ECONOMIC GEOLOGY RESEARCH UNIT

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Johannesburg

THE GEOLOGY OF THE JAMESTOWN HILLS AREA OF THE BARBERTON MOUNTAIN LAND, SOUTH AFRICA

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INFORMATION CIRCULAR No. 64

UNIVERSITY OF THE WITWATERSRAND

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September, 1971

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ABSTRACT

The Jamestown Hills area, known also as the Jamestown Schist Belt, constitutes the largest of a number of narrow, tapering, generally arcuate, schist belt remnants which trend in various directions away from the main east-northeast-trending grain of the Barberton Mountain Land. The Schist Belt, which has a strike length of approximately 35 kilometres, occurs on the northwest flank of the Barberton greenstone belt, wedged between the Nelspruit migmatite-gneiss terrain in the north and the Kaap Valley Granite diapiric pluton in the south.

The rocks of the Jamestown Schist Belt are comprised mainly of a variety of mafic and ultramafic assemblages that constitute part of the Lower Ultramafic Unit of the Onverwacht Group of the Swaziland Sequence. Interlayered with the mafic and ultramafic horizons, which include also a wide variety of amphibole, chlorite, talc, and carbonate schists are a number of distinctive, generally aluminous, siliceous schist and cherty sedimentary horizons. These rock assemblages are correlated with the Theespruit Formation as defined by Viljoen and Viljoen (1969a) from the type area on the southern side of the Barberton Mountain Land. Mafic and ultramafic assemblages, together with intrusive soda-rich felsic porphyry bodies, occupy the central core of the Jamestown Schist Belt and are correlated with rocks of the Komati Formation also defined by Viljoen and Viljoen (1969a). Whereas the mafic and ultramafic rocks in the type area are mainly of extrusive origin, those in the Jamestown Schist Belt appear to have been emplaced as penecontemporaneous near-surface sill-like bodies that underwent processes of differentiation to form cyclically layered successions of alternating dunite, peridotite, pyroxenite, and gabbro.

The Onverwacht formations in the eastern part of the Schist Belt are overlain mainly by sedimentary rocks of the Fig Tree and Moodies Groups. These successions are intensely deformed in the area of the New Consort Gold Mine and constitute part of the western closure of the Lily Syncline.

The rocks of the Jamestown Schist Belt have been complexly deformed and metamorphosed. An attempt is made in this paper to describe the structure of the Schist Belt and to relate the gold and other mineralization to the tectonic history of the area. Aspects relating to the petrology, metamorphism, and geochemistry of the Swaziland Sequence rocks are also described and discussed. Finally, a brief account is given of the gold, chrysotile asbestos, talc, magnesite, nickel, and verdite-buddstone mineralization occurring in the area. Available gold production data from 32 workings, and dating back to 1882, is tabled.

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THE GEOLOGY OF THE JAMESTOWN HILLS AREA OF THE BARBERTON MOUNTAIN LAND, SOUTH AFRICA

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CONTENTS (Continued)

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THE GEOLOGY OF THE JAMESTOWN HILLS AREA OF THE BARBERTON MOUNTAIN LAND, SOUTH AFRICA

INTRODUCTION

To the north of Barberton, and forming a wedge between the Kaap Valley Granite in the south and the Nelspruit gneisses and migmatites in the north, lies a long narrow tract of country generally referred to as the Jamestown Hills area, or the Jamestown Schist Belt (see locality map inset, Figure 1). The Schist Belt is approximately eight kilometres wide near Noordkaap in the east and tapers gradually westwards to a width of just over three kilometres where it disappears beneath the younger cover rocks (early Proterozoic) of the Transvaal escarpment. At its narrowest point, near the centre of the Schist Belt, it is just over one kilometre wide. The exposed length of the belt, from Noordkaap in the east to Kaapsehoop in the west is 35 kilometres.

The Jamestown Schist Belt is almost entirely comprised of Archaean rocks ($\sim$ 3 400 m.yrs) of the Onverwacht Group, the latter forming the lowermost stratigraphic division of the Swaziland Sequence. In the eastern part of the belt, near the New Consort Gold Mine, the Onverwacht rocks are overlain by Fig Tree Group assemblages, the latter, in turn, being overlain by Moodies Group sediments.

Investigations in the Schist Belt were commenced by the writer in 1964 and were initiated primarily with the view to establishing the geological controls of gold and other mineralization that were reported from the area. The investigations also formed part of a systematic study programme, undertaken by the Economic Geology Research Unit of the University of the Witwatersrand, Johannesburg, which was aimed at assisting, wherever possible, the local mining industry in its endeavours to locate additional ore deposits or extensions to known ore occurrences. The findings, together with additional information from other areas on the northwest flank of the Barberton Mountain Land were incorporated in a Ph.D. dissertation entitled "The Stratigraphy, Structure, and Gold Mineralization of the Jamestown and Sheba Hills Areas of the Barberton Mountain Land" (Anhaeusser, 1969).

The Jamestown Schist Belt has undergone a complex evolutionary development involving polyphase deformation and metamorphism. In this paper an attempt is made to outline the geological history of the region with special attention being given to structural aspects of the area. Factors influencing and controlling the distribution of precious and base metal mineralization in the Schist Belt are also discussed.

GENERAL GEOLOGY OF THE JAMESTOWN SCHIST BELT

A. INTRODUCTION

The earliest geological account of the Jamestown Hills area of the Barberton Mountain Land was that of Hall (1918) who regarded the area as the type-locality for his "Jamestown Series". In later years Visser (compiler, 1956) considered the "Jamestown Series" to constitute the basic assemblage of a post-Moodies intrusive complex which was referred to as the "Jamestown Igneous Complex". The Jamestown Schist Belt was retained as the type locality for the "Jamestown Complex" which was thought to have, as a co-magmatic acid phase, the hornblende tonalite mass of the Kaap Valley Granite.

In more recent years investigators in the northwestern part of the Mountain Land have questioned this interpretation and most workers have concluded that much of the mafic and ultra-mafic material of the Jamestown Complex actually constitutes part of a well-layered assemblage lying conformably below the Fig Tree Group. The many arguments that revolved around the concept of the "Jamestown Igneous Complex" are discussed fully by Viljoen and Viljoen (1967; 1969c) and Anhaeusser (1969) and will not be persued here. The view now accepted is that the assemblage of rocks previously classed as constituting part of the Jamestown Complex, and which virtually surround the entire Mountain Land, merely represent the more highly metamorphosed equivalents of the Onverwacht Group.

B. CLASSIFICATION AND DISTRIBUTION OF ROCK-TYPES

A fairly distinctive and persistent stratigraphical succession was recorded in the Louw's Creek - Joe's Luck - Consort Mine area by Anhaeusser (1964), and Viljoen (1964). This same stratigraphy, although somewhat modified in places, continues westwards into the Jamestown Schist Belt where it can be traced for considerable distances.

To the north, and forming the southern foothills of the Krokodilpoort Range, is the Nelspruit Granite mass which displays intrusive relationships along its contact with the Schist Belt. It is followed to the south by a northwest-trending, almost vertically dipping, series of ultramafic, mafic, and acid schists together with intercalated minor sedimentary horizons. These rocks have suffered considerable tectonic and metamorphic alteration resulting in the obliteration, in all but a few isolated occurrences, of any of the igneous, volcanic, and sedimentary characteristics they may originally have possessed.

Along the northern half of the Schist Belt the successions, as developed in the area north of the Consort Mine, continue westwards before most of them fold back on themselves in the vicinity of the Kaffir Creek Talc Mines. The assemblages involved in this part of the Schist Belt can be correlated fairly convincingly with the Theespruit Formation as it is developed in the type-area of the Onverwacht Group in the Komati River Valley (Viljoen and Viljoen, 1969a).

The southern half of the Schist Belt is somewhat different to the northern half, consisting almost entirely of mafic and ultramafic rocks of both massive and schistose habit. The sequence is characterized by the almost total absence of interlayered siliceous or acid material, but like the Komati Formation, with which it has been correlated, a feature of the succession lies in the presence of numerous intrusive bodies of quartz and felspar porphyry. The Komati Formation, as it is developed in the Jamestown Schist Belt, does however, differ considerably from its essentially volcanic southern counterpart in that the succession appears to have consisted originally of both intrusive and extrusive ultramafic and mafic material. The intrusive assemblage gave rise to a succession of layered differentiated ultramafic bodies comprising a number of cyclic units of dunite, peridotite, pyroxenite, and gabbro.

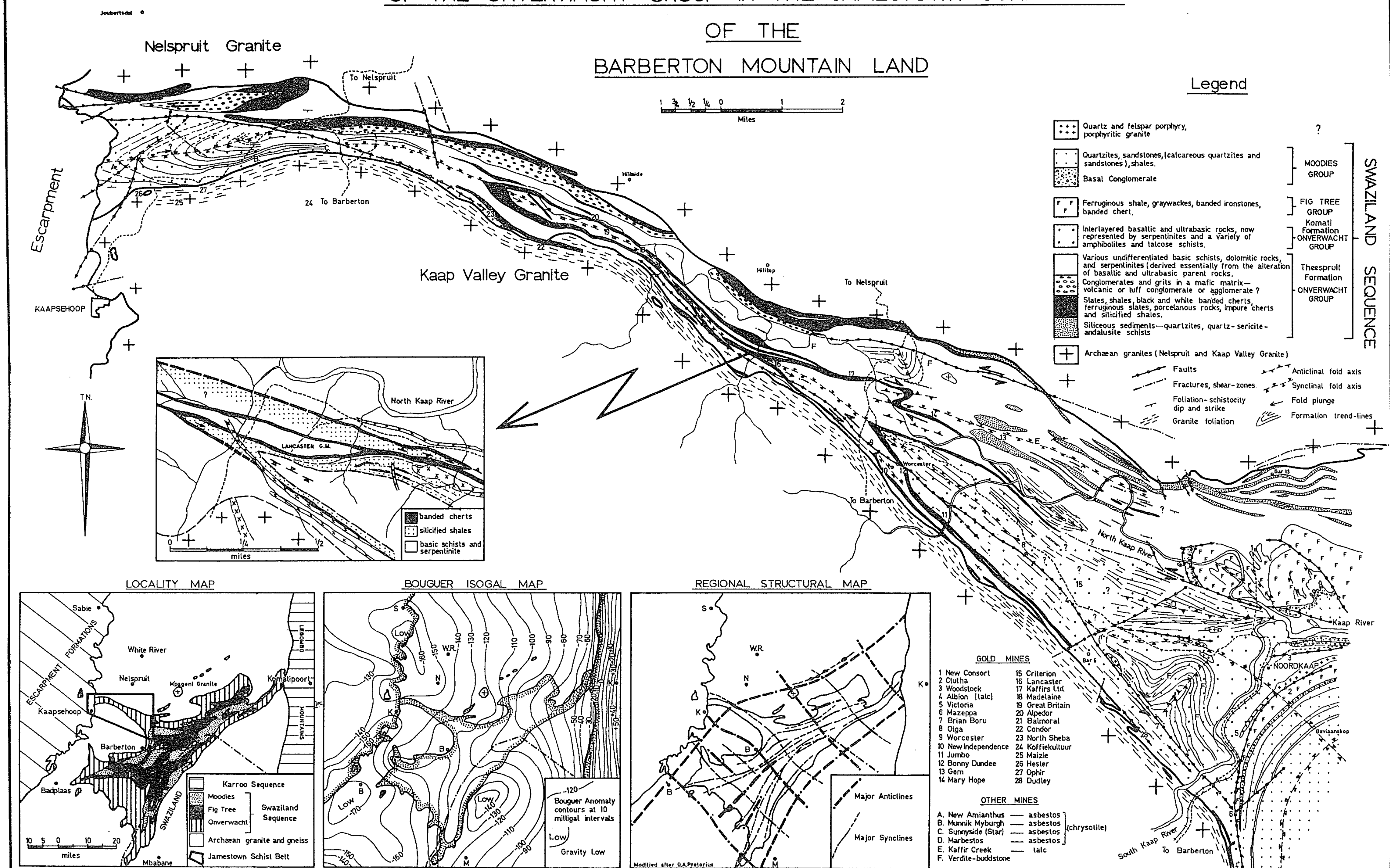
The southern contact of the Jamestown Schist Belt terminates against the Kaap Valley Granite which, in turn, displays intrusive contact relationships with the adjacent schists. The mafic and ultramafic schists along a narrow zone adjacent to the granite contact contain conformably interlayered sedimentary horizons, which increase in number westwards (see Figure 1). These siliceous sedimentary horizons and their enveloping mafic and ultramafic schists probably form part of the succession included with the Theespruit Formation. In the eastern part of the Jamestown Schist Belt, particularly in the Consort Mine area north of Noordkaap, the Onverwacht rocks are overlain by Fig Tree Group assemblages. The Fig Tree succession commences with the so-called "Consort Contact" along which silicified, cherty rocks (the Consort "Bar"), and the gold mineralization in the area, are invariably developed. The remaining Fig Tree rocks in the Consort area comprise successions of metamorphosed shaly sediments that grade upwards into felspathic tuffaceous greywackes and, locally, some conglomeratic phases. These rocks are overlain by a well-defined conglomerate zone which grades upwards into an impure quartzite horizon. These essentially arenaceous sediments constitute the lower members of the Moodies Group of the Swaziland Sequence and are developed principally in the area southeast and northeast of Noordkaap where they form part of the Eureka and Lily Synclines, respectively. In addition, a small, isolated, fault-bounded block of Moodies conglomerates and quartzites occurs in the area south-west of the Consort Mine and probably represents a remnant of the western extension of the Lily Syncline.

C. STRUCTURE

The Jamestown Schist Belt in its entirety is a complexly folded and faulted synclinorial structure that strikes almost at right angles to the regional trend of the main body of the Barberton Mountain Land to the southeast. The Schist Belt is made up of a number of major folds and faults, the nature of which are best demonstrated in Figure 1. Probably the most spectacular large-scale structures occur to the west of Noordkaap where the Handsup and Mundt's Concession differentiated ultramafic bodies form major anticlines. Many other, less obvious, large-scale folds occur near the Kaffir Creek Talc Mines and to the west and east of here.

Fig. 1

A RECONNAISSANCE MAP OF THE STRUCTURE AND STRATIGRAPHY OF THE ONVERWACHT GROUP IN THE JAMESTOWN SCHIST BELT OF THE BARBERTON MOUNTAIN LAND



Two major disharmonic fold structures were recorded, the most spectacular of which is the Handsup fold southwest of Noordkaap, with a detachment plane parallel to the northwest fold trend on the southwestern side of the fold. The other disharmonic fold occurs to the north of the Worcester Gold Mine and straddles the Barberton-Nelspruit road. This structure is also developed in differentiated ultramafic rocks, similar to those in the Handsup fold, and the detachment plane, in this instance, parallels the Nelspruit Granite contact. The Kaapsehoop body near the escarpment may also represent a disharmonic fold but no detailed structural mapping of this area is as yet available.

Because of the lack of marker horizons and continuous exposure in the isoclinally folded mafic and ultramafic assemblages, the exact number of folds present in the area remains obscure. It is suspected, however, that the formations are involved in a complexity of anticlinal and synclinal structures, some partly, or even entirely, eliminated by faulting.

A complex structural history was established for the rocks in the Consort Mine area by Viljoen (1964) and the added mapping by the writer showed that the strong folding, about axes trending northwest-southeast, continued into the eastern part of the Jamestown Schist Belt. Minor structural techniques of mapping were employed in this and other areas of the Schist Belt and it was possible to establish at least four recognizable phases of deformation (Anhaeusser, 1969).

The Schist Belt is traversed by numerous faults, fractures and shear zones. By far the most prominent zone of dislocation is the Albion Fault, which can be traced for a distance of about 24 kilometres along the southern edge of the Schist Belt. This fault acts as the detachment plane of the Handsup disharmonic fold. Another major fault known as the Kaap River Fault enters the eastern part of the Schist Belt in the area north of Noordkaap where it cuts out the southern half of the Lily Syncline. The fault continues westwards into the Schist Belt for an indeterminable distance. Most of the faults and fractures are, in effect, shear zones that parallel the regional trend of the schists in the area. Only in a few cases were cross-faults noted, and these are to be found mainly in the Mundt's Concession anticlinal structure.

D. METAMORPHISM

The Jamestown Schist Belt has suffered extensive dynamo-thermal metamorphism that owes its origin mainly to the emplacement of the Kaap Valley Granite in the south. In addition, there appears to be, superimposed on the regional metamorphic event, a thermal or contact metamorphic episode related to the Nelspruit Granite, and more particularly, to the mobilized border phase of the latter, which include also the intrusive pegmatites.

The metamorphism of the Schist Belt is generally of a low grade, being mostly confined to the greenschist facies. Only locally, and usually in close proximity to the invading granites, does the metamorphic grade increase into the upper sub-facies of the greenschist facies or into the amphibolite facies. All the formations have suffered alteration in one way or another and the mineralogical evolution of the metamorphic assemblages can be demonstrated with the aid of metamorphic petrology, coupled with minor structural analyses of the rocks (Anhaeusser, 1969).

E. MINERALIZATION

Practically all the gold mineralization in the area is structurally controlled, being particularly confined to the major fault and shear zones. The most important mineralized occurrence in the area is the New Consort Gold Mine, situated geologically, on the Consort "Contact". In the neighbourhood of the mine, this "Contact" has suffered several phases of deformation, one superimposed on the other, and giving rise to the mineralized zone containing the Consort ore-bodies.

Further gold deposits occur scattered throughout the Schist Belt but it is clear that the Albion Fault has played a part in localizing many small workings along its length of development. This fault has also been responsible for the localization of many small talc deposits. Talc mineralization is not, however, solely confined to the fault zones. Several bodies have been worked that owe their existence to the intrusion, into the ultramafic assemblages, of numerous felsic porphyry bodies. The Kaffir Creek Talc Mines, just over eight kilometres northwest of Noordkaap, appear to owe their origin to the intense folding and attenuation of the ultramafic and siliceous members of the lower part of the Onverwacht succession in the area.

The Marbestos chrysotile asbestos deposit on Mundt's Concession clearly formed as a result of folding of the differentiated ultramafic assemblage in the eastern part of the Schist Belt. Also in these differentiated mafic and ultramafic horizons, which are not confined to the Handsup-Mundt's Concession folds alone, are several occurrences of the semi-precious mineral verdite, and an ornamental stone often associated with it, known as buddstone. Locally, some magnesite of poor quality has been quarried. Chrysotile asbestos deposits occur also in the Kaapsehoop differentiated bodies where mining has occurred at the New Amianthus, Munnik Myburgh and Sunnyside (now Star) asbestos mines.

THE STRATIGRAPHY OF THE JAMESTOWN SCHIST BELT

A. INTRODUCTION

When mapping commenced in the Jamestown Schist Belt a great deal of uncertainty existed as to the origin of certain of the mafic rocks in the area. As mentioned earlier the Jamestown Belt was regarded by the Geological Survey (Visser, compiler, 1956) as the type-area for the so-called Jamestown Igneous Complex. Mapping in the area immediately east of the Schist Belt by Viljoen (1964), and Anhaeusser (1964), suggested that many of the rocks along the northern contact of the Mountain Land formed a layered succession, and it was proposed then, to include these rocks in the Onverwacht Group.

To simplify description the rocks of the Schist Belt have been grouped together into petrologically similar varieties. All the mafic and ultramafic rocks, as well as the associated siliceous horizons are regarded by the writer as belonging mainly to the Onverwacht Group and represent the oldest successions in the area. These will be described first, followed by the Fig Tree and Moodies assemblages which occur only locally in the eastern part of the Schist Belt.

The complete stratigraphic column in this area is difficult to define precisely due to the complicating factors of strong folding and faulting. Nowhere is there continuity of outcrop providing an unbroken and complete section of all the rock-types present in the area. It is thus not possible to provide anything other than an approximate account of the stratigraphic column as it appears in the Jamestown Schist Belt.

The Onverwacht Group, where best developed on the southern side of the Barberton Mountain Land, attains a total thickness in excess of 15 000 metres and has been subdivided into six formations by Viljoen and Viljoen (1969c). On the basis of distinctive lithologies and rock associations the Onverwacht rocks in the Jamestown Schist Belt correspond with only the Theespruit and Komati Formations as defined in the southern regions of the Mountain Land. Both these formations occur in the Lower Ultramafic Unit which embraces the lower three formations and which are distinct from the upper three formations. The latter formations, also referred to collectively as the Mafic to Felsic Unit, are almost entirely absent from the northern side of the Mountain Land.

A simplified stratigraphic column of the Jamestown Schist Belt is shown in Table 1. The intense folding and attenuation of the formations makes unrepresentative any values that might be ascribed to unit thicknesses and these have therefore been omitted from the stratigraphic column. A detailed geological map of the eastern portion of the Schist Belt is provided in Figure 2.

B. THE ONVERWACHT GROUP

(a) The Theespruit Formation

(i) Amphibolites and Mafic Schists

Dark amphibolites containing hornblende, or actinolite and hornblende, are found along a narrow zone on either side of the Jamestown Schist Belt adjacent to the Nelspruit and Kaap Valley Granite contacts. These rocks have a distinctive appearance and are either totally black or else they may contain sufficient plagioclase felspar to give the rock a dark greyish-black colouration.

Fig. 2

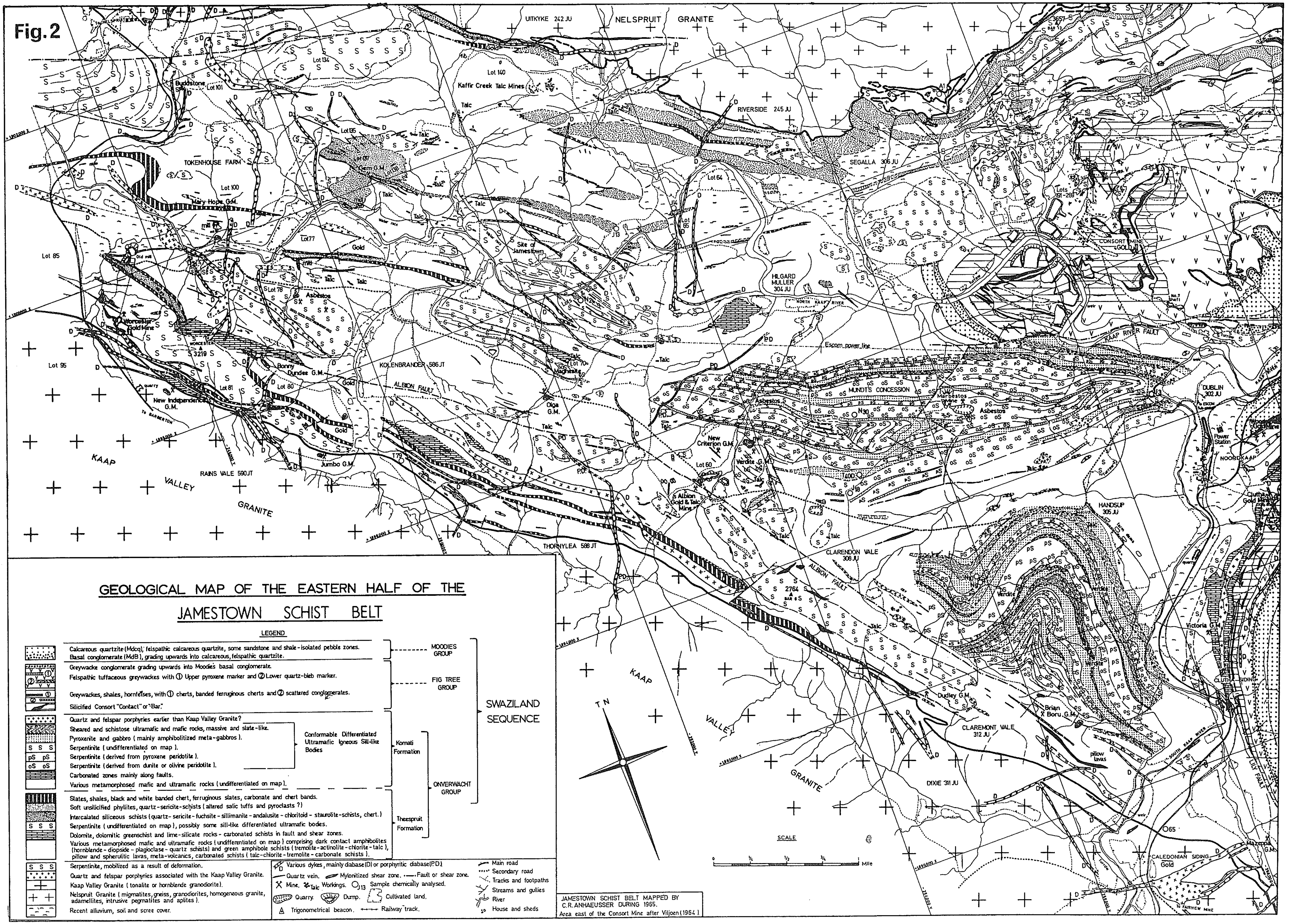

GEOLOGICAL MAP OF THE EASTERN HALF OF THE
JAMESTOWN SCHIST BELT
LEGEND
Calcareous quartzite (Mdcq), felspathic calcareous quartzite, some sandstone and shale - isolated pebble zones.
Basal conglomerate (MdB), grading upwards into calcareous, felspathic quartzite.
MOODIES GROUP
Greywacke conglomerate grading upwards into Moodies basal conglomerate.
Felspathic tuffaceous greywackes with ① Upper pyroxene marker and ② Lower quartz-bleb marker.
Greywackes, shales, hornfelses, with ① cherts, banded ferruginous cherts and ② scattered conglomerates.
Silicified Consort "Contact" or "Bar".
FIG TREE GROUP
Quartz and felspar porphyries earlier than Kaap Valley Granite?
Sheared and schistose ultramafic and mafic rocks, massive and slate-like.
Pyroxenite and gabbro (mainly amphibolitized meta-gabbros).
Serpentinite (undifferentiated on map).
Serpentinite (derived from pyroxene peridotite).
Serpentinite (derived from dunite or olivine peridotite).
Carbonated zones mainly along faults.
Various metamorphosed mafic and ultramafic rocks (undifferentiated on map).
Conformable Differentiated Ultramafic Igneous Sill-like Bodies
Komati Formation
Slates, shales, black and white banded chert, ferruginous slates, carbonate and chert bands.
Soft unsilicified phyllites, quartz-sericite-schists (altered salic tuffs and pyroclasts ?)
Intercalated siliceous schists (quartz-sericite-fuchsite-sillimanite-andalusite-chloritoid-staurolite-schists, chert.)
Serpentinite (undifferentiated on map), possibly some sill-like differentiated ultramafic bodies.
Dolomite, dolomitic greenschist and lime-silicate rocks - carbonated schists in fault and shear zones.
Various metamorphosed mafic and ultramafic rocks (undifferentiated on map) comprising dark contact amphibolites (hornblende-diopside-plagioclase-quartz schists) and green amphibole schists (tremolite-actinolite-chlorite-talc), pillow and spherulitic lavas, meta-volcanics, carbonated schists (talc-chlorite-tremolite-carbonate schists).
Theespruit Formation
ONVERWACHT GROUP
SWAZILAND SEQUENCE
Serpentinite, mobilized as a result of deformation.
Quartz and felspar porphyries associated with the Kaap Valley Granite.
Kaap Valley Granite (tonalite or hornblende granodiorite).
Nelspruit Granite (migmatites, gneiss, granodiorites, homogeneous granite, adamellites, intrusive pegmatites and aplites).
Recent alluvium, soil and scree cover.
Various dykes, mainly diabase (D) or porphyritic diabase (PD)
Quartz vein. Mylonitized shear zone. Fault or shear zone.
Mine. Talc Workings. O13 Sample chemically analysed.
Quarry. Dump. Cultivated land.
Trigonometrical beacon. Railway track.
Main road
Secondary road
Tracks and footpaths
Streams and gullies
River
House and sheds
SCALE
0 1/4 1/2 3/4 1 Mile
TN
JAMESTOWN SCHIST BELT MAPPED BY C.R. ANHAEUSSER DURING 1965.
Area east of the Consort Mine after Viljoen (1964)
NELSPRUIT GRANITE
KAAP VALLEY GRANITE
KAAP VALLEY GRANITE
UITKYKE 242 JU
Kaffir Creek Talc Mines
RIVERSIDE 245 JU
SEGALLA 306 JU
TOKENHOUSE FARM
Mary Hope G.M.
Site of Jamestown
HILGARD MULLER 304 JU
CONSORT MINE GOLD
KAAP RIVER FAULT
Escom power line
KOLENBRANDER 586 JT
ALBION FAULT
MUNDT'S CONCESSION
DUBLIN 302 JU
NOORDKAAP
Power Station
New Criterion G.M.
Verdite G.M.
Albion Gold & Talc Mine
Olga G.M.
Jumbo G.M.
RAINS VALE 590 JT
Bonny Dundee G.M.
New Independence G.M.
Worcester Gold Mine
THORNYLEA 588 JT
CLARENDON VALE 308 JU
HANDSUP 305 JU
Victoria G.M.
Dudley G.M.
Brian Boru G.M.
CLAREMONT VALE 312 JU
DIXIE 311 JU
pillow lavas
CALEDONIAN SIDING
Gold
Mazeppa G.M.
LILY FAULT
SOUTH KAAP RIVER
NORTH KAAP RIVER
Lot 85
Lot 95
Lot 100
Lot 101
Lot 134
Lot 135
Lot 140
Lot 64
Lot 60
Lot 77
Lot 78
Lot 80
Lot 81
Lots 191-268
Buddstone
Gem G.M.
Asbestos
Talc
Gold

