Faults.

Towards the southern part of the Mountain Land, numerous occurrences of Onverwacht rocks closely associated with Fig Tree sediments, have been mapped and described by the Geological Survey (Visser, et. al., 1956). From their description it appears likely that these rocks belong to the Upper Onverwacht succession, some of the siliceous material described, possibly forming part of the upper acid zone of the latter succession.

From the Barberton-Havelock Mine road and extending for many miles to the northeast, volcanic rocks have been reported by the Geological Survey (Visser, et. al., 1956), and are exposed at frequent intervals along the Makonjwa Range. For the greater part these lavas are exposed in erroded anticlinal arches in both Fig Tree and Moodies strata. Lavas ranging from basaltic to acidic varieties were found, many of them being amygdaloidal. Substantial chert bands were described as being interbedded with the lavas in places. From the above description these rocks may well represent the equivalents of the Upper Onverwacht.

Field mapping and petrological data led Herget (1963) to the conclusion that the serpentinites of the Montrose area were pre-Fig Tree in age. They contained layers of banded ferruginous chert, banded chert and shales and were found to occupy the cores of Zwartkoppie anticlines. T. Reimer (verbal communication) also found an association of banded cherts and serpentinites on the southern portion of the farm Schoongezicht 713 JT. Furthermore, both Herget (1963) and Reimer (verbal communication) suggested that these rocks be classed with the Onverwacht Series. However, neither of these investigators recorded the occurrence of basaltic or acidic lavas, and the serpentinites they found were associated with banded ferruginous cherts and shales. This assemblage is therefore different to any of the stages of the Onverwacht Series as developed in the type area in the Komati River Valley.

Also, from the position of the occurrence noted by Reimer, the serpentinites lie immediately above basal members of the Fig Tree Series. It is therefore suggested that this serpentinite-chert association may form a distinct layered zone close to the base of the Fig Tree Series. Thus, it seems unlikely that these rocks represent part of the Onverwacht Series.

(c) Remnants in the Badplaas Granite

Large amphibolitic tongues extend southwards into the Badplaas granitic terrain from the main outcrop of Onverwacht rocks in the Komati River Valley. They have a tendency to partly enclose adjacent homogeneous granite plutons in the area and in this respect are similar to the Jamestown and Nelshoogte Schist Belts which in turn separate the Kaap Valley Granite from the Nelspruit and Badplaas Granites respectively. The stratigraphy of these tongues that consist dominantly of amphibolites with interlayered siliceous horizons, leaves little doubt as to their similarity with the rocks of the Lower Onverwacht succession.

CONCLUSIONS

Detailed mapping in the southern and northern portions of the Mountain Land has indicated that it is possible to correlate with confidence the pre-Fig Tree successions of the Swaziland System. Reconnaissance surveys as well as a review of available literature has shown that this correlation is valid for most pre-Fig Tree rocks forming the periphery of the Barberton Mountain Land.

The Onverwacht Series, which refers to pre-Fig Tree rocks and which has its type area developed in the southern portion of the Mountain Land, has been divided into three stages the correlation of which around the Mountain Land has been effected by the use of distinctive marker horizons. These marker horizons have characteristic mineral assemblages and form recognizable features in the field. In addition the constant occurrence of certain stratigraphic sequences and rock associations is compelling evidence for correlation over large distances.

The three most important and distinctive rock-types within the Onverwacht Series are pillow basalts, ultrabasics and cherts. In other parts of the world this trinity of rocks is known as the ophiolite or greenstone assemblage and is characteristic of the initial magmatic phase of most geosynclines. As the Onverwacht Series lies at the base of the Swaziland System and, accounting for the fact that it is overlain by Fig Tree and Moodies rocks which are typical of the flysch and mollasse facies respectively, of geosynclines, it is concluded that the Onverwacht Series represents a true ophiolite assemblage. This being the case, it is reasonable to assume that the Onverwacht group of rocks should be developed not only in the southern portion of the Mountain Land (where the volcanic sequence attains a thickness of over 35,000 feet) but right the way around the Mountain Land.

Reconnaissance study has thus far supported this contention in localities far removed from the two principle areas discussed in this paper. As is common with ophiolite or greenstone assemblages, both thermal as well as dynamic metamorphism readily alters the volcanic rocks. This alteration is manifest in the Onverwacht Series of the Swaziland System yet, fortunately, critical field relationships have been preserved, thereby enabling a regional unanimity of observations and conclusions to be assembled.

Previously the South African Geological Survey have grouped the above-mentioned greenstones, which have lost all signs of their original structures such as pillows and amygdales into three main categories. Thus, the large majority of the Barberton greenstones have been classed into the so-called Jamestown Igneous Complex while some have been grouped as rocks of unknown origin and an additional small percentage have been classified with the Onverwacht Series. This grouping creates an erroneous impression as most of the rocks rightly belong to the Onverwacht Series and not to a Jamestown Complex. It is considered desirable at this stage therefore, to eliminate the Jamestown Igneous Complex from the literature and consider the Onverwacht Series as a well-layered stratigraphic sequence lying below the Fig Tree Series. This succession is traceable right around the Mountain Land and is capable of being subdivided and correlated according to normal stratigraphic procedures.