TABLE 1

STRATIGRAPHIC COLUMN OF SWAZILAND SEQUENCE ROCKS
IN THE JAMESTOWN SCHIST BELT

Lithostratigraphic Units		Rock-Types
Post-Moodies intrusives		- various mafic dykes - Kaap Valley Granite and some porphyry bodies. Nelspruit Granites, mobilized border phase, and pegmatites - serpentinites remobilized as a result of deformation
MOODIES GROUP		- felspathic quartzites - calcareous quartzites - conglomerates
FIG TREE GROUP		- felspathic tuffaceous greywackes - scattered pebble conglomerates - cherts, shales, greywackes
ONVERWACHT GROUP	Komati Formation	- quartz and felspar porphyries - intrusive differentiated ultramafic and mafic bodies (serpentinized olivine and pyroxene peridotites, pyroxenites, amphibolites, meta-gabbros) - talc-chlorite-tremolite-actinolite schists - meta-tholeiitic basalts with pillow structures - various carbonated greenschists, dolomitic rocks
	Theespruit Formation	- intercalated siliceous horizons (quartz-sericite schists, fuchsite-, sillimanite-, andalusite-, chloritoid-, staurolite schists) cherts, slates, tuff agglomerates, mafic pyroclastic rocks - serpentinites, talc-carbonate rocks, talc, talc-chlorite, talc-tremolite schists. Carbonate rocks - meta-tholeiitic basalts with pillows and ocelli - dark contact amphibolites

Granitic or migmatitic basement in part ?

The contact amphibolites are best developed in the area to the north and northwest of the Consort Mine where, in addition to the mobilized granite border phase which has invaded the schists, there occur a number of pegmatite intrusions. The pegmatites appear to have assisted in upgrading the metamorphism of this area. Elsewhere, along the Nelspruit Granite contact, amphibolites of this type may also be found, but at times siliceous as well as ultramafic horizons occur in direct contact with the granites. Along the Kaap Valley Granite side of the belt the contact-type amphibolites do not occur continuously but are gradational at times, into lower-grade actinolite, or even chlorite-actinolite schists.

Dark contact-type amphibolites were also found at an isolated occurrence on the western part of the farm Segalla 306 JU, approximately one kilometre from the granite contact. This occurrence of high-grade meta-basalts was regarded by the Geological Survey (Visser, compiler, 1956) as a xenolith of Onverwacht rocks surrounded by basic rocks of the Jamestown Igneous Complex.

Away from the influence of the granites the grade of metamorphism declines rapidly and the mineralogical composition changes accordingly. At the contacts the amphibolite schists consist essentially of strongly aligned, dark-green hornblende, plagioclase that varies in composition between albite and andesine, and some quartz. Locally the rocks are composed almost exclusively of hornblende while elsewhere the composition may vary to include diopside, almandine garnet, epidote and biotite. Diopside frequently occurs as distinct bands in the amphibolite, but is mostly restricted in its occurrence to areas immediately adjacent to the granite. The garnets in these rocks are not restricted in their development to the granite contacts alone, although most garnet-bearing amphibolites were found adjacent to the contacts. Epidote is fairly common in places and appears to be the result of the saussuritization of plagioclase felspar. Frequently fine fractures and joints in the amphibolite contain epidote fillings. Accessory minerals recorded in the contact amphibolites include magnetite, ilmenite, leucoxene and sphene.

In areas removed from the granite contacts the dark colouration of these rocks decreases and they become greenish in colour. A gradual decrease in the amount of hornblende can generally be discerned with tremolite-actinolite and chlorite becoming more prominent mineral phases. Everywhere these rocks have a schistose texture with a strong mineral alignment. Frequently the schistosity is intensified in the many shear zones occurring throughout the Schist Belt. The shear zones are often marked by the presence of a quartz vein, while in other instances, the rocks in the vicinity become exceptionally rich in carbonate, and take on a pale grey-green colouration. Where extreme carbonation has occurred massive dolomitic patches are encountered.

(ii) Origin of the Amphibolites and Mafic Schists

It has been well-established that amphibolites and rocks of the type just described could represent the metamorphosed products of the following assemblages :

(i) mafic igneous rocks

(ii) impure dolomitic limestone, together with calcareous and magnesian shales

(iii) sedimentary rocks influenced by effluents from ultra-mafic and mafic igneous rocks

The difficulties in distinguishing between para- and ortho-amphibolites are well-known and various attempts have been made to try to establish their origin by using major and trace element chemistry (Engel and Engel, 1951, 1953).

In the Consort Mine - Joe's Luck Siding - Louw's Creek area, Anhaeusser (1964) and Viljoen (1964) suggested that the various amphibolites and talc-chlorite schists represented the alteration products of a pre-existing layered, or stratiform, sequence of rocks. The very pronounced mineralogical banding was considered to be indicative of a sedimentary, rather than an igneous origin. The close association of these rocks with conformable siliceous horizons and shaly sedimentary bands was regarded as strong supporting evidence. However, with the continued field work in the Barberton Mountain Land, particularly in the Komati River Valley it became increasingly evident that most, if not all, the metamorphosed, mafic schists were originally of volcanic origin. Viljoen and Viljoen (1967, 1969a) recorded pillow structures, spherulites, amygdales, and variolites with increasing regularity in rocks that graded along strike into a variety of mafic schists similar to those found in the areas to the north of Barberton. In addition to the numerous structures of unequivocal volcanic origin found in the Komati River area, rock associations almost identical to those found in the north were recorded. The siliceous schists and the mafic meta-volcanic rocks were subsequently found to embrace a regular sequence which was named the Theespruit Formation by Viljoen and Viljoen (1967, 1969a).

There appeared little hope of finding any diagnostic volcanic structures in the Jamestown Schist Belt because of the considerable amount of deformation experienced by the formations in the area. However, several areas were located where pillow structures, amygdales, or gas cavities and ocelli had been preserved, some examples of which can be seen in Plate 1. Many other pillow volcanics were subsequently found in the far western part of the Jamestown Schist Belt by N.D. Harte (personal communication, 1967).

The original nature of the amphibolites and other mafic schists appears now to have been established. Most of the rocks in the Jamestown Schist Belt may be classified as ortho-amphibolites. In making this statement, the writer does not, however, preclude the possibility that some of these rocks may, in fact, be para-amphibolites derived from mafic tuffs or from impure dolomites or greywackes - assemblages that might well be expected to co-exist with the essentially volcanic or magmatic rocks that occurred in the area during Onverwacht times.

(iii) Serpentinites

Apart from the various amphibole schists just described, the Theespruit Formation in the Jamestown Schist Belt also contains numerous serpentinized ultramafic lenses and bands. Most of these rocks suffered thermal metamorphism and shearing, resulting in the development of a variety of schists including talc and tremolite schists and carbonate-bearing rocks. These schists, if followed along strike sometimes grade into serpentinites.

Serpentinites occur throughout the entire Schist Belt, and form an integral part of the assemblage that comprises the Theespruit Formation. In the area immediately north and northwest of the Consort Mine, a number of massive, irregular patches of serpentinite occur as apparently intrusive bodies. Intimately associated with the serpentinites are a great number of intrusive pegmatite bodies. These two rock-types are responsible for the almost total disruption of the formations and result in complex structural disturbances in and around the mine area.

In the neighbourhood of the Kaffir Creek Talc Mines further occurrences of massive serpentinites appear to intrude the formations in the area forming very prominent, lens-shaped ridges and low hills, while in other cases, extensive areas underlain by serpentinite and talc schists are relatively flat and have limited exposure. Where the stratigraphy is not entirely disrupted it can be seen that many serpentinized ultramafic horizons occur interlayered with metavolcanic rocks and siliceous schist horizons. Much of the ultramafic material has been involved in the formation of talc and talc-carbonate rocks, some of which have given rise to many irregular, and scattered, talc deposits in the Schist Belt.

A massive body of serpentinite occurs to the east of the Worcester Gold Mine and appears to form a large fold in the area. The serpentinite forms a large, bulbous body which trails off eastwards into a narrow band, ending near Kaffir Creek and was probably formed by a type of flowage folding when the area was subjected to compressive deformation. The serpentinites in the Schist Belt all seem to show this type of development as many of the occurrences are lensoid in shape, pinching out along strike and reappearing again further along as another bulbous mass.

In the area of the Kaffir Creek Talc Mines, the serpentinites have been almost entirely altered to talc or to talc-carbonate schists and massive talc-carbonate bodies. Small remnant patches of serpentinite are sometimes found completely encompassed by economically exploitable talc deposits.

Most of the serpentinites in the area appear to be intrusive, as indeed many of them are in the accepted sense of the word. However, it is the writer's contention that these rocks initially formed an integral part of the stratigraphy in the area prior to the onset of the severe deformation that affected the entire region. The serpentinites are thus not regarded as late intrusives as envisaged in the classical sense of the Alpine-type ultramafic intrusives described by Turner and Verhoogen (1960). Instead, the writer considers that the pre-existing interlayered ultramafic material was "squeezed" into its present position during intense folding, thereby creating the impression of having been emplaced by separate intrusion.

The serpentinites are invariably the most massive rock-types present in the area, and build characteristically rough, resistant, outcrops. On weathered surfaces the rocks may be somewhat brownish in colour, but generally they range from grey, grey-green or dark olive-green to dark bluish-green or bluish-black. The variation in colour was used as a basis by the Geological Survey (Visser, compiler, 1956) for dividing the serpentinites into two groups namely, Green Serpentinites, which they considered probably originated from magnesian-rich rocks of peridotitic composition, and Blue Serpentinites, which they stated, must originally have ranged in composition from pyroxenite to olivine hypersthenite.

Although mostly massive, some serpentinites show a foliation or pseudostratification that coincides with the attitude of the surrounding schists. Frequently, poorly developed veinlets and stringers of chrysotile asbestos fibre occur in these rocks, in addition to clusters and thin veins of magnetite. The serpentinites in the area display a consistent mineralogy and are generally composed of a dense felted matt of antigorite together with magnetite, the latter occurring as individual grains or as fine dust-like aggregates.

Very rarely were relics of the original mineralogy noted. In a few cases, however, small, strongly birefringent, olivine kernels were seen surrounded by antigorite. Pseudomorphs of antigorite after olivine are common and the outline of original olivines is often emphasized by a narrow rim, or fine dusting, of magnetite particles. Minute microscopic veinlets of chrysotile cross-fibre are also not uncommon. The antigorite is sometimes associated with tremolite blades and laths, the latter mineral clearly forming at the expense of the antigorite. There is often a gradational change from serpentinite, through serpentinite with tremolite, to talc-tremolite schists.

Other minerals encountered in the serpentinites examined include the alteration products of olivine known as iddingsite, a reddish-brown mineral, and serpophite, a pale yellowish-green mineral, both occurring as partial or complete pseudomorphs after olivine. Another commonly encountered mineral is chlorite, which usually occurs in radiating clusters and is pale green in colour. The chlorite displays a striking variety of birefringence colours ranging from dark-brown to anamalous colours of reddish-purple, violet, and blue. Occasionally talc occurs surrounded by a highly birefringent, shredded mineral, considered to be altered pyroxene. Carbonate minerals, calcite and dolomite, are invariably present and give rise, at times, to talc-carbonate and talc-tremolite carbonate schists. Small amounts of carbonate are always present even in the least altered serpentinized ultramafic horizons in the Jamestown Schist Belt.

(iv) Siliceous Schist Horizons

The Geological Survey (Visser, compiler, 1956) regarded several thin, siliceous horizons on Lot 140, Riverside 245 JU, and Segalla 306 JU, as intrusive tongues of Nelspruit Granite. That these siliceous schists represent rocks quite distinct from the Nelspruit Granite can clearly be seen on the farm Riverside 245 JU (Figure 2). Here, both rock-types occur close together, separated by a narrow zone of talc schist. The siliceous schists, in this instance, contain abundant andalusite, chloritoid, and staurolite (Anhaeusser, 1966).

In the northern half of the Jamestown Schist Belt the siliceous schist horizons occur as relatively narrow bands, parallel to the foliation in the adjacent mafic schists, and they represent a stratiform succession that can be traced eastwards to the area north of the Consort Mine. Here the same succession forms the lower part of the Onverwacht Group (Viljoen, 1964). In places the siliceous schists are nodular in appearance and are identical to the sheared sericitic schists containing small cherty-quartz nodules (porphyroblasts) found in the area between Eureka Siding and Louw's Creek Station (Anhaeusser, 1964).

Another variation of this rock-type is a bright-green, fissile, schistose rock, containing an abundance of the chromiferous mica known as fuchsite. Whitmore and others (1946), and Geijer (1963), found that chrome micas are invariably the product of hot solutions of magmatic derivation, the chrome having been introduced into the solutions either, as a result of the original fractionation of the volatile magma constituents or, through the leaching of igneous rocks containing this element. Both authors quote several examples where it appears that the chromium-bearing solutions generally emanate from a mafic or ultramafic magma. The fuchsite occurrences in the Jamestown Schist Belt are considered to be of this latter type, and were probably contaminated by solutions leached from the serpentinized ultramafic rocks surrounding them.

Despite the generally consistent mineralogy, the siliceous schist horizons display contrasting textures and form. The rocks may vary from friable, almost white-coloured, quartz-sericite schists to quartzitic rocks and even cherts. This variation may take place along strike. Quartz and sericite generally make up by far the greatest percentage of the total rock. Depending on the distance from the granite contacts various metamorphic minerals make an appearance. The siliceous-schists contain a variety of aluminous minerals with andalusite being the most commonly encountered Al_2SiO_5 polymorph. Sillimanite occurs immediately adjacent to the Nelspruit Granite contact as well as in schists that have been intruded by pegmatites. In addition to andalusite, sillimanite, sericite, and quartz, other minerals found in these rocks include chloritoid, staurolite, almandine garnet, muscovite, fuchsite, and pyrophyllite. Accessory minerals include biotite, chlorite, tourmaline, magnetite and ilmenite. In one sample, pink pleochroic dumortierite needles were seen.

The distinctive mineralogy of these rocks as well as their association with the meta-volcanics has proved important in the correlation of the early formations of the Onverwacht Group right around the entire Barberton Mountain Land. In Swaziland, Urie and Jones (1965) reported andalusite-bearing schists in the high-temperature zone of their meta-sedimentary assemblage in the northwestern part of the territory. As in the Jamestown Schist Belt, the Swaziland occurrences have a knotted appearance, resulting from the presence of anhedral porphyroblasts of andalusite. In the area north of the Consort Mine, sillimanite, occurring in the siliceous horizons close to the granite contact, was described by Hall (1918), van Eeden (1941), and Viljoen (1964). Between Louw's Creek and Sheba Siding, the writer (Anhaeusser, 1964) reported the presence of sillimanite, andalusite, and garnet, in the quartz-sericite schists, while in the southern part of the Mountain Land, the identical rock-types and mineralogy have been reported in the Komati River Valley by Viljoen and Viljoen, (1967, 1969a).

Apart from the strong foliation or schistosity developed in the siliceous rocks of the Jamestown Schist Belt they are also strongly folded and lineated, with the lineations aligned parallel to the fold axes of the minor crenulation and accordion folds. In addition to the minor fold structures in the area there is a major fold in the neighbourhood of the Kaffir Creek Talc Mines. Here the quartz-sericite schists converge, forming a fold closure on Lots 135 and 137, immediately east of Tokenhouse Farm (see Figure 2). The fold structure has been drawn out and attenuated by the intense shearing of the formations in the area and there is no continuity of outcrop. On the southern side of the nose of the fold, near the old workings and mill-site of the Gem Gold Mine, the once almost vertically dipping siliceous schists have suffered a major slide, and in the area immediately north of the North Kaap River, a massive block of quartz-sericite schist lies slumped across serpentinites and talc-tremolite schists. The foliation in this block is flat-lying, in strong contrast to the almost vertical schistosity of the adjacent schists.

In the well-developed and clearly exposed type-area of the Theespruit Formation in the Komati River Valley, Viljoen and Viljoen (1967, 1969a) found that many of the interlayered siliceous horizons were capped by chert. This relationship proved useful in the strongly folded areas of the Jamestown Schist Belt where younging directions were difficult to establish. Detailed structural mapping of the major fold in the quartz-sericite schist horizons in the Kaffir Creek Talc Mine area could not at first conclusively establish whether the structure was an anticline or a syncline. On the farm Riverside 245 JU one of the most northerly of the siliceous schist horizons has chert developed along its southern contact. The chert is slightly banded and does not appear to have formed as a result of metamorphism by the adjacent Nelspruit Granites. The evidence suggests, therefore, that the members of the northern limb of the fold structure are younging southwards towards the fold axis, and that the fold is, in fact, a syncline.

(v) Origin of the Siliceous Schists

The origin of the siliceous schist horizons in the Jamestown Hills area pose several problems as the rocks in the region have undergone extensive alteration. Metamorphism and structural disturbance have totally destroyed all evidence of the original nature of these formations.

As mentioned previously, siliceous, aluminous, quartz-sericite schistose rocks have been located in a number of widely separated parts of the Barberton greenstone belt. Rocks possessing similar characteristics have also been recorded in greenstone belts elsewhere in the world, particularly those of Western Australia, Rhodesia, and Canada. A study of the chemistry of these rocks demonstrates that they are very distinctive, being exceptionally rich in silica and alumina. Not infrequently, the oxides of these elements together constitute over 95 per cent of the total composition of the rocks. In some cases the alkali elements, particularly K_2O, and the oxides of iron are the only remaining constituents of note (see chemical analyses, Tables 5a and 6).

The distinctive chemistry of these rocks which appear to be characteristically developed in the lower successions of Archaean greenstone belts (Anhaeusser and others, 1969) suggests a common mode of origin. It was speculated (Anhaeusser, 1966) that the siliceous horizons in the Onverwacht Group may originally have represented either felsic lavas or tuffs or some unusual alumina-rich sediments. These possibilities were suggested before the mapping in the southern part of the Barberton Mountain Land had demonstrated conclusively that the rocks were intimately associated with mafic lavas near the base of the Onverwacht Group. In the Theespruit Formation in the Komati River Valley Viljoen and Viljoen (1969a) found that the siliceous sericite schists were the metamorphosed equivalents of felsic tuffs and bedded, reworked, fine- and coarse-grained siliceous tuffs and agglomerates. The latter were found to be aluminous, containing, in addition to quartz and sericite, conspicuous amounts of pyrophyllite together with andalusite, chloritoid, and staurolite. Siliceous aluminous schist horizons similar to those in the Barberton region have also been reported from the Tati Schist Belt in eastern Botswana (Mason, 1970). Evidence from this area showed that a number of alumina-rich siliceous horizons occur in the greenstone belt frequently associated with mafic and ultramafic volcanic assemblages and appear to be the products of felsic pyroclastic rocks (tuffs and agglomerates).

The distinctive character of these siliceous rocks - their mineralogy, chemistry, and field associations - leave little doubt that the highly altered siliceous schists in the Jamestown Schist Belt were also of pyroclastic origin.

(vi) Other Siliceous Horizons in the Jamestown Schist Belt

Apart from the typical Al-rich quartz-sericite schist horizons just described, a number of cherty sedimentary horizons also occur in the Theespruit Formation of the Jamestown Schist Belt. These form useful marker horizons and also occur conformably interlayered with the various mafic and ultramafic schists described earlier. The cherty horizons are best developed in the central and western parts of the Schist Belt (see Figure 1) but several horizons can be traced eastwards into the area between the Worcester Gold Mine and Noordkaap (see Figure 2). Many of the horizons also have thin intercalated slaty shales and impersistent bands of black, carbonaceous chert. Several carbonaceous chert horizons were sampled by the writer for Dr. K.A. Kvenvolden of the Exobiology Division of the Ames Research Centre, Moffett Field, California, who is currently investigating the possibility that these rocks may contain early life-forms. His study forms part of the National Aeronautics and Space Administration programme aimed at collecting and establishing a comprehensive record of primitive organisms developed throughout geological time. Recently, alga-like forms in amorphous carbonaceous matter were reported from sedimentary rocks of the Onverwacht Group by Engel and others (1968). These finds were made in the Komati River Valley in rocks similar to those found in parts of the Jamestown Schist Belt. Considerable doubt still exists, however, as to whether the spheroidal and cup-shaped microstructures as well as the filamentous forms, which show no distinguishing morphology, are biological in origin (Nagy and Nagy, 1968; 1969; personal communication, 1971).

In addition to the massive black chert and siliceous slaty rocks there are also ferruginous slates, porcellanous or leached impure chert, banded black and white chert, grits, and in places, conglomerates or volcanic agglomerate. The latter rocks are best developed in the western part of the Schist Belt where they occur prominently in the areas approaching the escarpment. The Geological Survey (Visser, compiler, 1956) considered that the cherty and slaty horizons comprised part of the Fig Tree assemblage. These, as well as the conglomeratic rocks, which they classed with the Moodies Group, they regarded as xenoliths, preserved in the invading rocks of the Jamestown Igneous Complex. The writer could find no evidence to support this contention and it is considered that the rocks in the area represent part of a conformable, alternating, and strongly folded meta-volcanic and meta-sedimentary succession.

Reconnaissance mapping (Figure 1) indicated that several cherty horizons outline a number of isoclinal folds in the area. The beds are steeply dipping and it is difficult to determine which of the folds form anticlines and which form synclines. The younging directions can, in some cases, be ascertained if chert cappings are developed and if these can readily be distinguished from cherty material produced as a result of metamorphism and recrystallization. In adjacent meta-basalts, N.D. Harte (personal communication, 1967) noted pillow structures which he found could be used to determine the facing directions. However, in isoclinally folded successions such as are developed in the Jamestown Schist Belt, it is questionable whether any reliance can be attributed to facing information obtained from pillow structures.

Several apparent fold closures occur in the chert horizons throughout the Schist Belt. At times, lack of continuous outcrop, faulting, and refolding of the horizons makes it difficult to decide just how many fold structures there are in the area. Many of the chert horizons can be traced from the Schist Belt into the Kaap Valley Granite where they extend, at times, for considerable distances before disappearing in the granites. Probably the best example of this type occurs on the farm Waterfall 461 JT, with other examples being found on Lot 89, Thornylea 588 JT, and Claremont Vale 312 JU. It would appear that the granite stoped its way into the Onverwacht successions in a relatively passive manner, prizing off and assimilating the material as it intruded. Some of the resistant chert horizons were left behind either as narrow bands jutting out from the Schist Belt into the granite, or as small xenoliths caught up, and entirely surrounded by the granite.

Most of the old gold workings in the Jamestown Schist Belt, that are not located along fault zones, are situated in these cherty horizons just described. Due to their brittle, competent nature, many faults and fractures developed in these rocks during deformation, thereby providing favourable structures into which mineralizing solutions could migrate.

(b) The Komati Formation

Rock-types correlated with the Komati Formation, as described in the southern part of the Mountain Land by Viljoen and Viljoen (1969a), occur in the central core of the eastern half of the Jamestown Schist Belt between the Barberton-Nelspruit road and Noordkaap. In addition, the Formation reappears at the western extremity of the Schist Belt immediately underlying the rocks of the Transvaal escarpment as well as farther west as an inlier exposed in the Elands River valley.

The various mafic and ultramafic assemblages of the Komati Formation occupy a position above the upper siliceous cherty horizon of the Theespruit Formation. This horizon appears to form a fold closure, immediately north of the Worcester Gold Mine, the northern arm of which can be traced eastwards for a distance of approximately 6.5 kilometres before it trails out into a mass of ultramafic schists. The southern limb can be traced for a distance of nearly 10 kilometres where it parallels the Kaap Valley Granite contact. Sporadic cherty patches were also noted in the meta-basalts in the areas to the northwest and east of Caledonian Siding.

Between these two arms just described, the rocks of the Komati Formation comprise a great mass of generally serpentinized ultramafic rock, together with a variety of amphibolitized mafic schists. The serpentinites occur as distinctive bands and ridges, interlayered with amphibolitized mafic material, and although often disconnected, and lensoid, they nevertheless, form part of a layered succession. The lensoid nature of the serpentinites is particularly prominent in the western part of the area where, along strike, the serpentinite ridges give way to zones of tremolite or talc. Most of the rocks making up the Komati Formation in the Jamestown Schist Belt comprise, however, a layered differentiated succession of ultramafic and mafic rocks, typified by the Handsup and Mundt's Concession differentiated bodies in the eastern part of the area and described by Anhaeusser (1969).

As these differentiated bodies form the subject matter of a separate paper (in preparation) they will not be dealt with in detail in this report. Briefly, the bodies consist of a number of cyclic differentiated units, each cycle generally commencing with dunites, peridotites, harzburgites, and pyroxenites and terminating with gabbroic rocks, the latter sometimes containing small patches of anorthositic gabbroic material. Certain of the rock units may be missing from individual cycles due either to incomplete differentiation within a cycle or because of elimination by folding and faulting. All the rocks have undergone alteration and now consist essentially of serpentinites and amphibolites with only occasional remnants of primary mineral phases still being preserved.

The differentiated bodies throughout the Jamestown Schist Belt are generally folded and contain a number of chrysotile asbestos deposits in addition to small scattered occurrences of the semi-precious rocks known as verdite and buddstone (see later).

The Kaapsehoop differentiated ultramafic bodies differ somewhat from those nearer Noordkaap in that they are comprised of alternating layers of dunite and orthopyroxenite with subordinate amounts of peridotite, harzburgite, clinopyroxenite and gabbro. From reconnaissance mapping Viljoen and Viljoen (1969a) have suggested that the Kaapsehoop differentiated bodies can be equated with the Stolzburg and Kalkkloof bodies north of Badplaas in the southwestern part of the Barberton Mountain Land.

In addition to the rocks described above, and which form by far the bulk of the Komati Formation in the Jamestown Schist Belt, there are zones consisting of dolomitized mafic and ultramafic material. This carbonation of the formations is prominent along zones of dislocation and shearing, particularly along the Albion Fault which slices through the southern part of the area, parallel to the general trend of the Schist Belt itself. The western extension of the Kaap River Fault is another zone along which considerable carbonation of the surrounding rocks has taken place.

The Komati Formation, as developed in the type-area in the Komati River Valley, is typified by the complete absence of any interlayered siliceous sediment or chert horizons and is made up of a thick succession of regular, alternating, bands of mafic and ultramafic volcanic material (Viljoen and Viljoen, 1969a). However, there are many bodies of quartz and felspar porphyry intrusive into the mafic and ultramafic horizons in the area. These generally occur as elongated lenses lying parallel to the layering of the formations. In the Jamestown Schist Belt, numerous quartz and felspar porphyry bodies likewise intrude the Komati Formation assemblages, particularly in the area separating the Mundt's Concession differentiated body from the one on the farm Handsup 305 JU (see Figure 2). A number of porphyry bodies also occur along, and adjacent to, the Albion Fault in the area southwest of the Handsup fold. In the Clutha Mine area, southeast of Noordkaap another long, narrow, quartz porphyry body, associated with carbonated greenschists and dolomitized meta-basalts, lies conformably between Fig Tree and Onverwacht Group rocks, parallel to the Lily Fault. Additional information concerning the chemistry of the porphyry intrusives is given in a later section dealing with the granitic rocks associated with the Jamestown Schist Belt.

The essential elements of the Komati Formation, as defined in the type-area in the Komati River Valley are, therefore, present in the Jamestown Schist Belt. The major difference in the two areas, however, lies in the fact that the Komati Formation developed in the southern part of the Mountain Land consists essentially of an extrusive sequence of pillow basalts together with alternating ultramafic horizons, most of which are also considered by Viljoen and Viljoen (1969a) to be extrusive in origin. These authors have found pillow structures in the ultramafic horizons and have amassed sufficient other information (Viljoen and Viljoen, 1969d) to suggest, quite conclusively, that some of these early ultramafic rocks were emplaced largely in the form of a succession of subaqueous flows which alternate with, and are intimately associated with, genetically related and distinctive mafic flows.

In the Jamestown Schist Belt on the other hand, the Komati Formation, although similar in many respects, is nevertheless, comprised essentially of an intrusive sequence of mafic and ultramafic rocks. These rocks, it would appear, were derived from magma introduced into a pile of essentially basaltic lava in the form of penecontemporaneous near-surface sill-like bodies. Differentiation processes were able to take place, producing a layered succession of alternating olivine and pyroxene peridotites, pyroxenites, and gabbros. The relative abundance of the various rock-types involved in this event suggests that the parent magma was initially of ultramafic composition. There can be little doubt that the emplacement of the intrusive sills took place very early in the history of the development of the Onverwacht Group as the differentiated bodies have been involved in the deformational phases that affected the area.

Despite the difference in character of these rocks displayed in both the Komati River Valley and in the Jamestown Schist Belt, it was suggested (Anhaeusser, 1969) that both types are intimately related to one another. The rocks of the differentiated bodies in the Jamestown Schist Belt were thus regarded as the igneous magmatic equivalents of the essentially volcanic mafic and ultramafic successions in the Komati River Valley. As a test of this hypothesis the writer suggested that a comparison be made of the bulk chemistry of the rocks from the two separate areas. The bulk composition of the Mundt's Concession-Handsup differentiated bodies was calculated (Anhaeusser, 1969, p. 137) but no chemical analyses of rocks from the southern part of the Mountain Land were available at the time for a direct comparison to be made. Since then much new chemical data has emerged from the Upper Mantle Project studies and, conveniently, bulk chemical comparisons are now available (Viljoen and Viljoen, 1969e - see Table 2). The results have confirmed the view, expressed earlier, that the diverse rocks contained in the differentiated bodies have been derived from the same parental magma-types that occur as extrusive lava flows in the Komati River Valley.

C. THE GEOCHEMISTRY OF THE THEESPRUIT AND KOMATI FORMATIONS

(a) Introduction

Only a limited amount of chemical data is available from the formations on the north-western flank of the Barberton Mountain Land. As almost all the rocks in the area have suffered varying degrees of metamorphism no rigorous geochemical investigations were embarked upon. It was established that the southern part of the Mountain Land was best suited to such a study and this area was investigated as part of the Upper Mantle Project programme. Much new chemical data pertaining to the Onverwacht volcanic assemblages emerged following the investigations of Viljoen and Viljoen (1969a, b). These authors were able to classify the volcanic assemblages of the Onverwacht Group on a geochemical basis and recognized, at the same time, rock classes totally unlike any widespread and generally accepted rock-types yet described. These new rock classes were referred to as basaltic and peridotitic komatiites and are prominently developed in the lower half of the Onverwacht stratigraphy, being particularly well-developed in both the Theespruit and Komati Formations.

TABLE 2 †

COMPARISON OF THE BULK CHEMISTRY OF THE LAYERED ULTRAMAFIC BODIES WITH THE AVERAGE CHEMISTRY OF PERIDOTITIC KOMATIITE

	1	2	3	4
SiO_2	46.64	46.80	50.13	45.94
Al_2O_3	4.01	2.56	3.24	2.98
Fe_2O_3	3.30	3.74	3.32	6.53
FeO	5.82	6.29	4.64	4.80
MgO	32.50	35.43	32.43	33.79
CaO	4.76	2.50	5.25	4.73
Na_2O	0.20	0.51	0.67	0.15
K_2O	0.04	0.06	0.03	0.03

† Table 2 after Viljoen and Viljoen (1969e)

1. Bulk chemical composition of the Ship Hill Ultramafic Body, Kaapmuiden area.
2. Bulk chemical composition of the Koedoe Ultramafic Body, Kaapmuiden area.
3. Bulk chemical composition of the Mundt's Concession-Handsup Ultramafic Body, Jamestown Schist Belt (Anhaeusser, 1969).
4. Average chemical composition of the peridotitic lava flows from the type area of the Komati Formation in the southern part of the Barberton Mountain Land.

N.B. All analyses calculated anhydrous.

Despite the altered nature of the rocks in the Jamestown Schist Belt and in other areas between Noordkaap and Louw's Creek on the northern side of the Mountain Land, some chemical similarities emerge from comparisons made with the rocks from the Komati River Valley. In the sections which follow all the available geochemistry of rocks from the northern area is tabulated and discussed.

(b) Mafic and Ultramafic Rocks

A total of eight chemical analyses of mafic and ultramafic rocks from the Jamestown Schist Belt and areas east of here are given in Table 3a. Excluded are analyses of rocks from the layered differentiated ultramafic bodies which are discussed elsewhere (Anhaeusser, 1969; also in preparation). For comparative purposes analyses of mafic and ultramafic rocks from the southern part of the Mountain Land are provided in Table 4. Viljoen and Viljoen (1969a) found it suitable to group the mafic rocks into four classes (see Columns 3-6 in Table 4) based mainly on the variability of calcium, aluminium, and magnesium, and, to a lesser extent, the silica and alkali contents of the basalts. Using these distinguishing characteristics the chemical analyses of the rocks from the northern area, listed in Table 3a, were grouped with one or other of the new classes of mafic volcanic rocks described from the Lower Ultramafic Unit in the Komati River Valley (Viljoen and Viljoen, 1969a). Thus the amphibole and chlorite schists listed in Columns 1-3 in Table 3a were equated respectively with the three classes of basaltic komatiite listed in Columns 3-5 in Table 4. Just how valid such a comparison of rocks of differing degrees of metamorphism and structural state may be is open to question. The geochemical correspondence may be purely fortuitous while on the other hand the similarities may be real. If the latter circumstance is, in fact, the case then one must assume that the chemical system remained a relatively closed one during the mineralogical transformation of the basalts, brought about by the dynamothermal alteration of the rocks in the northern areas of the Mountain Land.

TABLE 3a

CHEMICAL ANALYSES OF MAFIC AND ULTRAMAFIC ROCKS FROM THE LOWER FORMATIONS OF THE ONVERWACHT GROUP ON THE NORTHWESTERN FLANK OF THE BARBERTON MOUNTAIN LAND (EXCLUDING THE LAYERED DIFFERENTIATED ULTRAMAFIC BODIES)

	1	2	3	4	5	6	7	8
	J6†	J9†	J10†	CAA1*	CAT79*	65†	J7†	UD1
SiO_2	56.28	55.11	48.36	52.30	49.00	54.11	49.64	36.84
Al_2O_3	8.38	4.25	3.75	14.15	14.25	14.42	12.63	4.58
Fe_2O_3	10.77	8.14	13.97	1.48	2.12	10.34	16.92	3.96
FeO	-	-	-	9.44	8.04	-	-	6.40
MgO	9.47	16.51	19.26	6.06	8.33	5.73	5.63	31.24
CaO	8.64	12.28	9.11	10.66	9.88	9.64	9.77	0.14
Na_2O	3.30	0.90	0.16	2.15	1.75	1.93	2.69	0.03
K_2O	0.29	0.02	0.03	0.21	1.63	0.14	0.37	0.03
H_2O+	1.00	1.41	3.55	1.89	2.60	2.42	1.06	11.20
H_2O-	0.23	0.14	0.58	0.09	0.17	0.07	0.08	0.24
CO_2	0.11	0.11	0.03	0.11	0.61	0.53	0.15	-
TiO_2	0.73	0.39	0.54	0.95	0.70	0.82	1.32	-
P_2O_5	0.07	0.06	0.04	0.06	0.05	0.12	0.15	-
MnO	0.15	0.15	0.19	0.24	0.18	0.15	0.19	-
NiO	0.04	0.05	0.18	n.d.	n.d.	0.11	0.06	-
Total	99.46	99.52	99.75	99.79	99.31	100.53	100.85	94.66

Analysts and Methods Used

* National Institute for Metallurgy, Johannesburg (Standard gravimetric, volumetric, colorimetric and flame photometric).

† Average of 3 comparative X-ray fluorescence and chemical analytical determinations carried out by the National Institute for Metallurgy and Corner House Laboratories, Johannesburg.

Column 1. Tremolite-actinolite schist from the farm Crystal Stream 323 JU, south of Honeybird Siding, 16 Kms. east of Noordkaap.

2. Tremolite-actinolite schist from the farm Annex Riverbank 279 JU south of Honeybird Siding.

3. Talc-chlorite schist from the farm Crystal Stream 323 JU south of Honeybird Siding.

4. Dark contact amphibolite near the Nelspruit Granite contact northwest of the New Consort Gold Mine, eastern end of the Jamestown Schist Belt.

5. Dark contact amphibolite near the Kaap Valley Granite contact on the farm Thornylea 588 JT, approximately 10 Kms northwest of Caledonian Siding.

6. Tremolite-actinolite schist from the farm Bramber 313 JU north of Caledonian Siding.

7. Contact amphibolite from the Kaap River west of Honeybird Siding.

8. Partly serpentinized peridotite dyke (peridotitic komatiite) from the North Kaap River on Lot 88, west of the Worcester Gold Mine, Jamestown Schist Belt (Viljoen and Viljoen, 1969a).

TABLE 3b

CATION PERCENTAGES, CATANORMS, AND MESONORMS OF TWO CONTACT AMPHIBOLITES FROM THE JAMESTOWN SCHIST BELT

Cation Percentages	CAA1	CAT79	Catanorms	CAA1	CAT79	Mesonorms	CAA1	CAT79
Si	50.39	47.40	Ap	0.13	0.13	Ab	20.05	16.40
Al	16.04	16.21	Il	1.34	1.00	An	29.53	27.33
Fe^{+++}	1.07	1.55	Or	1.10	10.00	Bi	1.76	16.00
Fe^{++}	7.57	6.46	Ab	20.05	16.40	Act	32.63	25.87
Mg	8.75	12.08	An	29.09	26.95	Hy	8.48	1.70
Ca	11.01	10.25	Mt	1.61	4.53	Q	3.58	6.48
Na	4.01	3.28	Wo	10.94	10.18	Sph	2.01	1.50
K	0.22	2.00	En	17.50	24.16	Mt	1.61	4.78
Ti	0.67	0.50	Fs	6.90	5.96	Ap	0.13	0.88
P	0.05	0.05	Q	8.22	0.48			
Mn	0.16	0.16						
Totals	99.94	99.94						

TABLE 3c

MODAL ANALYSES OF TWO CONTACT AMPHIBOLITES FROM THE JAMESTOWN SCHIST BELT

	Volume per cent	Weight per cent
Sample CAA1 :		
Quartz	17.43	15.50
Hornblende	60.49	64.80
Plagioclase	21.95	19.50
Opaque minerals	0.10	0.20
Sample CAT79		
Quartz	1.76	1.50
Amphibole (hornblende, tremolite-actinolite)	70.35	71.60
Plagioclase } Sericite }	16.58	14.90
Epidote	10.94	11.50
Opaque minerals	0.35	0.60

TABLE 4

CHEMICAL ANALYSES OF ULTRAMAFIC AND MAFIC ROCKS FROM THE LOWER ULTRAMAFIC UNIT OF THE ONVERWACHT GROUP

	1	2	3	4	5	6
SiO_2	44.72	41.61	52.73	52.22	47.37	52.13
Al_2O_3	3.25	2.70	9.83	5.42	6.79	13.33
Fe_2O_3	6.02	5.63	1.23	0.98	1.18	2.24
FeO	5.52	4.35	9.70	8.88	8.08	9.94
MgO	25.35	30.58	10.10	15.25	20.39	6.35
CaO	6.97	4.29	9.99	12.83	8.31	8.98
Na_2O	0.49	0.15	2.65	1.21	0.39	2.97
K_2O	0.05	0.03	0.46	0.09	0.06	0.26
H_2O+	5.58	8.81	1.93	2.05	5.26	1.97
H_2O-	0.21	0.22	0.16	0.09	0.25	0.11
CO_2	0.26	-	0.14	0.17	-	0.07
TiO_2	0.52	0.31	0.85	0.56	0.46	1.09
P_2O_5	n.d.	0.02	0.06	0.05	0.05	0.07
MnO	0.19	0.17	0.22	0.22	0.19	0.21
Cr_2O_3	0.36	0.32	-	-	-	-
NiO	0.14	0.18	-	-	-	-

Column 1. Average chemical composition of 3 metaperidotites (peridotitic komatiites) from the Sandspruit Formation.

2. Average of 8 peridotitic komatiites from the Komati Formation.

3. Average of 3 basaltic komatiites (Barberton Type) from the Komati Formation.

4. Average of 5 basaltic komatiites (Badplaas Type).

5. Average of 4 basaltic komatiites (Geluk Type).

6. Average of 4 meta-tholeiitic basalts.

Above analyses quoted from Viljoen and Viljoen (1969a)

The remaining meta-basalts listed in Columns 4-7 in Table 3a coincide relatively favourably with average meta-tholeiitic basalts from the Onverwacht Group listed in Column 6 of Table 4. The meta-basalts from the Jamestown Schist Belt and areas to the east vary from dark contact amphibolites to tremolite-actinolite-chlorite schists. The metamorphic grade of these rocks ranges from the amphibolite facies through the upper greenschist facies into the intermediate subfacies of the greenschist facies as defined by Winkler (1967). Again it appears that, despite the metamorphic variability displayed by the rocks the diagnostic chemical features have not changed appreciably.

In Tables 3b and 3c the cation percentages, catanorms, mesonorms, and modal analyses of two contact amphibolites from the Jamestown Schist Belt are presented. The mesonorms were calculated according to the scheme devised by Barth (1962) which was designed to take into account the chemically more complicated mineral assemblages encountered in rocks classed within the amphibolite facies of metamorphism.

Chemical data are not available from the ultramafic rocks of the Theespruit Formation in the Jamestown Schist Belt. Most of the occurrences comprise serpentinized ultramafics with only rarely preserved primary mineral phases being present. Apart from the chemical data relating to the differentiated ultramafic bodies associated with rocks of the Komati Formation and which are to be presented elsewhere, only one additional chemical analysis is available that relates to an ultramafic rock in the Jamestown Schist Belt.

On Lot 88, west of the Worcester Gold Mine, a number of serpentinized ultramafic dykes intrude the more massive ultramafic members of a differentiated body that forms part of the disharmonic fold straddling the Barberton-Nelspruit road (see Figure 1). These ultramafic dykes are well-exposed in a bend of the North Kaap River and provide supporting evidence for the existence of a peridotitic magma as adduced also from the evidence in the type area of the Komati Formation by Viljoen and Viljoen (1969a). In Plate 3C some of the dykes are illustrated. They seldom exceed 20 cm. in width and can be traced for several tens of metres in exposures along both sides of the river bank. The dykes have sharply defined contacts and display dark, almost blackish-coloured chilled selvedges. They are intrusive into bluish-black serpentinized peridotites, the latter containing, in places, veins and irregularly distributed blebs of carbonate material. The dykes, like their host rocks, are serpentinized. Only a partial chemical analysis is available of material from one of these dykes (see Column 8, Table 3a). Despite the altered nature of the peridotitic dykes Viljoen and Viljoen (1969a) considered that strong similarities exist between the chemistry of these rocks and the Komati Formation peridotites from the southern part of the Mountain Land.

(c) Siliceous Schists

Two samples considered typical of the siliceous schist horizons in the Jamestown Schist Belt were chemically analysed and are presented in Columns 1 and 2 of Table 5a. In addition, partial analyses of five similar rock-types from the area are provided in Table 6. In Tables 5b and 5c the cation percentages, catanorms, mesonorms, and modal analyses of the two siliceous schists from the Jamestown Hills area are presented.

TABLE 5a

CHEMICAL ANALYSES OF SILICEOUS ALUMINOUS SCHISTS FROM THE JAMESTOWN SCHIST BELT FOR COMPARISON WITH SIMILAR ROCKS FROM ELSEWHERE IN THE BARBERTON MOUNTAIN LAND, RHODESIA, AND WESTERN AUSTRALIA

	1	2	3	4	5	6	7
	J13*	J14*	2†	AT2*	BR23	BR6	
SiO_2	79.53	78.28	90.04	59.93	58.12	71.75	76.74
Al_2O_3	12.76	17.52	6.71	26.26	24.45	14.73	15.96
Fe_2O_3	0.11	0.39	0.23	0.29	1.31	0.97	0.52
FeO	0.36	1.01	0.00	1.64	1.00	1.38	1.10
MgO	0.30	0.46	0.00	1.26	2.85	1.75	1.11
CaO	0.28	0.30	0.01	0.42	0.23	0.82	0.10
Na_2O	0.27	0.53	0.12	3.75	0.40	3.48	0.31
K_2O	3.86	1.48	2.31	1.63	7.92	3.55	2.22
H_2O+	1.74	0.88	1.06	3.72	3.34	1.04	1.44
H_2O-	0.23	0.20	0.06	0.32	0.13	0.17	0.08
CO_2	n.d.	n.d.	0.00	0.12	0.03	n.d.	0.01
TiO_2	0.53	0.55	0.05	0.45	0.13	0.25	0.35
P_2O_5	0.18	0.11	n.d.	0.05	n.d.	0.09	0.03
MnO	tr	0.01	0.01	0.02	0.06	0.04	0.05
Total	100.15	101.72	100.60	99.86	99.95	100.00	

Analysts and Methods Used

* National Institute for Metallurgy, Johannesburg (Standard gravimetric, volumetric, colorimetric and flame photometric).

† Mr. I Wright, Department of Geology, University of the Witwatersrand (X-ray fluorescence).

Column 1. Quartz-sericite-staurolite schist, Riverside 245 JU, eastern portion of Jamestown Schist Belt.

2. Andalusite and chloritoid-bearing quartz-sericite schist, north of above locality in the Jamestown Schist Belt.

3. Siliceous, sericite-bearing tuffaceous sediment (Theespruit Formation type area - Viljoen and Viljoen, 1969a).

4. Water worked, aluminous (pyrophyllitic) felsic tuff (Theespruit Formation type area - Viljoen and Viljoen, 1969a).

5. Mica schist, 1.6 Km west of Montezuma Mine, Odzi Gold Belt, Rhodesia (Swift, 1956).

6. Mica schist, Montezuma Mine, Odzi Gold Belt, Rhodesia (Swift, 1956).

7. Average composition of seven siliceous aluminous schists from Mt. Leonora; Westonia; Mt. Kenneth, Yalgoo Goldfield; Mt. Walton; Yandanhoo Hills; Southern Cross, and the Yilgarn Goldfields areas of Western Australia (Joplin, 1963).

TABLE 5b

CATION PERCENTAGES, CATANORMS, AND MESONORMS OF SILICEOUS ALUMINOUS SCHISTS FROM THE JAMESTOWN SCHIST BELT

Cation Percentages

	J 13	J 14
Si	78.17	75.00
Al	14.76	19.73
Fe^{+++}	0.05	0.28
Fe^{++}	0.28	0.81
Mg	0.46	0.63
Ca	0.28	0.28
Na	0.52	0.98
K	4.86	1.79
Ti	0.40	0.40
P	0.17	0.05
Mn	-	-
Totals	99.95	99.95

Catanorms

	J 13	J 14
Ap	0.45	0.13
Il	0.68	0.80
Or	24.30	8.95
Ab	2.60	4.90
An	-	-
Mt	0.05	0.49
En	0.92	1.26
Q	61.57	-
Fs	-	0.40
C	9.38	16.96

Mesonorms

	J 13	J 14
Ap	0.45	0.13
Sph, Mt	1.19	
Sph		1.00
Mt		0.28
Or	24.30	8.95
Ab	2.60	4.90
C	9.38	16.96
Q	62.03	66.29

TABLE 5c

MODAL ANALYSES OF TWO SILICEOUS ALUMINOUS SCHISTS FROM THE JAMESTOWN SCHIST BELT

	Volume per cent	Weight per cent
Sample J 13		
Quartz	58.04	55.90
Sericite	40.38	41.60
Staurolite	0.69	0.90
Opaque minerals	0.87	1.60
Sample J 14		
Quartz	57.96	53.30
Andalusite	38.94	42.50
Chloritoid	2.26	2.80
Opaque minerals	0.82	1.40

TABLE 6

PARTIAL CHEMICAL ANALYSES OF FIVE SILICEOUS ALUMINOUS SCHISTS - JAMESTOWN SCHIST BELT

	Sample No.	SiO_2*	Al_2O_3*	Fe_2O_3*	K_2O†	Na_2O†
1.	90	80.28	15.14	0.66	1.62	1.40
2.	162	74.32	16.66	1.06	1.00	1.73
3.	171B	70.80	19.82	0.46	5.31	1.27
4.	185	79.56	15.08	0.88	0.11	0.14
5.	196A	82.56	14.63	0.66	0.21	0.07
	Average	77.50	16.27	0.74	1.65	1.40

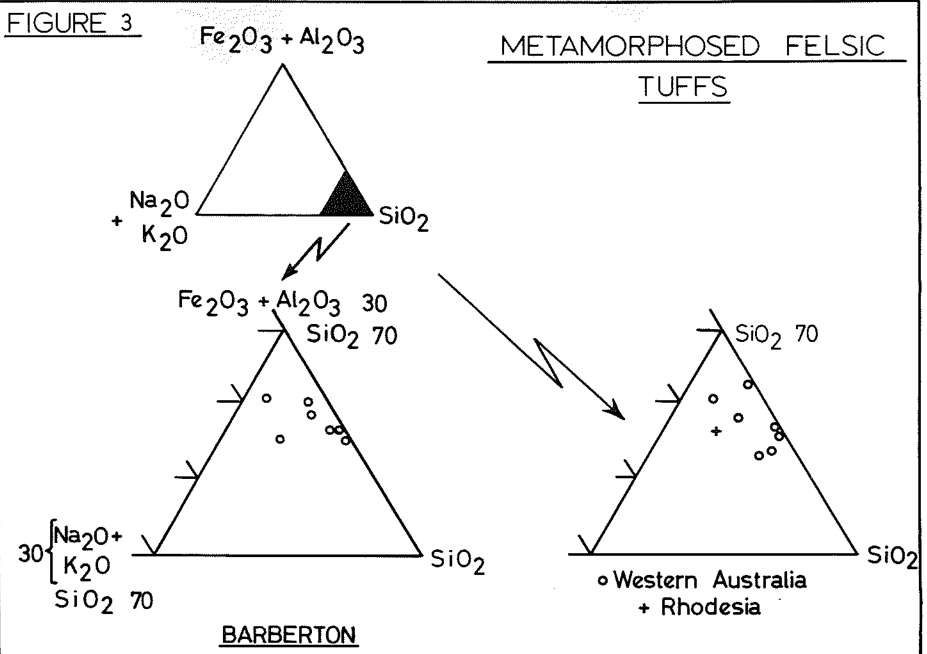
Analysts : * Anglo-Transvaal Consolidated Investment Company Limited.
† Alkali determinations by the author (flame photometric).