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Figure

Figure 1 Map showing the three subdivisions of the Onverwacht Series in the northern and southern parts of the Barberton Mountain Land.

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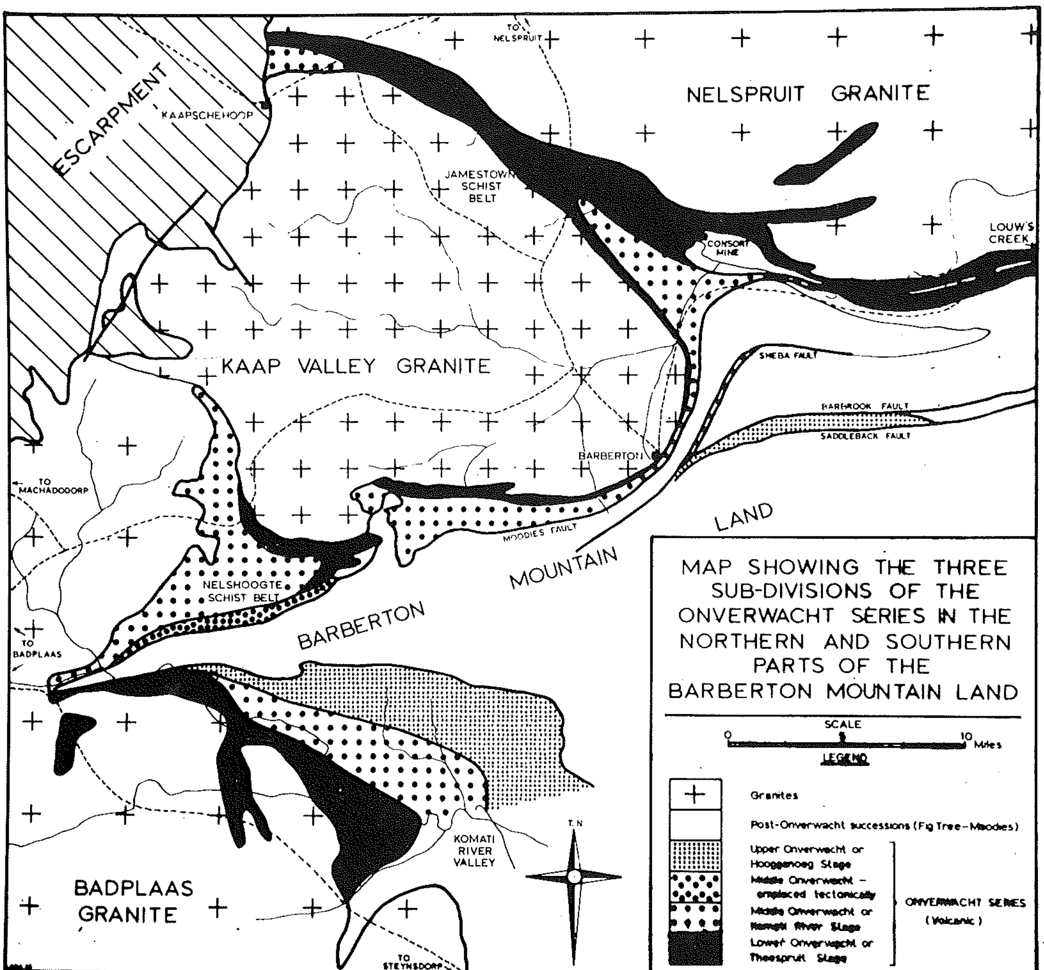
FIGURE 1


ESCARPMENT
KAAPSCHEHOOP
TO NELSPRUIT
NELSPRUIT GRANITE
JAMESTOWN SCHIST BELT
CONSORT MINE
LOUW'S CREEK
KAAP VALLEY GRANITE
SHEBA FAULT
BARBROOK FAULT
SADDLEBACK FAULT
BARBERTON
TO MACHADODORP
MOODIES FAULT
NELSHOOGTE SCHIST BELT
TO BADPLAAS
BARBERTON MOUNTAIN LAND
KOMATI RIVER VALLEY
T.N
BADPLAAS GRANITE
TO STEYNSDORP
MAP SHOWING THE THREE SUB-DIVISIONS OF THE ONVERWACHT SERIES IN THE NORTHERN AND SOUTHERN PARTS OF THE BARBERTON MOUNTAIN LAND
SCALE
0
5
10 Miles
LEGEND
Granites
Post-Onverwacht successions (Fig Tree–Moodies)
Upper Onverwacht or Hooggenoeg Stage
Middle Onverwacht – emplaced tectonically
Middle Onverwacht or Komati River Stage
Lower Onverwacht or Theespruit Stage
ONVERWACHT SERIES (Volcanic)