1. Andalusite-quartz-sericite schist; south bank of the North Kaap River, Lot 65.
2. Andalusite-quartz-sericite schist; Lot 64, immediately north of the river.
3. Andalusite-chloritoid-sericite schist; nose of fold in the area of the Kaffir Creek Talc Mines, Lot 137.
4. Quartz-sericite schist; same horizon as Sample J 13, but east of the latter on Lot 65.
5. Andalusite-sericite schist; north of the North Kaap River, and close to the Nelspruit Granite contact on the farm Riverside 245 JU.

As was pointed out earlier the most important distinguishing aspects of these rocks is their high content of silica and alumina. The original composition of the tuffaceous material that ultimately gave rise to the siliceous aluminous schists remains obscure, It is the impression of both the writer (Anhaeusser, 1969) and Viljoen and Viljoen (1969a) that the primary felsic pyroclastic material was modified after deposition. This reworking was probably due to a variety of causes, including surface weathering of the type that gave rise to many of the vast bentonite clay beds in North America (Ross, 1955). Furthermore, Viljoen and Viljoen (1969a) found evidence to suggest that some of the felsic tuffs had been reworked in an aqueous environment and that the subsequent alteration may have been aided by hot spring and late volcanic activity.

Two chemical analyses of siliceous aluminous schists from the Jamestown Schist Belt are included in Columns 1 and 2 of Table 5a for comparison with examples from the Komati River Valley (Columns 3 and 4), and from Rhodesian and Western Australian greenstone belts (Columns 5-7). The high degree of chemical correlation between these unusual rocks, all of which are located in similar geological settings is further demonstrated in the triangular diagram plots shown in Figure 3.

FIGURE 3



D. THE FIG TREE GROUP

Rocks of the Fig Tree Group are only developed in the eastern part of the Jamestown Schist Belt where they form part of the western extension of the Lily Syncline. The Fig Tree assemblage is best developed in the area of the New Consort Gold Mine. Much detailed work has already been done in the mine area, notably by Hearn (1943), van der Berg and others (1946), and Viljoen (1964), so that only a brief description will be given here and the new findings added.

At the base of the succession and in contact with the underlying Onverwacht Group schists there is invariably developed a hard, siliceous, chert-like rock known as the Consort "Bar". This notable horizon, along which most of the important gold mineralization has been located, was first mapped in detail around the Consort Mine by van der Berg and others (1946) and again later by Viljoen (1964). It became apparent that the area had been subjected to strong folding as well as granite and pegmatite invasion, the latter causing local disruption and elimination of the formations in the mine area.

Apart from the Consort "Bar", or Consort "Contact", as it is referred to locally, the Fig Tree rocks in the area consist of an alternating succession of shales, greywackes, and associated chert horizons. In addition, scattered-pebble conglomerates may be developed in places and the whole sequence is terminated by felspathic tuffaceous greywackes, and tuff conglomerates or agglomerates. A complete account of the stratigraphy of the Fig Tree assemblage east of the Consort Mine was given by Viljoen (1964). In addition to the rock-types already mentioned he was able to distinguish two marker horizons within the pile of tuffaceous material comprising the upper part of the Fig Tree Group. One of these he called the "Lower Quartz-Bleb Marker". This occurs towards the top of the succession, within the so-called "autolith" zone of the Geological Survey (Visser, compiler, 1956), later termed the felspathic tuffaceous conglomerate zone by

Anhaeusser (1964), and Viljoen (1964). The "quartz-bleb marker" constitutes a persistent laminated horizon, containing an abundance of highly sheared and flattened quartz lenses or "blebs". The second marker horizon was referred to as the "Upper Pyroxene Marker". This occurs at the very top of the felspathic tuffaceous greywacke zone, immediately underlying the basal conglomerate of the Moodies Group (see Figure 2), and consists essentially of coarsely crystalline diopsidic pyroxene together with lesser amounts of plagioclase, tremolite-actinolite, microcline, zoisite, and quartz (Viljoen, 1964).

The succession has undergone alteration and metamorphism with the result that the Fig Tree rocks in the area do not entirely resemble their equivalents in other parts of the Barberton Mountain Land. In fact, the Lily Syncline, between the Consort Mine and Louw's Creek, represents one of the few localities in the Barberton greenstone belt where rocks of the Fig Tree and Moodies Groups are sufficiently close to the granite contacts to have suffered thermal metamorphism.

The writer extended the mapping of the Consort Mine area westwards where it was found that the Fig Tree Group sediments do not continue very far into the eastern part of the Jamestown Schist Belt. The Fig Tree rocks, in fact, terminate in a synclinal structure, known as the No. 3 Shaft Syncline, situated to the west and southwest of the Consort Mine offices and mill. The following descriptions of the Fig Tree assemblage apply more specifically to the No. 3 Shaft Syncline area.

The Consort "Contact" or "Bar" occurs at the contact between the underlying mafic and ultramafic schists of the Onverwacht Group and the overlying Fig Tree assemblage. In places the "Bar" is well-developed and forms a conspicuous cherty outcrop several feet wide. In the area west of Consort Mine, the outcrops of the "Bar" are relatively poor, the best exposures being seen in some of the deeply incised gullies that drain into the North Kaap River. In most cases the "Bar" itself is only a few inches wide and its exact position is doubtful due to poor exposure. The schists underlying the Consort "Contact" are predominantly tremolite and talc-tremolite schists derived from serpentinites that build the low lying foothills of the Krokodilpoort Range. The Fig Tree rocks immediately overlying the "Bar" consist of metamorphosed shales and greywackes together with some thin chert bands. The grade of metamorphism here is not as high as that of the same sediments in the areas to the north and northeast of the Consort Mine where hornfelses are to be found. Some silicification of the shales has taken place resulting in the production of hard, brittle, strongly cleaved, slaty rocks.

The origin of the "Bar" separating the competent Fig Tree rocks from the less competent Onverwacht schists has been explained by Hearn (1943), van der Berg and others (1946), and Viljoen (1964), as having resulted from the silicification of the intensely sheared zone at the junction of the two rock-groups. Hearn (1943) was of the opinion that the siliceous solutions, which made their way into the zone of shearing, were introduced subsequent to the pegmatite intrusion, and that the mineralization of the "Bar" took place after the silicification.

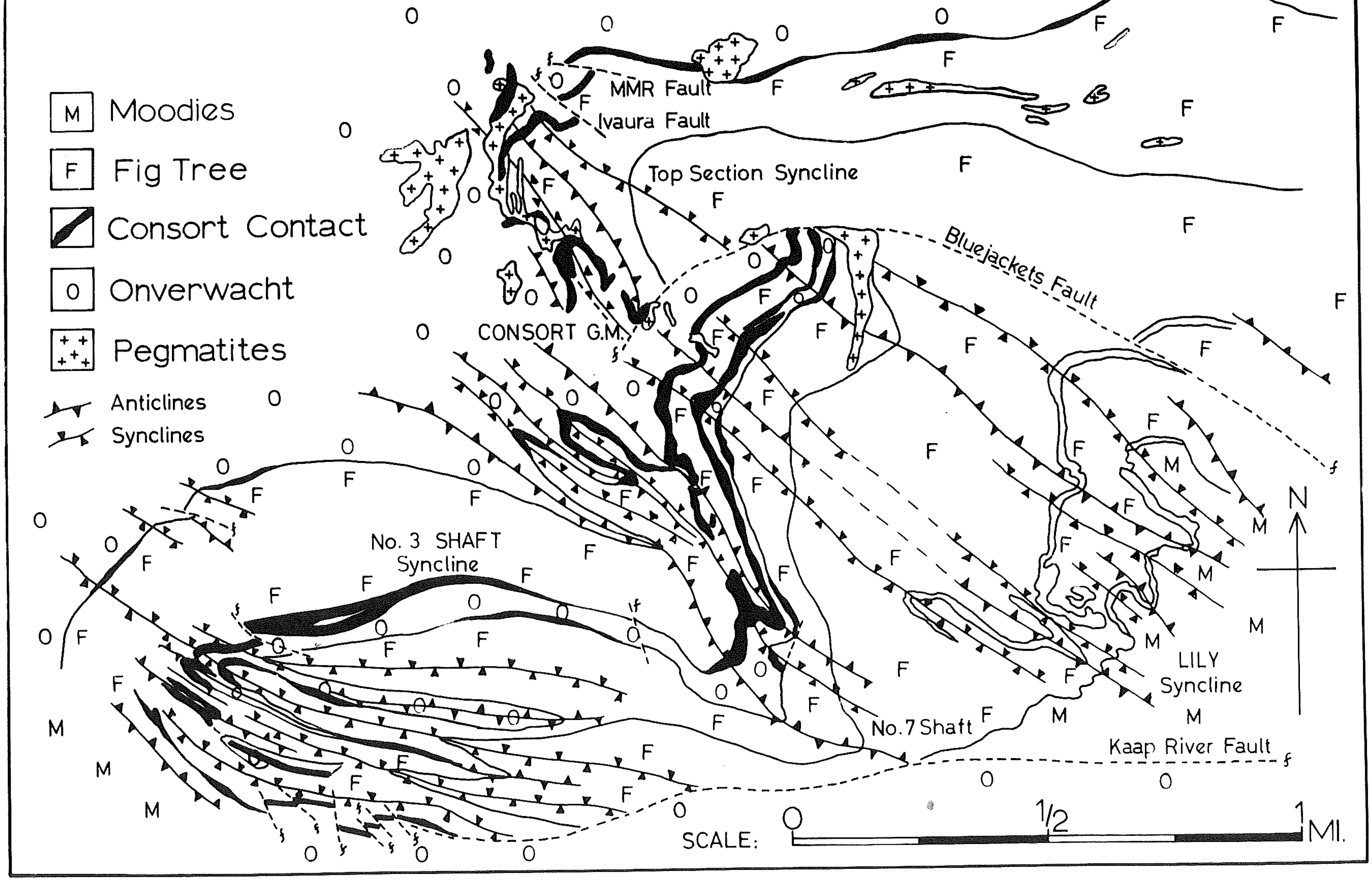
Van der Berg and others (1946) considered that the succession at the base of the Fig Tree Group consisted of alternating cherts and greenschists similar to the Zwartkoppie rocks in the Sheba Gold Mine. The Geological Survey (Visser, compiler, 1956) on the other hand, contended that the various ultramafic schists separating the chert horizons in the mine area belonged to the intrusive suite of the Jamestown Complex. Gribnitz and others (1961), and Viljoen (1964), placed the schists underlying the Consort "Contact" into the Onverwacht Group. The mapping in the No. 3 Shaft Syncline confirmed this view. From the Consort Mine eastwards the true nature of the stratigraphy can be demonstrated (see Figure 4). In this area only one chert horizon separates the Onverwacht schists from the Fig Tree shales. Earlier, three separate chert horizons, intercalated with shales and schists, were thought to exist in the mine area. Structural data presented by Viljoen (1964), and the writer (see Figure 5) show clearly that the main section of the Consort Mine as well as the No. 3 Shaft Syncline have been subjected to superimposed folding resulting in the production of a complex outcrop pattern and the duplication of stratigraphy. The Consort "Contact" in the No. 3 Shaft Syncline is followed by an alternating assemblage similar to that found in the area to the northeast of the Mine offices. The succession is composed of isoclinally folded strata causing a repetition of the same beds to take place several times over a distance of 800 metres.

In the synclinal cores of two of the fold structures, felspathic tuffaceous greywackes are preserved, which appear to correspond with those of the upper part of the Fig Tree succession to the east, described by Viljoen (1964). In these rocks, scattered-pebble conglomerates are developed in places and may correspond to the "quartz-bleb marker" horizon mentioned earlier. Flattened and folded chert pebbles from the No. 3 Shaft Syncline are shown in Plate 2B.

STRUCTURE AND STRATIGRAPHY OF THE CONSORT MINE AREA

FIGURE 4

Eastern part of map modified after Viljoen (1964)



The shales and slates in the No. 3 Shaft Syncline are typically fine-grained, well-banded, and dark-brown in colour. In thin-section the rocks consist of quartz, biotite, chlorite, some plagioclase, sericite, and carbonate at times. The greywackes are dark grey-brown or black on fresh surfaces but generally weather to a light grey-brown or reddish-brown colour. The rocks contain an abundance of angular quartz and chert fragments in a matrix composed predominantly of fine quartz, chlorite, biotite, sericite, iron oxides, carbonate, and clay minerals. Plagioclase felspar is also a common constituent. The grain-size of the components is very variable. The tuffaceous greywackes of the upper part of the Fig Tree succession also contain angular to euhedral crystals of plagioclase, some grains of which show zoning. In outcrop the rock is distinctively different from the earlier mentioned greywackes in that the felspar shows up prominently as white flecks in a dark grey-black matrix. The weathered rock is generally a pale grey colour. The greywackes are poorly bedded but in places show a weak foliation or cleavage.

In the southwestern part of the No. 3 Shaft Syncline quartz-sericite schists of the underlying Onverwacht Group outcrop for a short distance. These rocks are associated with tremolite-actinolite schists and have been exposed as a result of folding and faulting in the area between the Fig Tree succession and a small block of Moodies sediments. The quartz-sericite schists are themselves intensely folded (see Plate 2, C and D).

E. THE MOODIES GROUP

The main development of Moodies Group rocks in the Barberton Mountain Land are shown in the inset locality map in Figure 1. The successions generally occupy the central core of the Barberton greenstone belt and build high, rugged mountainous country. Moodies rocks are only developed at the eastern end of the Jamestown Schist Belt where they occur in the Eureka and Lily Synclines.

Between the Fig Tree rocks of the No. 3 Shaft Syncline and the mafic and ultramafic schists of the Onverwacht Group in the Consort Mine area, a small arcuate ridge of Moodies sediments occurs as an isolated, fault-bounded block (see Figure 2). The sediments in this block strike roughly north-south, almost at right angles to the northwest-trending schists which occur along the western and northern contacts.

Flowing through the centre of the block is the North Kaap River which has carved a gorge through the Moodies rocks, thereby creating a potentially favourable dam site (see Plate 5D). A weir, situated in the gorge, was once used to divert water into a canal leading to a small hydro-electric plant, near Joe's Luck Siding that generated power for the Consort Mine. This scheme was superceded by another diversion weir situated lower downstream in the Kaap River at the Junction of the North and South Kaap rivers where the volume of water was greatly increased.

The Moodies rocks are underlain in the east by a thin zone of felspathic tuffaceous greywackes, containing flattened chert fragments, and greywacke conglomerates. These pass conformably into Moodies rocks consisting, at the base, of a conglomerate horizon, the latter overlain by a calcareous felspathic quartzite horizon. The conglomerates and the quartzites probably represent part of the far western extension or closure of the Lily Syncline, the northern limb of which occurs approximately 2.8 kilometres to the east near the No. 7 Shaft Anticline. The conglomerate has all the characteristics typical of the basal conglomerate of the Moodies Group and the overlying quartzites are similar to the calcareous quartzites found in the Eureka Syncline to the southeast of Noordkaap (see Figure 2).

The basal conglomerate does not consist of a single conglomerate layer but a zone of numerous pebble bands separated by quartzitic material. The conglomerates and quartzites have suffered metamorphism and are mostly recrystallized and silicified. The pebbles are flattened, and aligned parallel to the bedding. Most of them consist of various types of banded chert, black chert, quartzite, granite and quartz porphyry. The quartzites are buff-coloured and when scratched leave a white carbonate stripe. The rocks are well-bedded and dip almost vertically or at steep angles to the east or northeast. They are thus slightly overturned in places. Minor folds such as intraformational drag folds and conjugate folds indicate compression in a horizontal plane in a north-south direction.

The Geological Survey map of the area (Visser, compiler, 1956) shows the Moodies rocks swinging around in a broad arc and extending in a southeasterly direction ending at a bend in the North Kaap River. The writer could not locate this southeasterly-trending limb but instead found the western extension of the Kaap River Fault, the fault plane of which is quartz filled for much of its length. The Kaap River Fault, which can be traced for several kilometres into the area to the east is a large reverse or high-angled thrust fault with an upthrow to the south, exposing characteristic Onverwacht schists along much of its length. In the area to the east, the Kaap River Fault (previously called the Main Southern Fault by Viljoen, 1964), truncates the fold trends of the Lily Syncline and eliminates, entirely, the southern half of this structure.

The western contact of the calcareous quartzites with the talc and tremolite schists of the Jamestown Schist Belt is nowhere clearly exposed but some of the schists adjacent to the Moodies rocks are sheared or foliated in a north-south direction and probably form part of the fault zone extending along the western side of the block of sediments. Near the weir, and probably in the fault zone, a quartz-felspar porphyry body outcrops.

Rocks correlated with the Moodies Group by Visser and others (1956) were thought to exist in the far western part of the Jamestown Schist Belt. As was mentioned in an earlier section the writer concluded that these rocks form part of the Theespruit Formation as they are intimately associated with silicified, porcelanous slates and cherts, and mafic schists. The rocks which resemble gritty conglomerates may, in fact, be tuff agglomerates of pyroclastic volcanic origin.

GRANITIC ROCKS OF THE JAMESTOWN HILLS AREA

A. INTRODUCTION

The Jamestown Schist Belt clearly owes much of its distinctive character to the granitic rocks flanking and intruding it along its margins. These have previously been described (Visser and others, 1956; van Eeden and Marshall, 1965; Anhaeusser, 1966; 1969; and Viljoen and Viljoen, 1969g), and will only be dealt with briefly in this paper. In addition, aspects of the geochemistry and geochronology of the granites from the area are also discussed.

B. THE KAAP VALLEY GRANITE

The oldest granitic rock-type in the Barberton region is the Kaap Valley Granite, a large intrusive diapiric pluton, or dome, separating the Jamestown Schist Belt from the remainder of the Mountain Land to the south. The granite which in effect is a hornblende and biotite-rich tonalitic gneiss has been ascribed an age of 3310 ± 40 m.yrs by Oosthuyzen (1970) who carried out U-Pb geochronological studies on a variety of granitic rock-types surrounding the Barberton Mountain Land. The Kaap Valley Granite intrudes the Onverwacht formations which are considered to be approximately 3550 ± 50 m.yrs old (Oosthuyzen, 1970).

Much, if not most, of the complex structural history of the northwestern flank of the Barberton Mountain Land has been ascribed to the emplacement of the Kaap Valley Granite mass (Anhaeusser, 1969). The Jamestown Schist Belt for example is considered to have developed as a result of the 'prizing apart' of the Onverwacht Group rocks from the main northeast-trending segment of the Mountain Land. The granite not only stoped and assimilated much of the material into which it intruded but it also provided the necessary stress and heat energy responsible for the structural and metamorphic transformation of the rocks surrounding it.

The Kaap Valley Granite, probably due to contamination from the material into which it intruded, is the most basic granitic rock-type anywhere in the region. This is illustrated by the chemistry of the granite which is provided in Table 6a. Features of the chemistry which make this granite distinctive from other varieties in the area are to be found in the high sodium, calcium, magnesium, and iron contents, and the relatively low amounts of potash and silica present in the rocks.

The distinctive composition, mode of emplacement, and field characteristics of the granite have led to it being classified with the Ancient Tonalitic Gneisses (Viljoen and Viljoen, 1969g). Diapiric granites of this type are widely developed in the early Precambrian cratons and are frequently responsible for the arcuation of greenstone belts (Anhaeusser and others, 1969).

C. THE NELSPRUIT GRANITE

Along the northwest flank of the Barberton Mountain Land a variety of gneisses, migmatites, and homogeneous granites build the elevated country (highest point 1 516 m.) referred to as the Krokodilpoort Range.

Values obtained for this granite-type indicate ages of approximately 3000 m.yrs (2.99 ± 0.07 b.yrs, de Gasparis, 1967; 3.16 ± .02 b.yrs, Oosthuyzen, 1970).

Along the immediate contact with parts of the Jamestown Schist Belt and areas north and east of the Consort Mine there occurs a narrow leucocratic intrusive border phase of the granite (Viljoen, 1964; Anhaeusser, 1966; 1969). This intrusive phase fragments the metabasalts, serpentinites, and siliceous schists of the Theespruit Formation and several large amphibolite xenoliths occur in the granites, well removed from the contact zone. The granite is strongly foliated and lineated and augen gneisses and mylonitized zones provide evidence of the deformation suffered by the rocks in the area.

The Nelspruit Granite provided a buttress on the northern flank of the Jamestown Schist Belt, the latter being squeezed between it and the Kaap Valley Granite on the south side. Just when the Nelspruit gneisses and migmatites developed is not known precisely. Viljoen and Viljoen (1969g) suggest that much of the Nelspruit terrain might have represented a zone of tonalitic gneisses and incorporated Onverwacht xenoliths. This region may then have been subjected to further phases of granitization and metasomatism resulting in the development of both homogeneous phases and migmatites.

Numerous intrusive pegmatites occur in the Consort Mine area. These have been described by Gribnitz and others (1961), Viljoen (1964), and Anhaeusser (1966; 1969). Allsopp and others (1968) established a Rb/Sr isochron age of 3.00 ± 0.03 b.yrs for these pegmatites which also cut the gold-bearing ore zones in the Consort Mine.

The granodioritic nature of the typical Nelspruit Granites is illustrated by the chemistry of these rocks (Columns 6-8, Table 6a). Partial analyses (alkali oxides) of the granite-gneisses and Consort Mine pegmatites are shown in Table 6b (3 and 4). Approximately equal proportions of potash and soda easily enable a chemical distinction to be made between the Nelspruit Granites and pegmatites and the Kaap Valley Granite.

D. QUARTZ AND FELSPAR PORPHYRIES

As mentioned earlier, felsic porphyry bodies are found intrusive into the Jamestown Schist Belt. Some of these porphyry bodies may be related to the Kaap Valley Granite but it is considered that many predate this event and represent discrete intrusives. These were preferrentially emplaced into rocks of the Komati Formation and appear to have been deformed by later structural events ascribed to the emplacement of the Kaap Valley Granite pluton (Anhaeusser, 1966; 1969).

Chemically the porphyry bodies are fairly distinctive. They are almost invariably soda-rich and have the lowest potash-soda ratios of all the granitic rocks from the Barberton Mountain Land. In Table 6b values of the alkali oxides of the various granites intrusive into the Jamestown Schist Belt are compared, while listed in Table 6c are several analyses of felsic porphyry bodies from the southern part of the Barberton region and which are intrusive into the Komati Formation in this area. Viljoen and Viljoen (1969b) also found felsic porphyry bodies in the upper formations of the Onverwacht Group but these were found to differ chemically from those emplaced stratigraphically lower in the sequence. The distinction is particularly evident in a comparison of the alkali contents of the different porphyry bodies.

STRUCTURE OF THE JAMESTOWN SCHIST BELT

A. INTRODUCTION

The Jamestown Schist Belt consists of a number of large- and small-scale structures forming collectively a major synclinorium. Many of the structural features encountered in the area have

TABLE 6a

CHEMICAL ANALYSES, NORMS, AND NIGGLI VALUES OF GRANITIC ROCKS FROM THE NORTHWEST FLANK OF THE BARBERTON MOUNTAIN LAND

(1) Chemical Analyses :

	1	2	3	4	5	6	7	8
	1	3	7	KV1*	Average	6	2	Average
SiO_2	65.19	65.28	62.62	66.27	64.84	68.83	72.30	70.57
Al_2O_3	15.18	15.35	15.44	15.81	15.44	14.25	13.15	13.70
Fe_2O_3	2.47	2.22	1.76	0.76	1.80	0.89	1.12	1.05
FeO	2.29	2.30	2.58	2.59	2.44	2.00	1.29	1.65
MgO	2.93	2.26	2.67	2.50	2.60	1.58	0.84	1.21
CaO	3.77	4.26	4.48	4.49	4.25	3.13	1.57	2.35
Na_2O	4.33	5.00	4.95	5.44	4.93	4.62	4.34	4.48
K_2O	1.89	1.91	2.55	1.16	1.53	2.42	4.23	3.33
H_2O+	1.35	0.24	1.20	0.83	0.90	0.36	0.20	0.28
H_2O-	0.08	0.28	0.24	0.21	0.20	0.04	0.24	0.14
CO_2	-	0.78	0.77	-	-	-	0.70	-
TiO_2	0.69	0.44	0.46	0.35	0.49	0.38	0.33	0.36
P_2O_5	0.24	0.15	0.19	0.13	0.18	1.55	0.13	0.84
MnO	0.05	0.04	0.04	0.04	0.04	0.02	0.05	0.04
Total	100.46	100.51	99.95	100.58		100.07	100.49	

Analysts and Method Used

* National Institute for Metallurgy, Johannesburg (Standard gravimetric, volumetric, colorimetric and flame photometric).

Column 1. Kaap Valley Granite below Kaapsehoop escarpment (Visser, compiler, 1956).

2. Kaap Valley Granite, Lot 95 (van Eeden and Marshall, 1965).

3. Kaap Valley Granite, Trio 469 JT (van Eeden and Marshall, 1965).

4. Kaap Valley Granite collected by the writer from the Barberton Prison Quarry, Barberton 369 JU.

5. Average of 4 analyses of Kaap Valley Granite (hornblende tonalite)

6. Nelspruit Granite from Pretorius Kop, Kruger National Park (Visser, compiler, 1956).

7. Composite Nelspruit Granite from various localities in the Nelspruit area (van Eeden and Marshall, 1965).

8. Average of 2 analyses of Nelspruit Granite (granodioritic migmatites)

Note : For sample localities see Anhaeusser (1969, p. 243).

(2) Norms

	1	3	7	KV1	6	2
Ap	0.34	0.04	0.04	0.30	3.70	0.04
Il	1.37	0.54	0.53	0.42	0.76	0.32
Or	11.12	14.49	19.32	6.85	14.46	29.31
Ab	36.68	55.22	53.98	48.35	38.77	46.63
An	16.40	9.22	8.04	14.23	5.28	1.55
Mt	3.71	2.05	1.61	1.42	1.39	0.97
Wo	-	0.32	1.12	4.26	-	-
En	-	3.68	4.30	6.92	-	1.27
Fs	-	1.16	1.68	1.76	-	0.56
Q	20.58	12.11	8.24	15.38	27.24	20.94
C	-	-	-	-	2.04	0.47
H_2O	1.43	-	-	-	0.40	-
FeS	-	-	-	-	0.20	-
Hy	7.69	-	-	-	6.01	-
Di	1.11	-	-	-	-	-
Cc	-	1.18	1.16	-	-	0.95

(3) Niggli Values

	1	3	7	KV1	6	2
si	245	245	225	248	306	371
al	34	34	33	35	37	40
fm	31	26	27	25	21	16
c	15	17	17	18	15	9
alk	20	23	23	23	27	35
k	0.22	0.20	0.26	0.20	0.26	0.39
mg	0.53	0.48	0.52	0.60	0.49	0.39
ti	-	1	1	1	-	1

TABLE 6b

K_2O AND Na_2O CHEMICAL ANALYSES OF GRANITES AND PORPHYRY BODIES INTRUDED INTO THE JAMESTOWN SCHIST BELT *

		K_2O	Na_2O	K_2O/Na_2O
(1) Kaap Valley Granite				
CS1		1.07	4.71	0.23
115a		1.19	5.25	0.23
3		1.91	5.00	0.38
KV1		1.16	5.44	0.21
	Average	1.33	5.10	0.26
(2) Quartz-felspar porphyries				
T38		0.66	8.31	0.08
94		3.18	3.60	0.88
N15		0.44	7.25	0.06
46		1.06	6.25	0.17
	Average	1.34	6.35	0.21
(3) Nelspruit Granite				
N58		4.23	3.87	1.09
T16a		4.17	3.10	1.35
T16c		3.94	4.08	0.97
AA10		4.74	3.82	1.24
	Average	4.27	3.72	1.15
(4) Pegmatites (Consort Mine)				
OG 107		5.98	3.75	1.59
OG 108		2.68	4.55	0.60
	Average	4.33	4.15	1.04

Analysts : Alkali determinations carried out by the author (flame photometric)

* For sample localities see Anhaeusser (1969, p. 243).

TABLE 6c

CHEMICAL ANALYSES OF PORPHYRY BODIES INTRUSIVE INTO THE ONVERWACHT GROUP ON THE SOUTHERN SIDE OF THE BARBERTON MOUNTAIN LAND

	1	2	3	4
	VP5		R17	LV2
SiO_2	68.84		71.26	63.23
Al_2O_3	14.60		14.40	15.33
Fe_2O_3	0.26		0.73	1.91
FeO	1.51		1.15	2.42
MgO	1.45		1.10	2.41
CaO	2.80		0.55	3.08
Na_2O	5.12	5.46	8.22	4.58
K_2O	1.61	1.74	0.27	4.48
H_2O+	1.02		0.95	0.93
H_2O-	0.11		0.06	0.18
CO_2	2.60		0.31	0.99
TiO_2	0.30		0.21	0.45
P_2O_5	0.11		0.10	-
MnO	0.05		0.03	0.08
Total	100.38		99.24	100.07

Column 1. Typical felspar porphyry intrusive into the Komati Formation in the type area.

2. Average alkali values for three porphyry bodies similar to the one above.

3. Soda-rich variety of felspar porphyry intrusive into the Komati Formation in the type area.

4. Porphyry intrusive into Hooggenoeg Formation of the Onverwacht Group. Londozi Stream Section.

Above analyses quoted from Viljoen and Viljoen (1969a; b).

already been mentioned in earlier sections of this paper. It is intended here to present a more detailed account of the various structural parameters that could be measured consistently throughout the area. Besides the systematic measurement of strike and dip of schistosity in the Jamestown Schist Belt, and foliation in the Nelspruit and Kaap Valley granites, the typical small-scale structures recorded included minor crenulation, accordion, and conjugate folds, and linear structures such as those produced by the alignment of micro-fold axes or the elongation of rock particles and minerals.

For convenience of description the area has been divided into two regions. The first is the area occupied by the Jamestown Schist Belt, extending from Noordkaap westwards, and the second is the No. 3 Shaft Syncline area of the Consort Gold Mine.

B. MAJOR STRUCTURES IN THE JAMESTOWN SCHIST BELT

(a) Folds

Several major fold structures have been identified in the eastern half of the Jamestown Schist Belt. Possibly the most spectacular of these is the disharmonic fold on the farm Handsup 305 JU, immediately west of Noordkaap. This major structure, developed in differentiated mafic and ultramafic rocks correlated with the Komati Formation, was regarded by the Geological Survey (Visser, compiler, 1956) as "a shallow syncline with an axis pitching towards the southwest". The detailed mapping of the stratigraphy and structure of the fold could not verify this statement. The petrological investigations indicated that the rocks form a differentiated sequence younging in a direction away from the fold axial plane of the structure. In addition, where schists were found interlayered with the more massive ultramafic rocks they generally indicated a vertical, or near vertical, dip of the planes of schistosity.

It was established that the fold represented an anticlinal structure, plunging steeply to the northeast. Measurement of the strike of the schistosity proved to be difficult due to the strong influence of the magnetic serpentinized ultramafic rocks on the Brunton compass. The formation trends could, however, be clearly seen on aerial photographs. The fold axis of the structure strikes approximately 33° N, but the dip of the fold axial plane could not be determined accurately. The writer suspects, however, that it is very steep, probably approaching vertical.

As mentioned earlier, the Handsup fold structure is an exceptionally fine example of a disharmonic fold, having a clearly defined detachment plane (the Albion Fault) parallel to the northwest trend of the Jamestown Schist Belt, on the southwestern side of the fold. In the field it can be seen that the actual detachment plane is low-lying with respect to the relief, and controls the local drainage. On the south side of the detachment plane the rock-types are virtually identical to those of the fold, consisting essentially of serpentinites and interlayered meta-gabbros. In addition, metamorphosed pillow basalts, complete with large rounded orbicular inclusions, or ocelli, are preserved in the area which has suffered only limited structural disturbance. The ocelli, examples of which are shown in Plate 1C, are considered evidence of liquid immiscibility in the primitive basalts (J. Ferguson, personal communication and manuscript in preparation, 1971).

The Handsup fold appears to have formed as a result of late movements in the area north of Barberton and probably developed as a direct result of the inflection of the Eureka Syncline to the east. Ramsay (1963) referred to the Handsup structure as being part of the Woodstock Anticline and classified it as an early fold (equivalent to his First Structures, F1). Roering (1965), in his attempt to synthesize the structural history of the main gold producing areas of the Barberton Mountain Land, argued in favour of younger movements having been responsible for the development of the fold. He maintained that "if the northwest folding (Ramsay's F3) was intense enough to produce the conspicuous fold pattern in the Consort locality, where Moodies as well as Fig Tree sediments were involved, then the more incompetent basic schists would have suffered even stronger deformation". The fact that the disharmonic fold is still prominent is more convincingly attributed to its having been superimposed on the Jamestown fabric, and not to its representing an undisturbed remnant of a very early structure.

The writer found evidence in the Jamestown Schist Belt suggesting that the last apparent movement along the Albion Fault had been left lateral transcurrent dislocation. The fold is envisaged as having been generated by a force from the southeast (i.e. from the direction of the Eureka Syncline). As the stress built up along the fault zone the rocks on the northern side of the dislocation were detached from those to the south and the formations swelled into a massive disharmonic structure. As the fold developed and grew larger, it forced the northwest linear trend of the Mundt's Concession fold to buckle, changing the strike to an east-southeast, and ultimately, to an almost east-west trend (see Figures 1 and 2, and Plate 3B).

The second prominent structure in the Jamestown Schist Belt is that of the fold just mentioned above, namely the Mundt's Concession differentiated ultramafic body, situated immediately north of the Handsup fold. Ramsay (1963) considered this fold to be linked to the F3 period of fold generation, and he called the structure the Noordkaap Antiform. The initial work in the Jamestown Schist Belt (Anhaeusser, in : Pretorius, 1967) led the writer to believe that the rocks of the Komati Formation, which occupy the central portion of the Schist Belt, formed a boat-shaped, synclinal keel-structure. The Mundt's Concession fold in the area west of Noordkaap was, according to this interpretation, a syncline plunging west.

Continued work in the area, however, showed this explanation to be incorrect. It was the petrological study, and not the structural mapping however, that provided evidence to suggest that the fold was, in fact, an anticline. The differentiation trends of the mafic and ultramafic successions clearly showed the younging direction of the rocks to be away from the central core or fold axis of the structure, in a manner identical to the Handsup occurrence mentioned earlier. Accurate structural work in the area was impeded by the magnetic character of the rocks, but again, the trends could be clearly discerned on aerial photographs (see Plate 3B). There appears little doubt that the two differentiated bodies, forming the Mundt's Concession and Handsup folds, are part of the same formation. The intervening valley between the two structures marks the synclinal divide separating the exposed rock-types of the anticlines, which are identical in form, character, and composition, to one another.

The southern limb of the Mundt's Concession fold is strongly disturbed in the area southwest of the Marbestos Mine where the regular east-west trend of the formations becomes disrupted and obscure. Likewise, the regular, layered trend of the formations on the northwest side of the Handsup fold become poorly exposed and no direct connecting link can be made between the formations in the two structures. The disruption of the stratigraphy in this area appears to have been due to several factors, the most important of which was the drag or shearing movements caused by the Albion Fault which flanks the area to the south. As the fault is approached in the regions east of the Albion Gold Mine, and southeast of the Verdite Gold Mine, scattered blocks of the differentiated ultramafic assemblage swing around into the fault zone, where they are completely truncated.

When the Handsup disharmonic fold was formed by a stress from the southeast, the rocks on the northwestern side of the structure suffered more intense compression and compaction, resulting in their complete loss of identity. The area is at present underlain by a variety of talc, talc-tremolite, tremolite-actinolite, and various carbonate-bearing mafic schists. In addition, the area is intruded by numerous disconnected and irregular quartz and felspar porphyry bodies, some of which are responsible, locally, for the production of small talc deposits. The valley separating the Mundt's Concession fold from that of the Handsup structure appears to be the intervening syncline between the two anticlines. There is evidence that considerable faulting took place in this valley. A prominent white quartz vein, representing the fault trace, can be followed for over three kilometres. A sheared and brecciated zone, now strongly silicified, also occurs south of the main road near the turnoff to the Marbestos Mine.

What happens to the two major fold structures in the areas to the east is not at all clear. Poor exposure in the South Kaap River valley, and the cover of Fig Tree and Moodies sediments of the Eureka Syncline, do not allow many conclusions to be drawn. It is certain, however, that these Onverwacht formations continue southeastwards under the younger successions. This is evidenced by the reappearance, in the underground workings of the Sheba and Fairview Gold Mines, to the southeast, of serpentinites and a variety of greenschists.

An interesting relationship exists in the Noordkaap area where the competent Fig Tree and Moodies formations of the Eureka Syncline overlie the less competent Onverwacht rocks of the eastern part of the Jamestown Schist Belt. The generation of the great arcuate structure of the Eureka Syncline, with a fold axis trending northwest, took place more-or-less synchronously with the development of the similar trending Jamestown Schist Belt. The sedimentary successions of the Eureka structure were subjected to deformation that resulted in the development of a 'concentric-type' fold structure, whereas the Schist Belt formations, wedged between the invading Kaap Valley Granite and the Nelspruit Granite, were drawn out into long, narrow, tapering, 'similar-type' fold structures. The relatively incompetent serpentinites and mafic schists of the Onverwacht succession appear to have acted as a lubricant and as the inflection of the Eureka Syncline intensified this major structure was thrust in a northwesterly direction over the rocks of the eastern part of the Schist Belt. A zone of detachment, or décollement, resulted at the interface between the over-riding competent rocks and the underlying incompetent varieties. The décollement, marked approximately by the trace of the Lily Fault southeast of Noordkaap, acted as a zone under severe tensional stress. Into this environment was intruded a long, narrow quartz-felspar porphyry body (see Figure 2). It is of interest to note that a similar décollement structure has been recognized by Viljoen and others (1969) in the Steynsdorp Anticline on the southern side of the Barberton Mountain Land. The zone of tension created in this area is also associated with small intrusive granitic bodies or bosses.

Another major fold structure, and one which probably forms the true axis of the entire Jamestown Schist Belt, occurs to the north of the Worcester Gold Mine. The fold, which is not very clearly exposed, is defined by the convergence of the uppermost cherty horizon of the Theespruit

Formation in the area just east of the Nelspruit-Barberton road. Rocks of the Komati Formation, lying stratigraphically above the chert horizon do not show any fold closures, the area having instead a strong linear trend, marked by prominent schistosity in the metamorphosed mafic and ultramafic horizons. From stratigraphic and structural evidence the fold is a syncline plunging steeply to the southeast on a bearing of approximately 127°.

To the west of the major fold described above, reconnaissance mapping indicated the presence of further fold closures (see Figure 1). South of the trigonometrical beacon Hilltop, isoclinal folds were encountered, and N.D. Harte (personal communication, 1967) recognized an anticlinal structure, outlined by chert horizons of the Theespruit Formation, with a fold hinge closing in a southeasterly direction. The writer found further that the synclinorial fold axis of the Schist Belt could be traced westwards, from the Worcester Mine area towards the escarpment. An additional fold-hinge of an east plunging synclinal structure was located on the farm Ridges 487 JT and Lot 159, approximately eight kilometres from the escarpment near Kaapsehoop (for localities consult 1:50,000 map, Visser, compiler, 1956). On a regional scale it would appear that between the farms Waterfall 461 JT and Langrand (Lot 160) an elevated area developed, from which the Jamestown Schist Belt tapered in two directions. The area to the east is represented by most of the exposed Schist Belt while that to the west is obscured by the younger cover of the escarpment formations. Exposures of the far westerly continuation of the Belt can, however, be seen in the Elands Valley, eight kilometres west of Kaapsehoop, where the Elands River has cut its way down through the Transvaal and Godwan formations in the area. Evidence of the existence of an anticlinal, or elevated, zone extending through the far western part of the Jamestown Schist Belt is further strengthened by the gravity data (see the Bouguer Isogal inset map, Figure 1). Low gravity values extend from Badplaas, in a northeasterly direction parallel to the escarpment, and traverse the western extension of the Schist Belt before swinging north towards Sabie.

North of the Worcester Gold Mine, near the Nelspruit-Barberton road, two further large-scale fold structures are developed. Immediately north of the North Kaap River is a 'Z'-shaped drag fold, developed in a banded cherty horizon of the Theespruit Formation. Some of the sediments encountered in this horizon, between the Mary Hope gold workings and those of the Kaffir's Limited Gold Mine, are comprised of ferruginous shales, cherts, phyllites, and quartz-sericite schists. The rocks are all very steeply dipping and are strongly schistose parallel to the trend of the formations. The cherty horizon, outlines a drag fold, formed as a result of intraformational right-lateral transcurrent movement. The formations are intensely cleaved and almost all traces of the original bedding have been entirely obliterated. In the fold hinges the axial plane cleavage is particularly strongly developed and it is only in the contrasting black and white banded cherts that the original layering can be seen, the latter transgressed at right angles by the cleavage. From the attitude of the steeply dipping drag fold it would appear that the northern part of the structure produces an anticline and the southern part a syncline, both plunging steeply to the east on a bearing of approximately 100°.

To the north of the 'Z' fold is a disharmonic fold with a detachment plane on the northern side of the structure, trending almost parallel to the Nelspruit Granite contact, which occurs about 500 metres to the north. The folded rocks consist of serpentinites, together with interlayered meta-gabbros, and form a succession very similar to those encountered in the Handsup and Mundt's Concession folds. As mentioned before, the Jamestown Schist Belt is comprised of a series of isoclinal folds, the exact number of which are difficult to determine precisely. The great similarity of the rocks of the Handsup-Mundt's Concession bodies with those of the abovementioned disharmonic fold, and several other folds in the Schist Belt, leads one to consider whether or not the rocks might form part of one and the same stratigraphic succession. The isoclinal folding may have been sufficiently complex to account for the scattered remnants of differentiated mafic and ultramafic rocks which seem to form separately definable, yet unconnected, fold structures. Alternatively, each of these folded differentiated assemblages may have developed from separate intrusions of magma. They could thus represent discontinuous sill-like bodies injected into the Onverwacht successions.

The disharmonic fold north of the Worcester Mine developed as a result of left lateral movement along the detachment plane north of the structure. The rocks south of the fault comprise the folded differentiated assemblage, while those to the north consist of poorly exposed sediments, meta-basalts, and serpentinites. It appears that, as movement took place along the detachment plane, the rocks on the south side of the fault were prevented from moving to the east by a small body of gneissic granite which occurs in the area to the northwest of the Kaffir Creek Talc Mines and which lies within the Schist Belt itself (see Figure 2). The mafic and ultramafic assemblages were presumably folded as they were forced against this granite buttress.

Another major fold structure occurs to the north of the North Kaap River, in the region of the Kaffir Creek Talc Mines. Onverwacht rocks, forming part of the layered succession to the north of the Consort Gold Mine, continue westwards into the eastern part of the Jamestown Schist Belt where they eventually become involved in complex folding. The successions affected consist predominantly of a variety of metamorphosed mafic and ultramafic schists, serpentinite, and siliceous aluminous schist horizons. The latter rock-types, which form conspicuous outcrops, were used to establish the structure in the area. The rocks are strongly schistose and have been drawn out and attenuated by a combination of compression, at right angles to the formations, and shearing, in a direction parallel to the regional trend of the Schist Belt. The result is that numerous shredded, and discontinuous, lenses of siliceous schist appear to "float as rafts" in rocks comprised of talc, chlorite, tremolite, actinolite and carbonate schists. Lenses and irregular masses of serpentinite and talc-carbonate rocks also occur in the area.

The disconnected siliceous schist horizons converge, however, on Lots 135 and 137 and are not found again to the west. Reasons for suggesting that the quartz-sericite schists form part of a synclinal structure have already been given. Apart from the younging directions, deduced from the presence of chert cappings to the siliceous horizons, no other evidence as to the plunge of the structure was forthcoming from the area. In the nose of the fold the quartz-sericite schists are intensely folded with small-scale crenulation (kink-band), accordion, and conjugate folds particularly prominent. The development of these highly plicated rocks in the fold closure is analogous to the parasitic folding so frequently found in the cores of isoclinal folds. The approximate position of the fold axis of the synclinal structure can be seen in Figure 1 where it strikes east-southeast at approximately 110°. Once again the fold axial plane has a near vertical attitude.

Immediately south of this structure, and partly straddling the North Kaap River in the neighbourhood of the site of the old mining settlement of Jamestown, is another fold structure, the limits of which are indeterminable due to poor exposure on the northern and southeastern flanks. The structure again consists of a differentiated assemblage of serpentinized ultramafic rocks, together with intercalated meta-gabbros and amphibolitized pyroxenites, identical to those found in the Handsup and Mundt's Concession bodies, described earlier. From the differentiation trend of the assemblages it appears that the fold is an anticline with a closure in the southeast. The strike of the fold axis parallels the 130 degree regional trend of the Schist Belt. The axial plane of the fold cannot be measured accurately but is probably near vertical, while the plunge is estimated to be at a high angle to the southeast.

(b) Faults

The Jamestown Schist Belt is traversed by a number of longitudinal strike faults, some of which are clearly evident in the field. The Albion Fault, about which mention has already been made, can be traced from Caledonian Siding northwestwards for a distance of about 24 kilometres, adjacent and parallel to the Kaap Valley Granite contact. In the southeast the fault acts as the detachment plane for the Handsup disharmonic fold. Further northwest, the fault is responsible for truncating obliquely the trends of the rocks of the Komati Formation and near the Worcester Gold Mine it causes left-lateral transcurrent dislocation of the cherty horizons of the upper part of the Theespruit Formation.

In the field the fault can be traced practically along its entire length, the fault plane usually being filled by white vein quartz. Near Kaffir Creek the fault zone is marked by a massive white quartz vein and areas of intense carbonation. In the area northwest of the Handsup fold, numerous quartz and felspar porphyry bodies intrude the fault plane. Elsewhere the rocks adjacent to the fault are strongly sheared and schistose with talc schists commonly developed.

A second major fault is the Kaap River Fault located on the north side of the Mundt's Concession differentiated body, and separating the latter from the No. 3 Shaft Syncline of the Consort Mine area. This fault is best developed northeast of Noordkaap where a white quartz vein also marks the fault plane. The fault extends eastwards along the Kaap River, the rocks to the south of it being upthrown along its entire length. The fault dissipates itself westwards in the Jamestown Schist Belt where it becomes part of an intraformational shear zone, strongly carbonated in places.

A third strike fault that can be traced for 10 kilometres occurs along the northern side of the Schist Belt and, like the two other faults just described, appears to have suffered late left lateral transcurrent movement. The fault seems, furthermore, to have developed fairly late in the history of the Schist Belt. It can be traced from the northwest, where it forms the detachment plane for the small disharmonic fold north of the Worcester Mine, eastwards into the

Nelspruit Granite north of the Kaffir Creek Talc Mines. In the granite terrain the fault builds a massive, resistant ridge of white vein quartz and the granites adjacent to it are strongly sheared.

Many other shear zones occur in the Jamestown Schist Belt, these generally being aligned parallel to the regional trend of the schists. Most of them are intraformational shear zones, their presence being marked by numerous white quartz veins and zones of carbonation in the mafic schists.

To the northwest of the Consort Gold Mine, near the Nelspruit Granite contact, several faults occur that are aligned roughly parallel to the Consort fold trend. These faults possibly developed at the same time as the intense folding in the Consort Mine area. Rocks to the northwest of the mine were forced to accommodate themselves under compressional conditions. The serpentinites were able to "flow" easily and were squeezed into a number of irregular bodies, some of which invaded the sedimentary rocks of the Fig Tree Group. The siliceous-schist horizons, on the other hand, were thrust in a northwesterly direction and were aided in their movement by displacement due to faulting.

Faults also occur in the Mundt's Concession ultramafic body where they cut obliquely across the strike of the successions. In the valley separating the latter body from the Handsup fold a fault parallels the axial plane of the synclinal structure. This fault trends towards the Woodstock Fault or mylonite zone, and may be part of this dislocation. The region where the faults may link together is, however, covered by ploughed farmlands.

C. MINOR STRUCTURAL DATA

Figure 5 summarizes the structural data for various parts of the Schist Belt. Measurements in the area west of the Nelspruit-Barberton main road (A), show poles to schistosity planes dipping generally in excess of 70°, with a maxima at 85°. The strike of the schistosity in this area is approximately 115°. Further east (B), the strike changes to between 120° and 130°. There is also a greater spread of the attitude of the schistosity from about 50° to vertical. As can be seen from the stereographic plots of the schistosity (A and B) there is a preferential southerly dip to most of the formations throughout the Schist Belt. Figure 5C, shows a plot of the attitude and plunge of minor folds in the area, while D is a plot of lineations, found particularly in the quartz-sericite schist and cherty horizons, but which are also present in many of the amphibole and chlorite schists found throughout the region. Many of the lineations are produced by folding on a microscopic scale. This variety is manifest in the brittle cherty horizons as well as in some of the mafic schists. The mafic schists, particularly near the granite contacts, also show a preferred mineral alignment or "stretch-lineation". The lineations have a fairly wide spread on a great circle, the latter coinciding with the axial plane cleavage and schistosity directions throughout the area. This spread indicates that folding continued after the lineations were formed.

Most of the minor folds yielded relatively consistent values and these are plotted in Figure 5C. Although there is a spread of minor fold axes from about 0° - 80°, a maxima (± 60°) indicates a fairly consistent plunge direction to the southeast. The axial planes of these minor folds are generally very steep, approaching vertical in most cases. A few folds were found plunging to the northwest. The spread of plunge directions in the area is considered to be due either, to differential compression of the folds, and hence, a variation of movement in the 'a' tectonic transport direction or, it may indicate the existence of an earlier tightly folded terrain, the features of which have been entirely destroyed by superimposition of the strong linear Schist Belt trend.

Structural data from the Jamestown Schist Belt and other areas north and northeast of Barberton have led the writer to conclude that at least four phases of deformation affected the rocks in the area (Anhaeusser, 1969). Briefly, and in order of development, these structural phases which can be grouped into two major episodes occurred as follows :

Episode 1 : Regional NE-SW fold and fault trend of the Barberton greenstone belt.

Episode 2 : Emplacement of Ancient Tonalitic Gneiss diapiric plutons.

The emplacement of the Kaap Valley Granite diapiric pluton produced a schistosity (F1) which everywhere parallels the granite contacts. Superimposed on the schistosity is a stretch lineation (F2) produced mainly by the alignment of platy minerals or micro-fold axes. The F1-F2 phases of deformation are closely related in time. The third deformational phase (F3) was

<u>STEREOGRAPHIC PLOTS OF STRUCTURAL PARAMETERS RECORDED FROM THE JAMESTOWN SCHIST BELT</u>

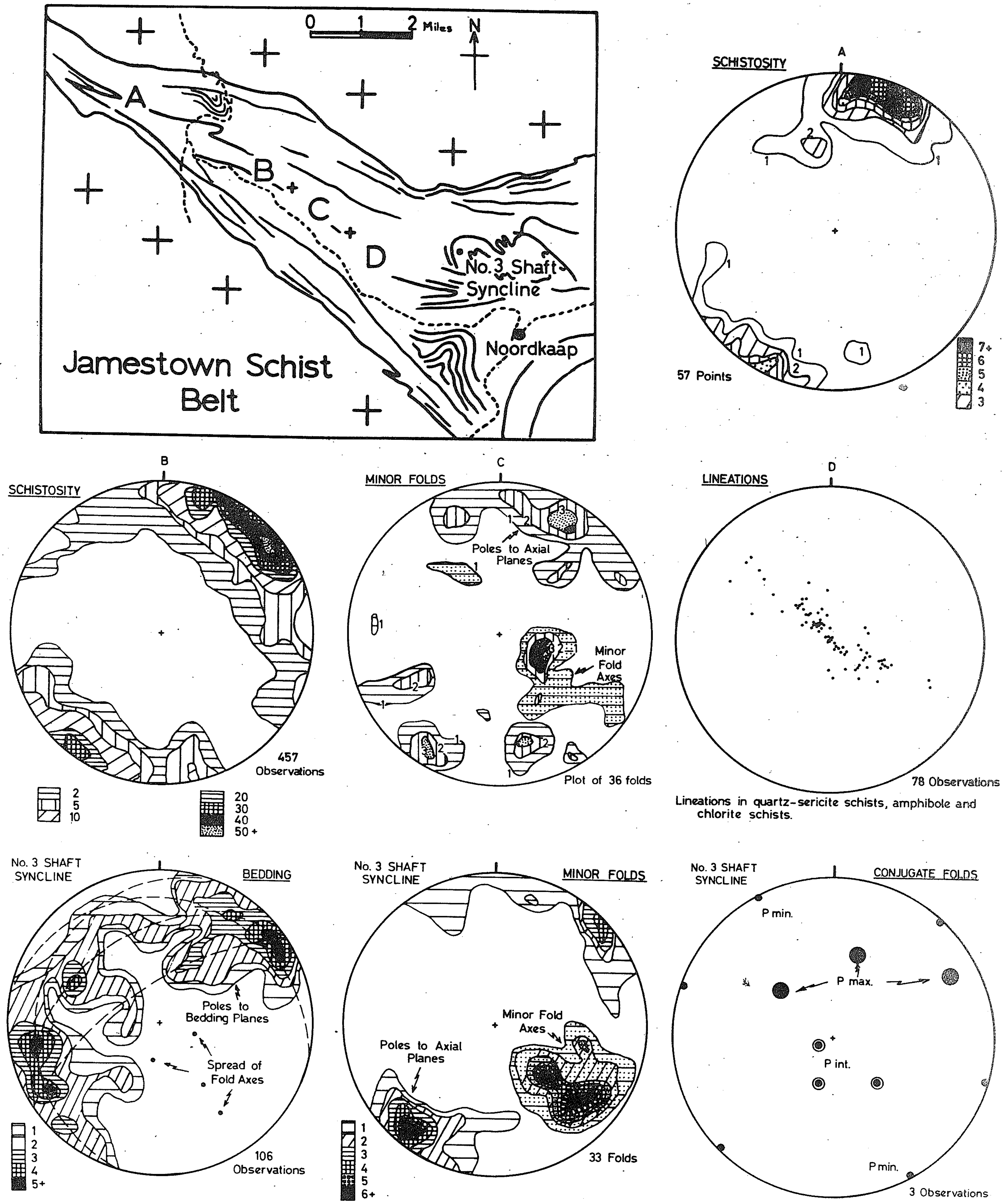


FIGURE 5 : Stereographic plots of : (i) steeply dipping schistosity (A and B), (ii) minor folds (C) and (iii) stretch lineations (D) recorded from Onverwacht assemblages in the eastern part of the Jamestown Schist Belt.
Bedding plane, minor fold, and conjugate fold data from Fig Tree sediments of the No. 3 Shaft Syncline of the Consort Mine is also presented.

responsible for large scale inflections such as those associated with the refolding of the Eureka Syncline and the development of the Handsup disharmonic fold structure to name only a few examples. Finally, the fourth phase of deformation (F4) was responsible for the regional development of crenulation, accordion, and conjugate folds, all superimposed on earlier structures. These folds were produced as a result of a vertical stress field, the latter probably caused by reactivation of early faults by continued upward emplacement of the granites.

D. THE STRUCTURE OF THE CONSORT MINE AREA

The Consort Mine area, approximately three kilometres north of Noordkaap at the eastern end of the Jamestown Schist Belt, comprises a number of isoclinal folds made up of a series of parallel anticlines and synclines (see Figure 4). From this diagram it is evident that the entire Consort Mine area consists mainly of four major fold structures with which are associated many smaller folds. The folds all have axial plane traces striking approximately south-southeast and they plunge at variable angles in the same direction. From north to south these main folds are listed by Viljoen (1964) as follows :

(i) the Top Section Syncline

(ii) the Prince Consort Syncline

(iii) the No. 7 Shaft Anticline, and

(iv) the No. 3 Shaft Syncline.

The Top Section Syncline was found by Viljoen (1964) to consist of the east-west-trending Consort "Contact" together with hanging wall hornfelses that swing south into a rather tight fold, the southeastern continuation of which is truncated by the Blue-jackets Fault. The writer, mapping the area to the west, found that the cherts and hornfelses of the Consort "Contact" were greatly disturbed by faulting and pegmatite intrusion in the hinge zone of the structure. Isolated blocks of Fig Tree sediments occur scattered and twisted between irregular, very coarse-grained pegmatites associated with the mobilized border phase of the Nelspruit Granite to the north. In addition, masses of 'apparently intrusive' serpentinite, in places altered to tremolite or talc-tremolite schist, further complicate the geology of the area.

The Prince Consort Syncline occurs in the area south of the Blue-jackets Fault and, according to Viljoen (1964), is the best exposed of the major folds. He found that the most striking feature of all the fold structures is the very regular orientation of their axial plane traces which have an average bearing of 145°. The vast majority of these folds were found to plunge at various angles to the south-southeast, the attitude of their axial planes often being nearly vertical or steeply southwest dipping, thus indicating slight overfolding to the northeast.

The No. 7 Shaft Anticline, southeast of the Mine offices consists of a series of synclines and anticlines, two anticlinal structures being known as the Hard Cash Anticline and the Shires Anticline. These structures, like most of the other folds in the area, plunge to the south-southeast at variable angles. Surface exposure of the folds is poor and they have been delimited mainly by underground mapping.

The No. 3 Shaft Syncline, to the west of the No. 7 Shaft Anticline, was remapped by the writer. Most of the area underlain by the main fold structure comprises a number of isoclinal folds also making up a series of parallel trending synclines and anticlines (see Figure 4). Much of the area lies in a wide meander plain of the North Kaap River and is not well-exposed. Furthermore, part of the area has now been covered by massive slimes dumps from the Consort Mine. Sufficient evidence was forthcoming from the area, however, to show that the rocks have been deformed in a manner similar to those in the main body of the mine to the east and northeast.

Structural data pertaining to the No. 3 Shaft Syncline area is presented in Figure 5. Small folds, similar to the one shown in Plate 2A, indicate a spread of fold plunges ranging between 5° and 70° on a bearing averaging 115°. In the area to the east, Viljoen (1964) found a similar spread of fold plunges ranging between 20° and 80° to the southeast on a bearing averaging about 145°.

The plunges of the No. 3 Shaft Syncline folds show two maxima at about 30° and 50°, whereas Viljoen (1964) showed only one maxima at 50°. The axial planes of the folds in the No. 3 Shaft Syncline are generally very steep with most of them dipping south, again indicating slight overfolding to the northeast. The orientation of the fold axes has been confirmed by plotting the poles to the bedding surfaces on a stereogram (the pi-diagram method of Ramsay, 1962), a method which is useful for detecting variations in fold plunge. As indicated in Figure 5 the poles to bedding show a very irregular spread which is interpreted as indicating an original deformed surface. Had an original flat surface been in existence prior to the folding then the poles to the bedding planes would have formed a regular great circle, and the pole to this circle would have represented the fold axis. A number of great circles can be drawn through the bedding pole maxima in Figure 5 enabling at least four fold axes to be plotted. The poles to the numerous possible great circles all lie roughly in one plane but have variable plunges to the south-southeast.

The above evidence from the No. 3 Shaft Syncline, coupled with that of the other fold structures in the Consort Mine area clearly indicates that some type of irregular and deformed surface must have existed prior to the folding at present evident in the area. Ramsay (1963) found two sets of folds developed underground in the Consort Mine. He stated that "early folds, probably F2 structures with intense mineral orientation parallel to their axes, are deformed by later, F3, structures". This F3 trend (a northwest-southeast trend) is so prominent throughout the northern part of the Barberton Mountain Land that Roering (1965) referred to it as "the Consort Trend".

The development of the Consort Trend, with a bearing of ± 135° in the Consort Mine area, is clearly due to a stress field acting in a southwest-northeast direction, thereby causing the superimposition of the NW-SE fold trend. Further evidence of the orientation of the stress field responsible for the Consort Trend is afforded by small-scale accordion and conjugate folds such as those shown in Plate 2 C and D. Pebbles flattened by an earlier deformation are also folded about NW-SE trending fold axes (Plate 2B). A plot of three conjugate folds in quartz-sericite schists (Figure 5) shows a somewhat variable spread of the P. max. stress direction. Two of the points, however, indicate a sub-horizontal maximum stress in a NNE-SSW and a ENE-WSW direction, and the P intermediate poles concentrate fairly consistently near the vertical plane.

MINERALIZATION IN THE JAMESTOWN SCHIST BELT

A. INTRODUCTION AND HISTORY

Following the discovery of gold in 1873 in the Lydenburg-Spitskop-Pilgrim's Rest Goldfield prospectors gradually worked their way southwards along the narrow Godwan plateau of the Transvaal Drakensberg Escarpment and discovered further reefs and alluvial gold at a place known to the early hunters as the Duiwel's Kantoor. This settlement was later renamed Kaapse Hoop and it became a small township for the area which had been thrown open as public diggings.

The Kaap Valley, below the Duiwel's Kantoor escarpment was, in these early days, a very unhealthy region and was known as the Valley of Death due to the high incidence in the area, of tsetse fly, malaria, and wild animals. In 1874 Tom McLachlan ventured from the Spitskop diggings near Sabie and found traces of gold in the Kaap Valley, but these were not payable and he was driven out of the area by fever and horse-sickness. McLachlan then moved on to northwestern Swaziland where he discovered alluvial gold between Popinyana Creek and Pigg's Peak in 1881 (Pretorius, 1965).

In 1882, a trio of resolute prospectors named Ingram James, Magnus Jeffries, and a Frenchman, Auguste Robert (French Bob) moved into the Kaap Valley from the Duiwel's Kantoor diggings and found James Murray working alluvial gold. With Murray were his partners Bob Watson and Tom Elsie. The discovery was worked in secret until 1883 when another prospector, Harry Culverwell stumbled on their workings and spread the news of the find. A rush ensued and within days the camp had grown to a large settlement that became known as Jamestown, so named after the earlier discoverers' James Murray and Ingram James. Jamestown thus became the first miners' settlement in the Kaap Valley, and it had a population of about 150 people. The settlement acted as a base for most of the subsequent prospecting in the area, but as it was an extremely unhealthy place, with fever claiming many victims, its existence was short-lived.

Jamestown was sited at the confluence of Kaffir Creek and the North Kaap River, the latter also being known formerly as the Lampagwana River. The settlement was situated on the north bank of the North Kaap River and it had, running through it, the Jamestown water race. The water was diverted into this canal by means of a weir situated about 6.5 kilometres upstream along the North Kaap River. The water was used primarily for washing alluvial gravels (Plate 4A) and for driving stamp mills such as that of the Gem Battery, near the Kaffir Creek Talc mines (Plate 4B).

The Jamestown alluvial field did not yield any great quantities of gold. The "Barberton Herald" of August 10th. 1886, reported that nuggets weighing as much as 58 ounces were found, but these appear to have been rare finds. Interest in the Jamestown area soon diminished and the prospectors moved off to higher ground across the Kaap Valley where French Bob, in May 1883, discovered alluvial gold in Concession Creek, on Moodies Estates, near Barberton.

A number of gold mines were subsequently worked in the Jamestown Schist Belt. Most were small-scale operations of the type illustrated in the historical pictures shown in Plates 4 and 5. Today the only gold mine still in production in the Schist Belt is the New Consort Gold Mine. This mine has been in existence since 1887 and has yielded over 1.25 million ounces ($\sim$ 35 400 Kgs) of gold (see Table 7).

In the following sections aspects relating to the mineralization of the Jamestown Hills area are discussed, consideration being given particularly to gold, asbestos, talc, magnesite, nickel, and the semi-precious occurrences of verdite and buddstone.

B. GOLD

Apart from the New Consort Gold Mine which has been described by Hearn (1943), and Gribnitz and others (1961) several additional gold deposits occur scattered throughout the length of the Jamestown Schist Belt between Caledonian Siding in the southeast and Kaapsehoop on the escarpment. The more significant deposits are located on the reconnaissance map of the Schist Belt (Figure 1).

Most of the important gold ore bodies occur scattered along, or adjacent to, the Albion Fault. These include the Brian Boru, Albion, Olga, Jumbo, Bonny Dundee, Worcester, Lancaster, and Madelaine gold workings. However, only two of these mines, namely the Worcester and the Albion Gold Mines, produced really significant quantities of gold. Apart from the gold workings along the Albion Fault, several other deposits are situated in the hard, brittle, more competent, cherty horizons that extend the length of the Schist Belt. Examples of this type are the Gem, Mary Hope, New Independence, and Kaffirs Limited, ore bodies. Most of the remaining gold workings are situated along shear zones in the schists, where gold-quartz veins are generally developed parallel to the schistosity trends. The Dudley, Criterion, and Verdite workings are examples of this type. The Verdite Gold Mine is located northeast of the Albion Gold Mine, in rocks of the Mundt's Concession differentiated body and is plotted in Figure 2. A few small deposits are to be found in the Kaap Valley Granite in shear zones very close to the contacts with the Schist Belt. Most of these occurrences are located just north of Kaapsehoop (Koffiekultuur, Maizie, Hester, Ophir) while the Caledonian workings are located in a shear zone in the granite near Caledonian Siding. The quantity of gold recorded from the mineralized occurrences in the granites amount only to a few hundred ounces. Available production figures from 32 workings in the Jamestown Schist Belt, including the Consort Mine,are given in Table 7.

C. CHRYSOTILE ASBESTOS

Four chrysotile asbestos deposits have been mined from time to time in the Schist Belt. Three of the occurrences are located in the Kaapsehoop differentiated ultramafic body where chrysotile-bearing serpentinites alternate with resistant ridges of pyroxenite. Two of the mines, the New Amianthus and the Star Asbestos mines are presently operating while the Munnik Myburgh Mine has not been in production for a number of years. A detailed account of the ore bodies worked by these mines has been given by van Biljon (1964). Two unusual minerals, stichtite [$3(Mg_6Cr_2(OH)_{16}CO_3 \cdot 4H_2O$] and barbertonite [$Mg_6Cr_2(OH)_{16}CO_3 \cdot 4H_2O$], have been described from the New Amianthus Mine by Hall (1921), and Frondel (1941). Hall (1924) also reported the presence of oval lumps of nickel sulphide occurring with the asbestos in the New Amianthus deposit.

In the eastern part of the Schist Belt the Marbestos Mine recovers mainly grade 7 asbestos fibre. The mine occurs in the Mundt's Concession ultramafic body discussed earlier, the ore-body itself being situated in serpentinites occupying the core of the anticlinal fold structure (see Plate 3A and B). The asbestos occurs in a zone of serpentinized olivine peridotite that is sandwiched between meta-gabbros on the one side and serpentinized pyroxene peridotite on the other. There is fibre development in many other places where the serpentinized ultramafic rocks occur, but the quality and density of fibre is poor. Prospecting has been carried out further west of the Marbestos Mine in the same potential ore horizon, where cross-faulting has caused the local development of

TABLE 7

MINE LOCALITIES, AND GOLD AND SILVER PRODUCTION DATA
FROM 32 DEPOSITS IN THE JAMESTOWN HILLS AREA FOR THE PERIOD 1882-1967

Mine	Locality (Farm or Lot)	English Tons	Ounces Gold	Ounces Silver
Albion	Lot 60 Sect. C (K.B.)	8,898	7,915.717	184.480
Alpedor	Waterfall 461 JT	3,728	234.010	125.800
Bonny Dundee	Lot 80 Sect. C (K.B.)	433	184.470	28.680
Bousfield's (Woodstock)	Lot 132, Sect. A. (K.B.)	7,627	2,310.724	154.489
Caledonian	Bramber South 349 JU	-	665.000	-
Consort	Segella 306 JU, Mundt's Concession and Lots 191-200, 259, 260, 265, 266 and 269, Sect. D. (K.B.)	3,540,814	1,258,292.397	64,017.029
Criterion	Lot 60 Sect. C (K.B.)	23	201.000	-
Entente (Consort)	Lots 191 and 192, Sect. D (K.B.)	6,117	502.040	240.920
Gem	Lot 138 Sect. D (K.B.)	-	47.000	-
Golden Crown	Lots 85 and 95A, Sect. C (K.B.)	100	369.000	-
Great Britain	Waterfall 461 JT	130	217.060	-
Hercules	Lot 100 Sect. D (K.B.)	-	48.000	-
Hester	Uitkyk Lot 465	12,130	1,426.394	205.485
Lancashire (Lancaster)	Lot 88 Sect. C (K.B.)	1,572	106.190	47.980
Madeline	Waterfall 461 JT	113	73.510	4.860
Maiden City	Lot 165 Sect. C (K.B.)	4,641	352.055	21.836
Mary Hope	Lot 100 Sect. D (K.B.)	3,046	113.410	10.852
Noordkaap Syndicate	Noordkaap Area ?	41,400	11,942.527	1,604.590
North Kaap Alluvial	Jamestown Area ?	-	6,372.000	-
North Sheba	Ridges 487 JT	1,578	571.670	63.150
Olga	Lot 70 Sect. C (K.B.)	3	0.820	-
Plein D'Or (Consort)	Lots 191 and 192, Sect. D (K.B.)	530	457.000	-
Potosi	Lot 85 Sect. C (K.B.)	41	67.650	-
Riverside	Riverside 245 JU	-	46.000	-
Spitzkop Farm	Lot 140 Sect. D (K.B.)	2,011	259.250	-
Tokenhouse	Lot 100 Sect. D (K.B.)	1,094	314.540	-
Uitkyk	Uitkyk Lot 465	621	94.290	10.350
Verdite	Mundt's Concession	2,041	290.704	15.020
Victoria	Lot 129 Sect. A (K.B.)	25,445	16,241.500	303.400
Witkopje (Consort)	Lot 191 Sect. D (K.B.)	90	28.000	-
Woodstock	Lot 132 Sect. A (K.B.)	17,571	46,093.110	291.740
Worcester	Lots 85 and 95A, Sect. C (K.B.)	670,831	185,090.424	20,079.107
TOTALS	English Tons	4,352,628	1,540,927 ozs.	87,410 ozs.
	Metric Tons	4,431,400	43,652.3 Kgs.	2,476.2 Kgs.

K.B. = Kaap Block. For the location of the Lots referred to in Table 7 the reader is referred to the published 1:50,000 scale geological map of the Barberton area (Visser, compiler, 1956).

From 1967 to 1970 an additional 212900 Metric Tons of ore were milled from the New Consort Mine yielding 3 531 Kgs. of combined gold and silver.

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fibre seams. The quantity, as well as the quality, of this ore does not, however, appear to be of a high enough standard to warrant exploitation. Farther to the west, near Kaffir Creek, longer fibre than that recovered at the Marbestos Mine has been worked in the past on Lots 77 and 78, but no mining has taken place in the area for several years. In the Schist Belt it is clear that the asbestos fibre is best developed where serpentinites forming part of the layered differentiated bodies are involved in structural deformation.

D. TALC

A number of talc workings occur scattered throughout the Schist Belt. The most prominent deposits,now largely mined out, are to be found in the area of the Kaffir Creek Talc Mines, nine kilometres west of Noordkaap. The talc is developed in highly altered serpentinites that have been caught up in the intense folding and shearing experienced by the formations in the area. Many of the deposits are located adjacent to blocks, or continuous bands, of quartz-sericite or quartz-fuchsite schist. As mentioned earlier, the formations in the area of the talc mines have undergone isoclinal folding and metamorphism. The talc in the Kaffir Creek area developed as a result of the strong deformation, coupled with steatization processes associated with the intrusion of nearby granite magma. Carbon dioxide metasomatism of the serpentinites also took place, resulting in the production of dolomitic and talc-carbonate rocks. Isolated pods of high quality talc have been mined in the area but generally the talc has many impurities and is mainly of industrial grade.

Most of the remaining talc occurrences in the Schist Belt are situated either along faults or are adjacent to quartz and felspar porphyry intrusives. The Albion fault-zone has been responsible for the development of a great number of small talc deposits, a notable example being the Albion Mine, where both talc and gold have been worked. Numerous small talc workings occur south of the Mundt's Concession differentiated body and in the area northeast of the Handsup fold where they are associated with the felsic porphyry intrusives. These talc occurrences formed as a result of hydrothermal activity associated with the emplacement of the porphyry bodies. The talc developed as a result of the steatization of serpentinized peridotites.

E. MAGNESITE

Only one magnesite deposit has been investigated in the Jamestown Schist Belt and this proved to be of poor quality, and never constituted a minable ore body. It occurs on Lot 70 in serpentinized ultramafic rocks forming part of the western extension of the Mundt's Concession differentiated ultramafic body. In many respects the magnesite has formed under the same geological conditions as the large deposits in the Kaapmuiden area, about 37 kilometres to the northeast and described by van Zyl and others (1942) and Viljoen and Viljoen (1969f). In this area the magnesite is developed in magnesium-rich dunite zones in the Kaapmuiden differentiated ultramafic bodies where large (2-5 mm.) cumulus olivine crystals constitute up to 90 per cent of the rock.

That the magnesite occurs generally in magnesian-rich rocks was shown to be the case by examining some of the ultramafic host rocks of the magnesite deposits. Thin-section study showed that many olivine crystals have survived the alteration processes and occur as fresh, high birefringent cores, surrounded by antigorite, talc, and magnesite. Although no suitable olivine grains could be extracted from the magnesite occurrence in the Jamestown Schist Belt, the writer was able to separate some large olivines from the Sugden Siding magnesite body 13 kilometres east of Noordkaap. This magnesite occurrence, like those near Kaapmuiden, and the one in the Jamestown Schist Belt, is developed in a layered differentiated serpentinite body and has been described previously by van Zyl and others, (1942) and Anhaeusser (1964).

Olivines analysed using the X-ray methods of Yoder and Sahama (1957) and Jambor and Smith (1964) yielded values of Fo 92.5 to Fo 100 (Anhaeusser, 1969). Similar values were obtained by

Viljoen and Viljoen (1969f) from olivines extracted from the Kaapmuiden bodies. The rocks in the layered ultramafic bodies on the northwestern flank of the Barberton Mountain Land, in which magnesite tends to form, are thus exceptionally rich in magnesia. Although there is, as yet, no proof, it appears that where the magnesian content of the ultramafic rocks diminishes somewhat there is more likelihood of the development of chrysotile asbestos in serpentinites suitably deformed.

F. NICKEL

Nickel mineralization of significance has so far only been reported from two localities in the entire Barberton Mountain Land. Hall (1921) noted nickel sulphides in the Kaapsehoop area while near Sheba Siding reports of the so-called trevorite nickel occurrence were given by Crosse (1921), Partridge (1943) and Anhaeusser (1964). The major components of this ore comprise the new minerals de Wall (1970a, b) has called willemseite [$H_2(NiMg)_3Si_4O_{12}$] and nimite [$H_8(NiMg)_5Al_2Si_2O_{18}$]. In addition, he described ferroan trevorite [$NiFe_2O_4$], violarite [Ni_2FeS_4], millerite [NiS] and reevesite [$Ni_{18}Fe_6(OH)_{48}(CO_3)_3 \cdot 12H_2O$] in the ores (de Waal, 1968; 1969; 1970c).

Samples of serpentinite from a number of localities in the Jamestown Schist Belt showed concentrations of nickel above the normal background values associated with ultramafic rocks (see Table 8).

TABLE 8

TABLE COMPARING THE NICKEL CONCENTRATIONS (in PPM) OF ULTRAMAFIC ROCKS FROM VARIOUS PARTS OF THE WORLD AND THE JAMESTOWN SCHIST BELT

Description of Rocks and Reference		Nickel in ppm
Peridotite	(Rankama and Sahama, 1950)	3160
Ultrabasic rocks	(Goldschmidt, 1954)	up to 3600
Peridotite	(Average of 5 analyses, Clarke, 1924)	1600
Ultramafic rocks	(Turekian and Wedepohl, 1961)	2000
Ultramafic rocks	(Goles, 1967)	1500-2000
Ultramafic rocks from the Jamestown Schist Belt	(Average of 30 analyses, (Anhaeusser, 1969)	3100

Twelve samples out of a total of 30 analysed yielded values equal to, or greater than, an average value of 3100 ppm Ni obtained from the Schist Belt samples. The lowest nickel concentration recorded was 1700 ppm and 5700 ppm marked the uppermost value obtained (Anhaeusser, 1969). It is considered that the above-average background Ni values can be ascribed to slight concentration of the metal, consequent upon the thermal and dynamic metamorphism associated with the emplacement of the intrusive granites in the area north of Barberton. Several samples of mafic schists associated with the serpentinites gave values ranging between 400 and 1700 ppm Ni.

Recent prospecting in the area to the north of the Consort Gold Mine, by Rand Mines Limited, has exposed several shear zones in light yellow-green serpentinites. In some of these, nickeliferous magnetite occurs as irregular veins and patches but the quantity and grade of the ore found to date does not warrant exploitation (D.S. Macaulay, personal communication, 1970). Several serpentinite samples from the above locality and containing visible sulphides, were examined by the writer under the ore-microscope. Some specimens contained abundant finely disseminated millerite (NiS), together with lesser amounts of pyrrhotite, and magnetite. Nickel prospecting is currently being undertaken in the Barberton Mountain Land but no significant finds have yet been reported.

G. VERDITE AND BUDDSTONE

In addition to the minerals already mentioned, a semi-precious variety of serpentine, known locally as verdite, has been quarried from several localities in the Jamestown Schist Belt. The verdite is an attractive dark-green rock that has been used for small ornaments as well as for the purpose of interior decorations in buildings. It has, in fact, been used in the interior of such prominent buildings as the Bank of England, and South Africa House in London.

True verdite is soft, and easily worked, but several occurrences of a hard, siliceous variety have been mined expressly for the manufacture of jewellery. The verdite does not occur in large quantities and is frequently intergrown with grey or greyish-green talc. Some deposits of verdite are also associated with a highly colourful, green and white banded, and highly contorted rock known locally as "buddstone" (see Plate 3D). This rock is also used as an ornamental stone or as semi-precious material for the manufacture of jewellery. As far as the writer is aware the occurrence of verdite and buddstone is unique to the Barberton Mountain Land, and in particular to the Jamestown Schist Belt and to the belt of Onverwacht rocks flanking the Kaap Valley Granite southwest of Barberton.

The verdite has been quarried from about six separate deposits, five of which are situated in the Jamestown Schist Belt. Two localities where buddstone is associated with the verdite, are known, the one being in the Jamestown Schist Belt north of the Worcester Mine, and the other occurring southwest of Barberton. Three verdite quarries are situated in approximately the same stratigraphic horizon around the Handsup fold west of Noordkaap. The Verdite Gold Mine on Mundt's Concession, besides producing gold, which occurred on shear surfaces in serpentinized ultramafic rock, also produced talc and verdite. The rock has also been quarried on Lot 87 where it is located in the layered ultramafic body northwest of the Worcester Gold Mine.

The verdite occurrences are confined to the layered differentiated bodies and appear to have formed as a result of structural disturbance coupled, possibly, with some hydrothermal activity. The deposits are generally very small and pod-like, most of them being no larger than a few square metres. The verdite is found at the contact between pyroxene peridote layers and the overlying, more massive, metagabbroic layers. Generally there has been some shearing, or differential movement, along the contacts of these two rock-types resulting in the production of mafic and ultramafic schists. Why the verdite developed in some places and not in others could not be established.

The buddstone deposit located north of the Worcester Gold Mine occurs in serpentinites associated with the disharmonic fold in the area. The buddstone itself is developed between off-shoots of a small diabase dyke-swarm.

In thin-section the hard siliceous verdite consists of a micro-crystalline quartz matrix that has partially or completely replaced the host-rock serpentinite. Scattered remnants or radiating blades of talc occur together with a fine, matted, greenish-coloured phyllosilicate that resembles chlorite or sericite. Anhedral magnetite or nickeliferous magnetite grains occur scattered throughout this matted material and may be responsible for imparting to the rock the distinctive greenish colouration. The buddstone, in thin-section, resembles in part the siliceous verdite, but the greenish coloured phyllosilicates occur as distinctive partings between a matrix of microcrystalline quartz and plagioclase (albite). The rocks show microscopic folds, a feature that is also prominent in hand specimens.

Not much is known about the verdite and buddstone mineralogy. Clearly silica has played a major replacement rôle in the development of these rocks and it is certain that a detailed study will reveal the presence of a number of uncommon nickel silicates (phyllosilicates and chlorites) similar to those already found associated with nickel mineralization in the area by de Waal (1970c).

CONCLUSIONS

The Jamestown Schist Belt represents a tightly folded synclinorial structure trending at right angles to the main body of the Barberton greenstone belt. The formations caught up in the strongly deformed Schist Belt are comprised mainly of a variety of mafic and ultramafic assemblages belonging to the lower part of the Onverwacht Group stratigraphy. These assemblages, together with a limited development of Fig Tree and Moodies sediments, are intruded by Kaap Valley and Nelspruit granites and demonstrate many of the changes that Archaean rocks of this type undergo when subjected to dynamo-thermal metamorphism associated with diapiric granite emplacement. The region, whilst not serving as one of the best in the Barberton area for detailing the stratigraphy of the Swaziland Sequence, nevertheless provides some local variation and also demonstrates the complex nature of the geology generally found in schist belts flanking, or protruding into, granites surrounding Archaean greenstone occurrences.

* *

LIST OF REFERENCES

Allsopp, H.L., Ulrych, T.J. and Nicolaysen, L.O., 1968, Dating Some Significant Events in the History of the Swaziland System by the Rb-Sr Isochron Method : Can. J. Earth Sci., V.5, p. 605-619.

Anhaeusser, C.R., 1964, The Geology of the Lily Syncline and Portion of the Eureka Syncline between Sheba Siding and Louw's Creek Station, Barberton Mountain Land : Unpub. M.Sc. thesis, Univ. Witwatersrand, Johannesburg.

Anhaeusser, C.R., 1966, Facets of the Granitic Assemblage on the North-West Flank of the Barberton Mountain Land : Inform. Circ. No. 32, Econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg, pp. 27.

Anhaeusser, C.R., 1969, The Stratigraphy, Structure and Gold Mineralization of the Jamestown and Sheba Hills Areas of the Barberton Mountain Land : Unpub. Ph.D. thesis, Univ. Witwatersrand, Johannesburg, pp. 332.

Anhaeusser, C.R., Mason, R., Viljoen, M.J. and Viljoen, R.P., 1969, A Reappraisal of Some Aspects of Precambrian Shield Geology : Geol. Soc. Amer. Bull., V.80, p. 2175-2200.

Barth, T.F.W., 1962, A Final Proposal for Calculating the Mesonorm of Metamorphic Rocks : Jour. Geol., V. 70, No. 4, p. 497-498.

Clarke, F.W., 1924, The Data of Geochemistry : 5th Ed. Bull. 770, U.S. Geol. Surv. pp. 841.

Crosse, A.F., 1921, A Rich Nickel Ore : J. chem. Soc. S. Afr., V.21, No. 8, p. 126.

De Gasparis, A.A.A., 1967, Rb-Sr Isotopic Studies Relating to Problems of Geochronology on the Nelspruit and Mpageni Granites : Unpub. M.Sc. thesis, Univ. Witwatersrand, Johannesburg.

De Waal, S.A., 1968, Nickel Minerals from Barberton South Africa IV. Reevesite, a member of the hydrotalcite group : National Inst. for Metall., Res. Rep. No. 428, pp. 6., Johannesburg.

De Waal, S.A., 1969, Nickel Minerals from Barberton South Africa I. Ferroan trevorite : Amer. Miner. V. 54, p. 1204-1208.

De Waal, S.A., 1970, Nickel Minerals from Barberton South Africa III. Willemseite, a nickel-rich talc : Amer. Miner. V. 55, p. 31-42.

De Waal, S.A., 1970b, Nickel Minerals from Barberton, South Africa. II. Nimite, a nickel-rich chlorite : Amer. Miner. V. 55, p. 18-30.

De Waal, S.A., 1970c, Nickel in South Africa with Special Reference to Low-Grade Nickeliferous Ores : National Inst. for Metall., Res. Rep. No. 897, pp. 67, Johannesburg.

Engel, A.E.J. and Engel, C.G., 1951, Origin and Evolution of Hornblende-Andesine Amphibolite and Kindred Facies - Abstract of paper presented in Detroit, Mich. : Bull. geol. Soc. Amer., V. 62, No. 12 (Pt. 2), p. 1435-1436.

Engel, A.E.J. and Engel, C.G., 1953, Grenville Series in the Northwest Adirondack Mountains, New York. (Part 1) : Bull. geol. Soc. Amer., V. 64, p. 1013-1048.

Engel, A.E.G., Nagy, B., Nagy, L.A., Engel, C.G., Kremp, G.O.W. and Drew, C.M., 1968, Alga-like Forms in Onverwacht Series, South Africa : Oldest Recognized Lifelike Forms on Earth : Science, V. 161, p. 1005-1008.

Frondel, C., 1941, Constitution and Polymorphism of the Pyroaurite and Sjögrenite Groups : Amer. Miner., V. 26, p. 295-315.

Geijer, P., 1963, On the Source of Chromium in Micas : Arkiv. for Mineralogi Och Geologi, V. 3, No. 23.

Goldschmidt, V.M., 1954, Geochemistry : Oxford, Clarendon Press, pp. 730.

Goles, G.G., 1967, Trace Elements in Ultramafic Rocks : in: Wyllie, P.J. (editor), "Ultramafic and Related Rocks". John Wiley and Sons, Inc., New York, p. 352-362.

Gribnitz, K.H., Poole, E.J. and Voges, S., 1961, Geological Notes on the Swaziland System : Unpub. Rep. Geol. Dept. E.T.C. Mines Ltd., Barberton.

Hall, A.L., 1918, The Geology of the Barberton Gold Mining District : Mem. No. 9, geol. Surv. S. Afr., pp. 347.

Hall, A.L., 1921, On a New Occurrence of Stitchtite from the Barberton District : Trans. geol. Soc. S. Afr., V. 24.

Hall, A.L., 1924, Note on Oval Lumps of Nickel Sulphide in Asbestos from Kaapsche Hoop, in the Barberton District : Trans. geol. Soc. S. Afr., V. 27, pp. 57-61.

Hearn, M.G., 1943, A Study of the Working Properties of the Chief Gold Producer of the Barberton District, Eastern Transvaal : Unpub. D.Sc. thesis, Univ. Witwatersrand, Johannesburg.

Jambor, J.L. and Smith, C.H., 1964, Olivine Composition Determination with Small-Diameter X-Ray Powder Cameras : Geol. Mag., V. 33, No. 264, pp. 730-741.

Joplin, G.A., 1963, Chemical Analyses of Australian Rocks. Part I : Igneous and Metamorphic : Bull. 65; Bureau of Min. Res., Geol. and Geophys., Commonwealth of Australia, pp. 446.

Mason, R., 1970, The Geology of the Country Between Francistown and Madinare - Northeastern Botswana : Unpub. Ph.D. thesis, Univ. Witwatersrand, Johannesburg, 186 pp.

Nagy, B., and Nagy, L.A., 1968, Investigations of the Early Precambrian Onverwacht Sedimentary Rocks in South Africa : Contr. No. 175, Program in Geochronology, Univ. of Arizona, Tucson, pp. 209-215.

Nagy, V., and Nagy, L.A., 1969, Early Precambrian Onverwacht Microstructures : Possibly the Oldest Fossils on Earth? : Nature, V. 223, No. 5212, pp. 1226-1229.

Oosthuyzen, E.J., 1970, The Geochronology of a Suite of Rocks from the Granitic Terrain Surrounding the Barberton Mountain Land : Unpub. Ph.D. thesis, Univ. Witwatersrand, Johannesburg, pp. 94.

Partridge, F.C., 1943, Trevorite and a Suggested New Nickel-bearing Silicate from Bon Accord, Sheba Siding, Barberton District : Trans. geol. Soc. S. Afr., V. 46, p. 119-126.

Pretorius, D.A., 1965, Fragments of History : Guide to Post-Congress Excursion, Barberton Mountain Land - 8th. Ann. Congr., geol. Soc. S. Afr., Johannesburg.

Pretorius, D.A., 1967, Eighth Annual Report for 1966 : Econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg, pp. 46.

Ramsay, J.G., 1962, The Uses and Limitations of Beta-Diagrams and Pi-Diagrams in the Geometrical Analysis of Folds : Inf. Circ. No. 7, Econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg.

Ramsay, J.G., 1963, Structural Investigations in the Barberton Mountain Land, Eastern Transvaal : Trans. geol. Soc. S. Afr., V. 66, p. 353-401.

Rankama, K. and Sahama, T.G., 1950, Geochemistry : University of Chicago Press, pp. 912.

Roering, C., 1965, The Tectonics of the Main Gold Producing Area of the Barberton Mountain Land : Inform. Circ. No. 23, Econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg, pp. 23.

Ross, C.S., 1955, Provenance of Pyroclastic Materials : Bull. geol. Soc. Amer., V. 66, p. 427-434.

Swift, W.H., 1956, The Geology of the Odzi Gold Belt : Bull. 45, Geol. Surv. Rhodesia, pp. 44.

Turekian, K.K. and Wedepohl, K.H., 1961, Distribution of the Elements in Some Major Units of the Earth's Crust : Bull. Geol. Soc. Amer., V. 72, p. 175-192.

Turner, F.J. and Verhoogen, J., 1960, Igneous and Metamorphic Petrology (2nd ed.) : McGraw-Hill Book Company, Inc. New York, pp. 694.

Urie, J.G. and Jones, D.H., 1965, Metamorphic Zones of the Archaean Fold Belt in Northwestern Swaziland : Unpub. Paper presented at the 8th. Ann. Congr. of the Geol. Soc. S. Afr., Johannesburg.

Van Biljon, W.J., 1964, The Chrysotile Deposits of the Eastern Transvaal and Swaziland : in: Haughton, S.H. (ed.) : The Geology of Some Ore Deposits in Southern Africa : Geol. Soc. S. Afr., V. 2, Part 8, p. 625-669.

Van der Berg, J.J., Schoeman, J.J. and Lombaard, A.F., 1946, Surface Geology of the Consort Mine Area : Unpub. Rep. Geol. Dept. E.T.C. Mines Ltd., Barberton.

Van Eeden, O.R., 1941, Die Geologie van die Shebarante en Omstreke, Distrik Barberton : Unpub. D.Sc. thesis, Univ. Stellenbosch.

Van Eeden, O.R. and Marshall, C.G.A., 1965, The Granitic Rocks of the Barberton Mountain Land in the Transvaal : Unpub. Rep. prepared for submission to the Geological Society of South Africa (8th. Ann. Congr.).

Van Zyl, J.S., Boardman, L.G., Brandt, J.W. and De Villiers, J.E., 1942, Magnesite in the Union of South Africa : Mem. No. 38, geol. Surv. S. Afr., 88 pp.

Viljoen, M.J., 1964, The Geology of the Lily Syncline and Portion of the Eureka Syncline between the Consort Mine and Joe's Luck Siding, Barberton Mountain Land : Unpub. M.Sc. thesis, Univ. Witwatersrand, Johannesburg.

Viljoen, M.J. and Viljoen, R.P., 1967, A Reassessment of the Onverwacht Series in the Komati River Valley : Inform. Circ. No. 36, Econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg, pp. 35.

Viljoen, M.J. and Viljoen, R.P., 1969a, The Geology and Geochemistry of the Lower Ultramafic Unit of the Onverwacht Group and a Proposed New Class of Igneous Rocks : Spec. Publ. 2, Geol. Soc. S. Afr., p. 55-85.

Viljoen, R.P. and Viljoen, M.J., 1969b, The Geological and Geochemical Significance of the Upper Formations of the Onverwacht Group : Spec. Publ. 2, Geol. Soc. S. Afr., p. 113-151.

Viljoen, M.J. and Viljoen, R.P., 1969c, An Introduction to the Geology of the Barberton Granite-Greenstone Terrain : Spec. Publ. 2, Geol. Soc. S. Afr., p. 9-27.

Viljoen, M.J. and Viljoen, R.P., 1969d, Evidence for the Existence of a Mobile Extrusive Peridotitic Magma from the Komati Formation of the Onverwacht Group : Spec. Publ. 2, Geol. Soc. S. Afr., p. 87-112.

Viljoen, R.P. and Viljoen, M.J., 1969e, Evidence for the Composition of the Primitive Mantle and Its Products of Partial Melting from a Study of the Mafic and Ultramafic Rocks of the Barberton Mountain Land : Spec. Publ. 2, Geol. Soc. S. Afr., p. 275-295.

Viljoen, R.P. and Viljoen, M.J., 1969f, The Relationship Between Mafic and Ultramafic Magma Derived from the Upper Mantle and the Ore Deposits of the Barberton Region : Spec. Publ. 2, Geol. Soc. S. Afr., p. 221-244.

Viljoen, M.J. and Viljoen, R.P., 1969g, A Proposed New Classification of the Granitic Rocks of the Barberton Region : Spec. Publ. 2, Geol. Soc. S. Afr., p. 153-180.

Viljoen, R.P., Saager, R. and Viljoen, M.J., 1969, Metallogenesis and Ore Control in the Steynsdorp Goldfield, Barberton Mountain Land, South Africa : Econ. Geol., V. 64, No. 7, p. 778-797.

Visser, D.J.L. (compiler), 1956, The Geology of the Barberton Area : Spec. Publ., 15, Geol. Surv. S. Afr., 253 pp.

Whitmore, D.R.E., Berry, L.G. and Hawley, J.E., 1946, Chrome Micas : Amer. Miner. V. 31, p. 1-21.

Winkler, H.G.F., 1967, Petrogenesis of Metamorphic Rocks : Revised (2nd ed.), Springer-Verlag, Berlin, Heidelberg, New York, 220 pp.

Yoder, H.S. and Sahama, Th. G., 1957, Olivine X-ray Determinative Curve : Amer. Miner., V. 42, p. 475-491.

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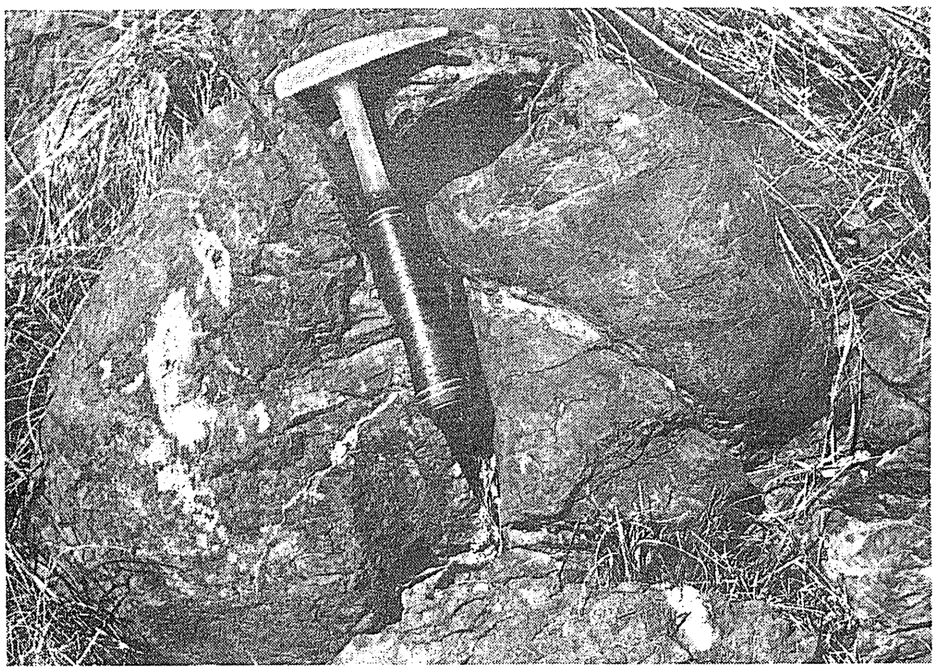
PLATE 1

A



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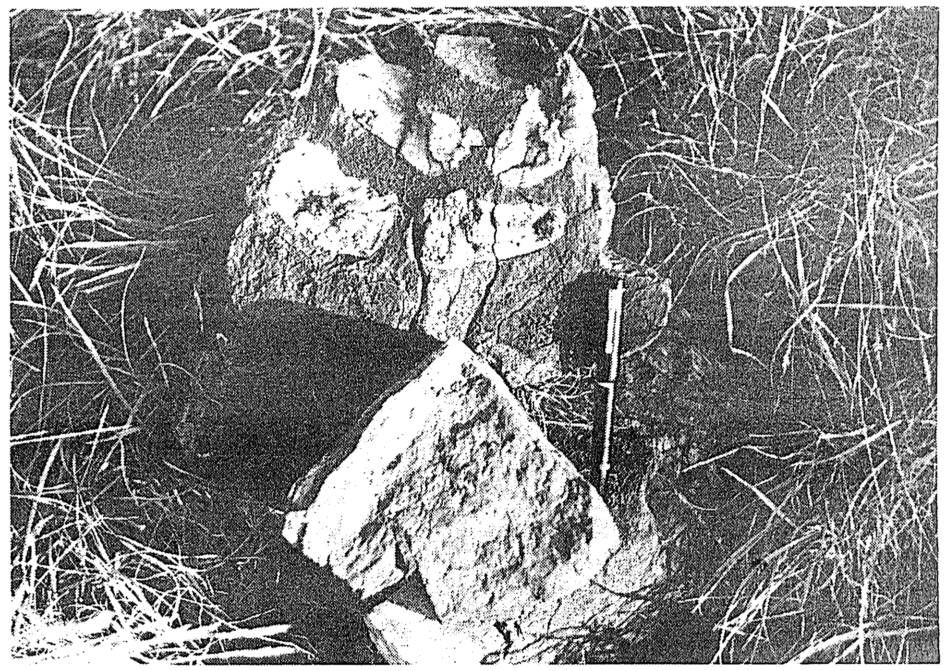
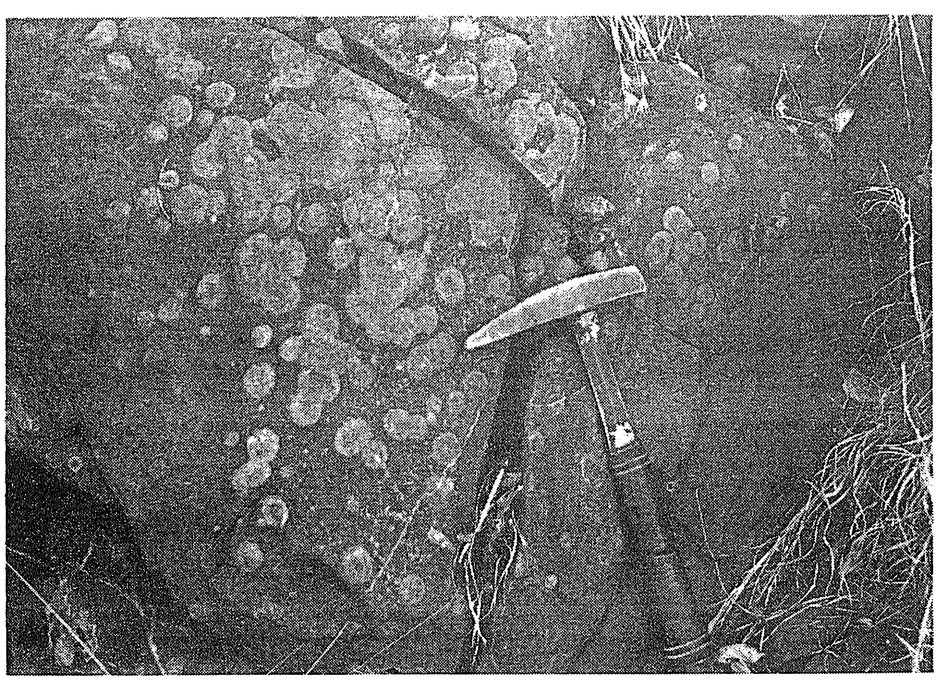


A. Pillow structure in meta-basalts of the Onverwacht Group in the eastern part of the Jamestown Schist Belt near the Brian Boru Gold Mine. The pillows have suffered metamorphism obliterating most volcanic structures but here the interstitial pelagonitic calcareous parting between the pillows has been preserved.

B. Large quartz-filled gas cavities occurring at the top of a metamorphosed pillow. Small amygdales were not encountered as they were probably destroyed by the metamorphic events. Locality same as A above.

C



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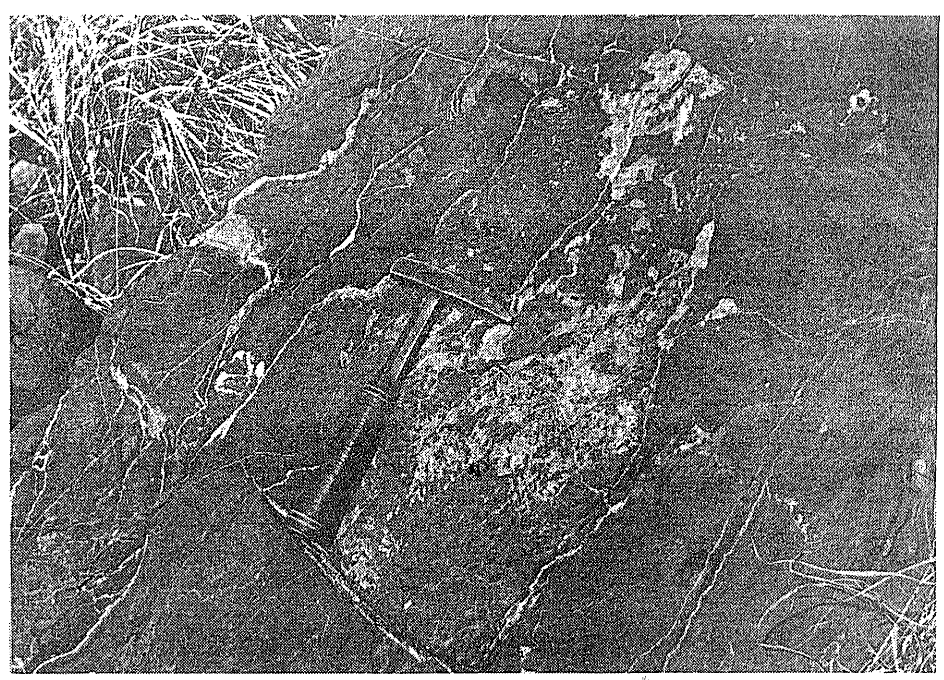
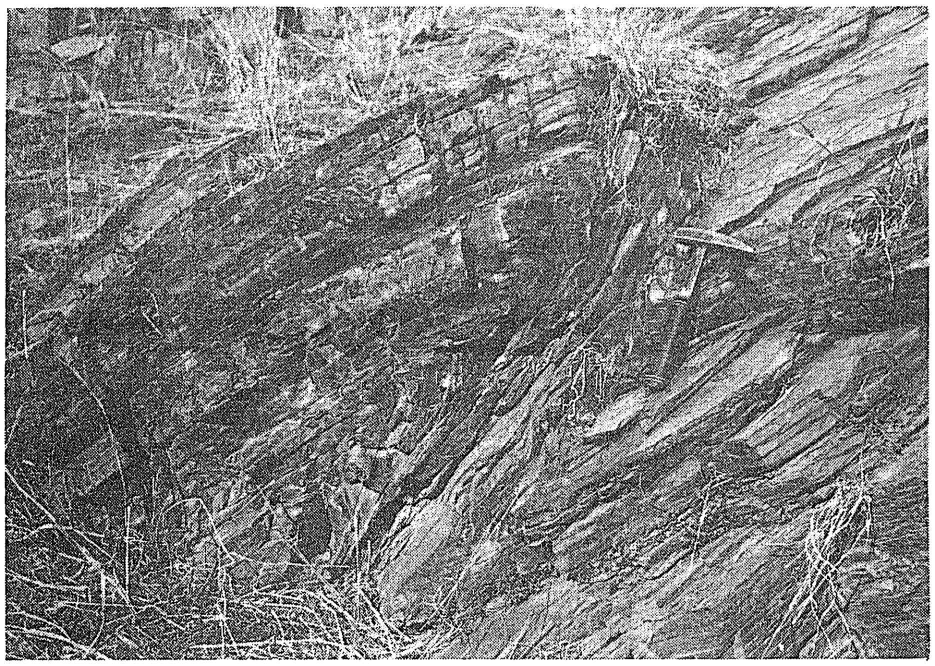


C. Large orbicular structures (some as large as a tennis ball were noted) in meta-basalts in the area west of Clutha Siding near the Brian Boru Gold Mine. These structures are large ocelli.

D. Altered and thermally metamorphosed metabasalts (actinolite-hornblende) with stringers and veinlets of calcareous material pervading the outcrops. This calcareous "sweat" material frequently occurs in metavolcanic rocks that formerly contained pillow structures and other interstitial pelagonitic sediment.

PLATE 2

A



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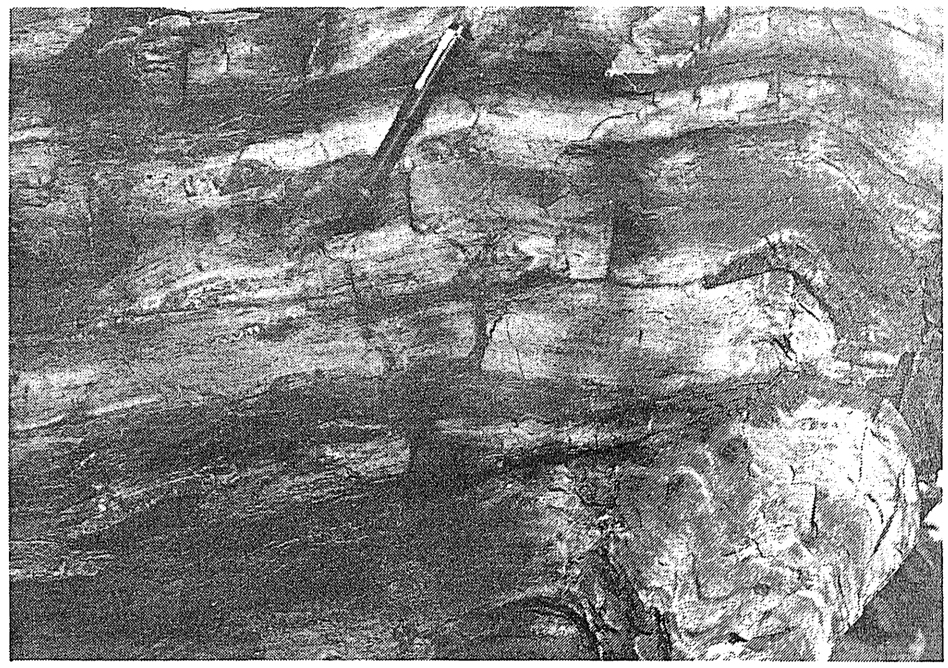
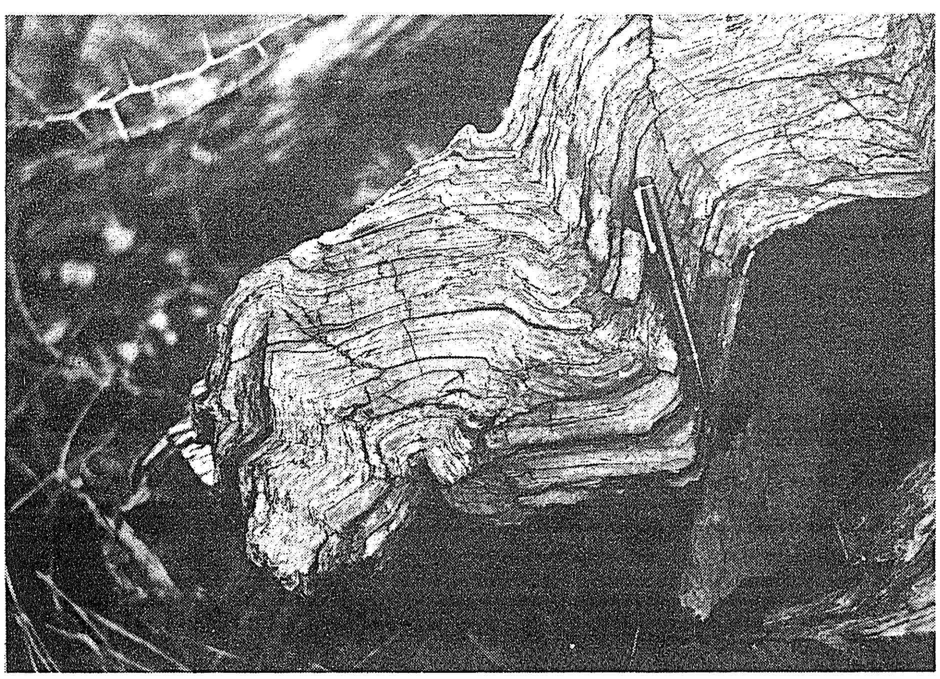


A. Large fold structure in metamorphosed Fig Tree shales and greywackes of the No. 3 Shaft Syncline - Consort Gold Mine. Fold axes plunge at intermediate to shallow angles to the southeast (Consort trend ± 135°). Axial plane of fold shown dips north at 53°.

B. Deformed conglomerate pebbles in the upper part of the Fig Tree assemblage of the No. 3 Shaft Syncline. Flattened chert pebbles can be seen with their long axes parallel to the bedding. To the right of the pen is a chert pebble folded by the Consort deformational trend.

C



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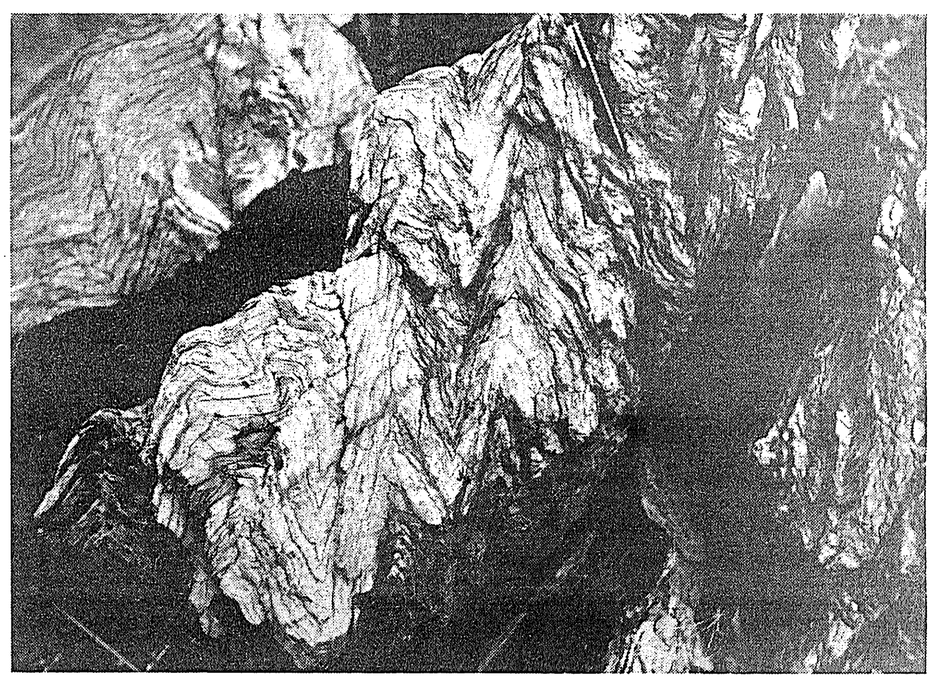
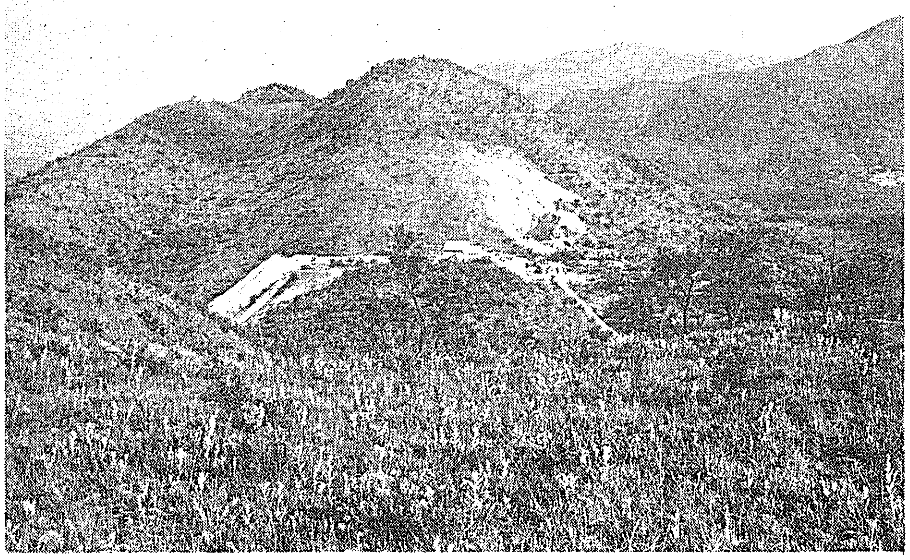


C. Conjugate fold in quartz-sericite schists (Onverwacht) in the area immediately southwest of the No. 3 Shaft Syncline. The stress field calculated from this fold indicates a near horizontal P. max acting in a direction SW-NE.

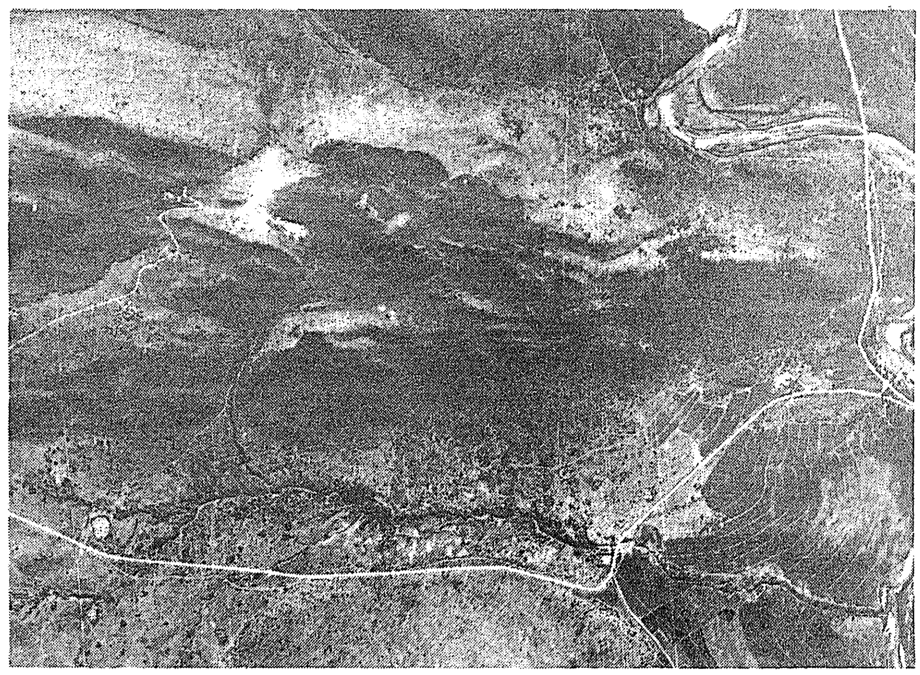
D. Accordion folds in quartz-sericite schists associated with the conjugate fold shown in C. The fold axes plunge southeast and strike parallel to the minor folds in the No. 3 Shaft Syncline. The development of this phase of deformation was due to the influence of the Kaap Valley Granite diapiric pluton.

PLATE 3

A



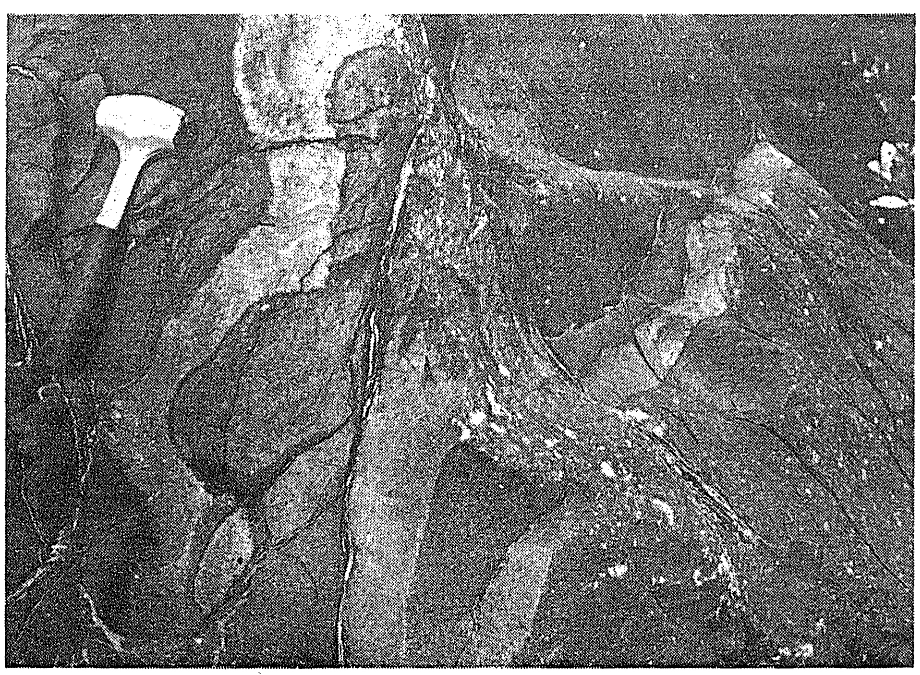
B



A. General view, looking east, of the Marbestos Mine showing the mine quarry and some of the layering of the differentiated ultramafic body. The quarry is located on serpentinized peridotite, the ridge to the left consisting of serpentinized pyroxene-bearing peridotite. North of this meta-gabbros occupy the hollow and are followed once again by a further ridge of serpentinite.

B. Aerial photograph of the eastern portion of the Mundt's Concession differentiated ultramafic body. The Marbestos chrysotile asbestos deposit occupies the core of the anticlinal structure.

C



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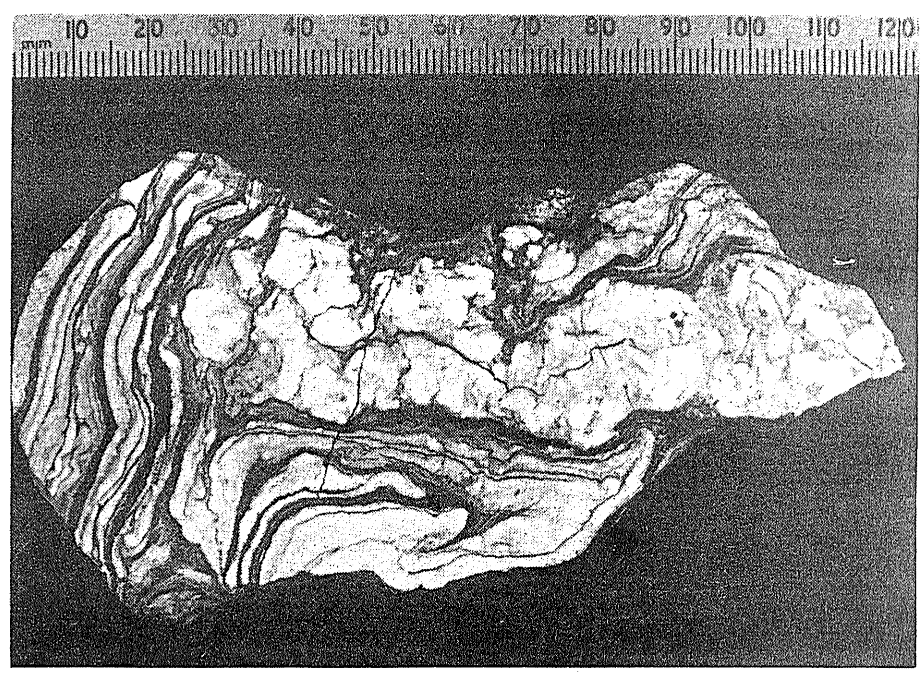
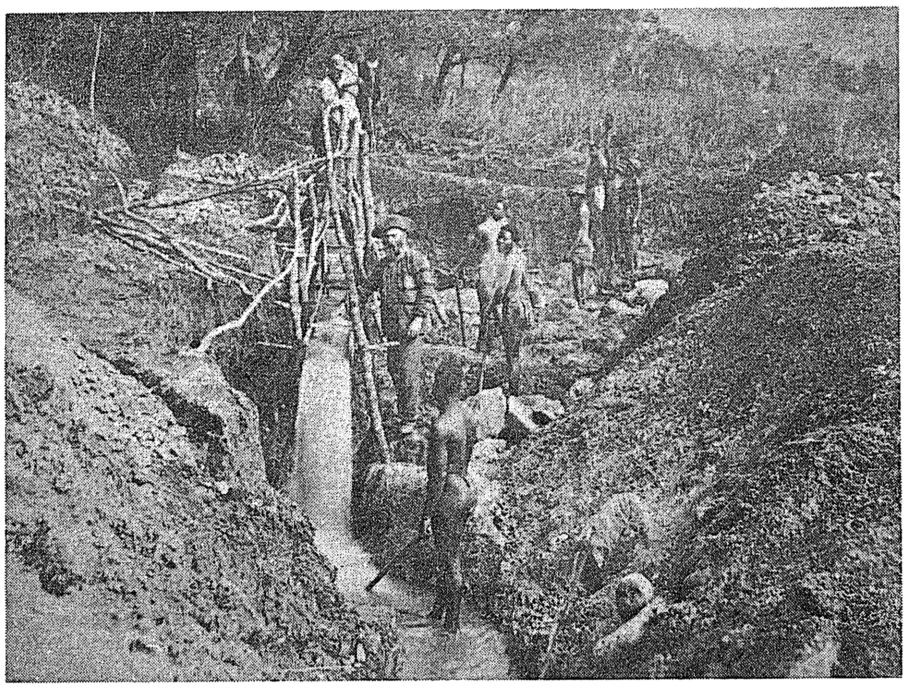


C. Irregular serpentinized peridotite dykes intrusive into massive serpentinites forming part of a differentiated ultramafic body located on Lots 87 and 88, west of the Worcester Gold Mine in the central portion of the Jamestown Schist Belt. In places along the dykes narrow, dark-coloured chilled selvedges are evident and white carbonate blebs and vein-fill material occurs irregularly in the serpentinite.

D. Specimen of the ornamental stone known as buddstone from the Jamestown Schist Belt illustrating the irregular pattern of folding typically associated with these rocks. The dark bands in reality are dark green in colour with the various tones of grey and white shown in the photograph representing a variety of paler green colours.

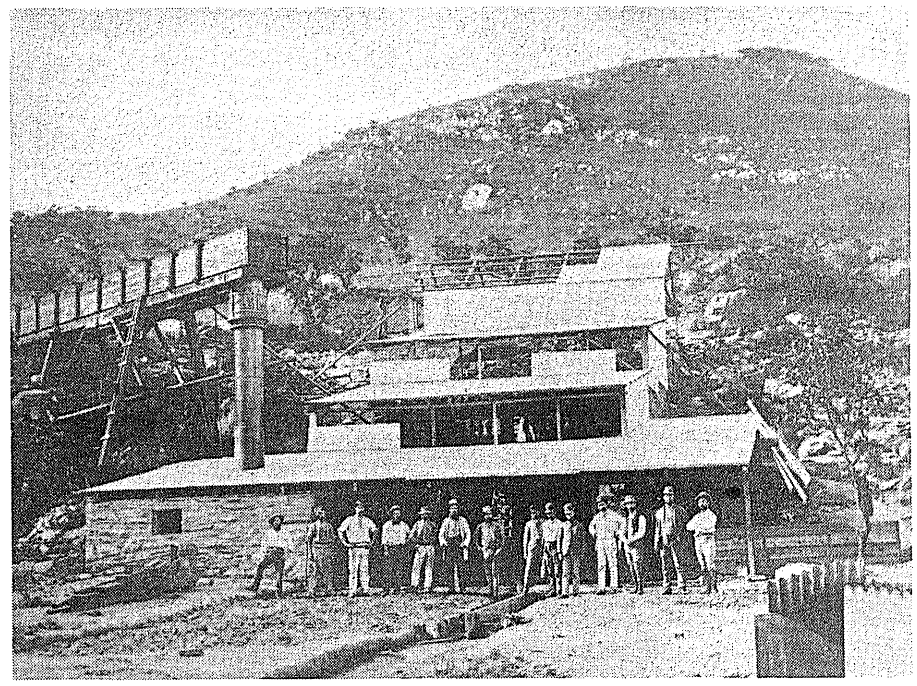
PLATE 4

A



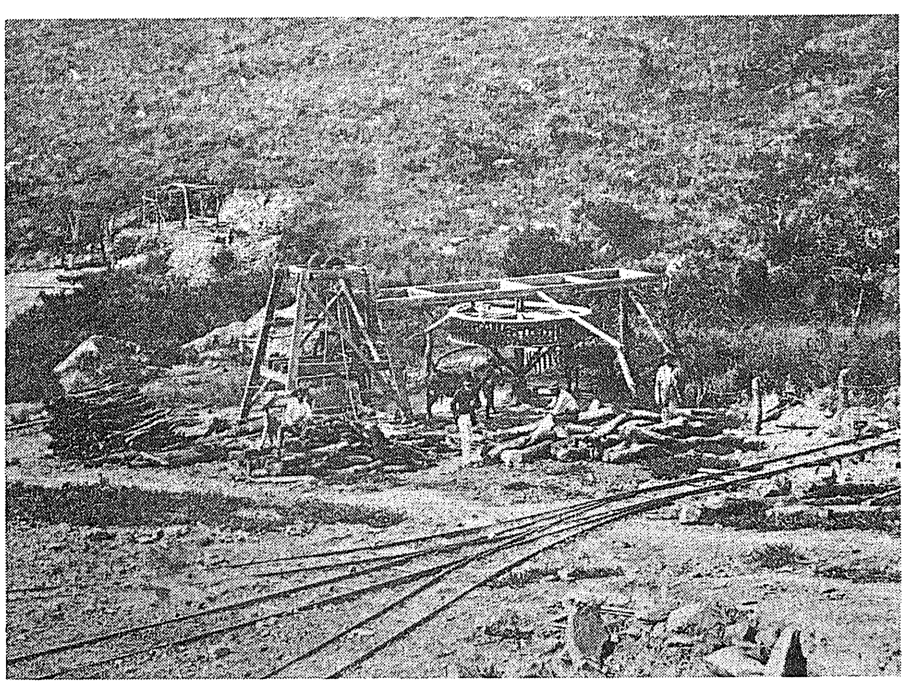
ALLUVIAL DIGGINGS NEAR JAMESTOWN IN THE JAMESTOWN SCHIST BELT - CIRCA 1884

B



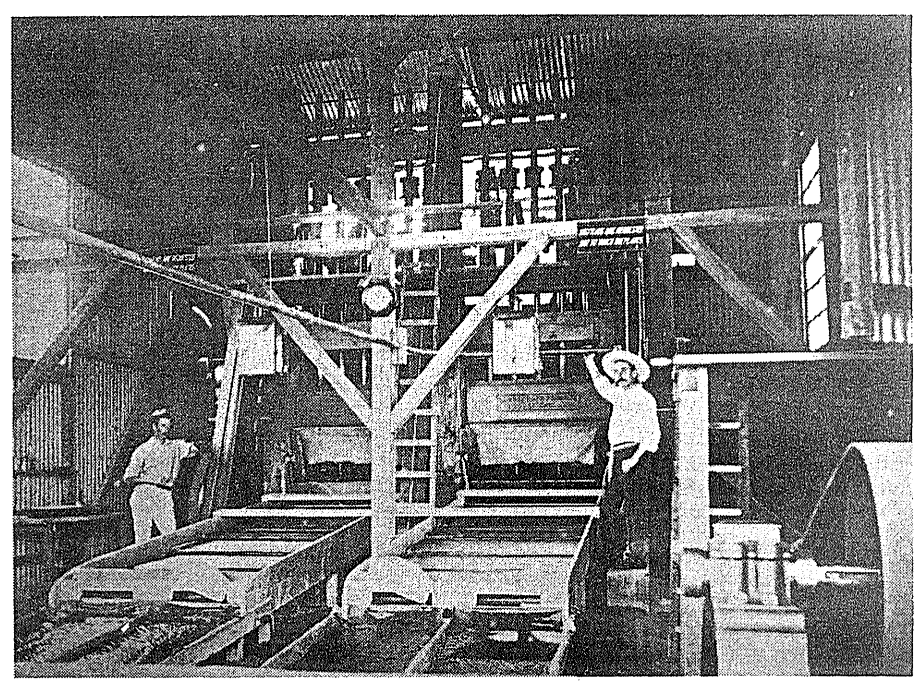
THE GEM BATTERY NEAR THE KAFFIR CREEK TALC MINES, JAMESTOWN SCHIST BELT - CIRCA 1890

C



THE VICTORIA GOLD MINE NEAR CLUTHA SIDING - CIRCA 1887

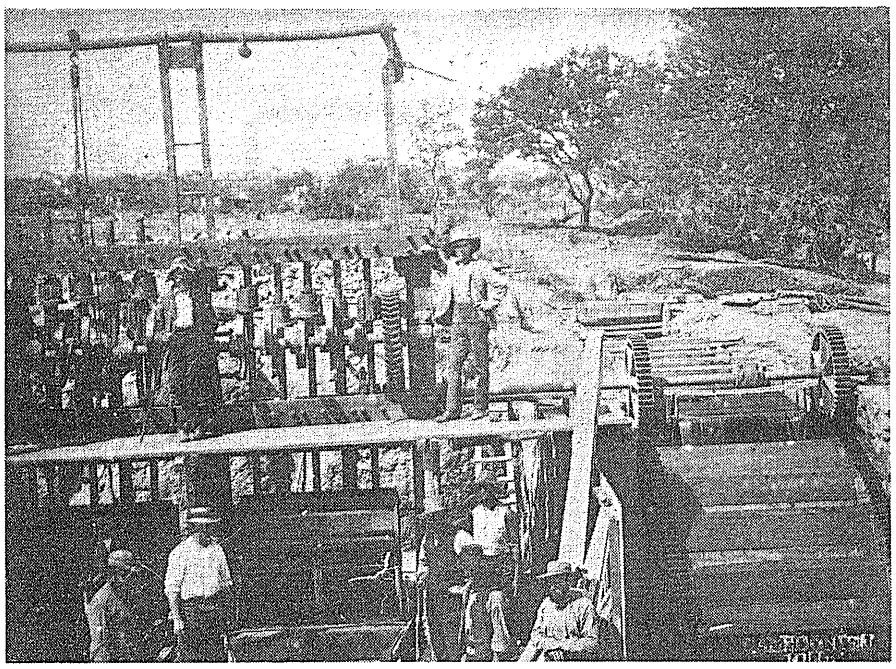
D



THE INTERIOR OF THE 10 STAMP BATTERY SITUATED AT THE CONSORT GOLD MINE - CIRCA 1887

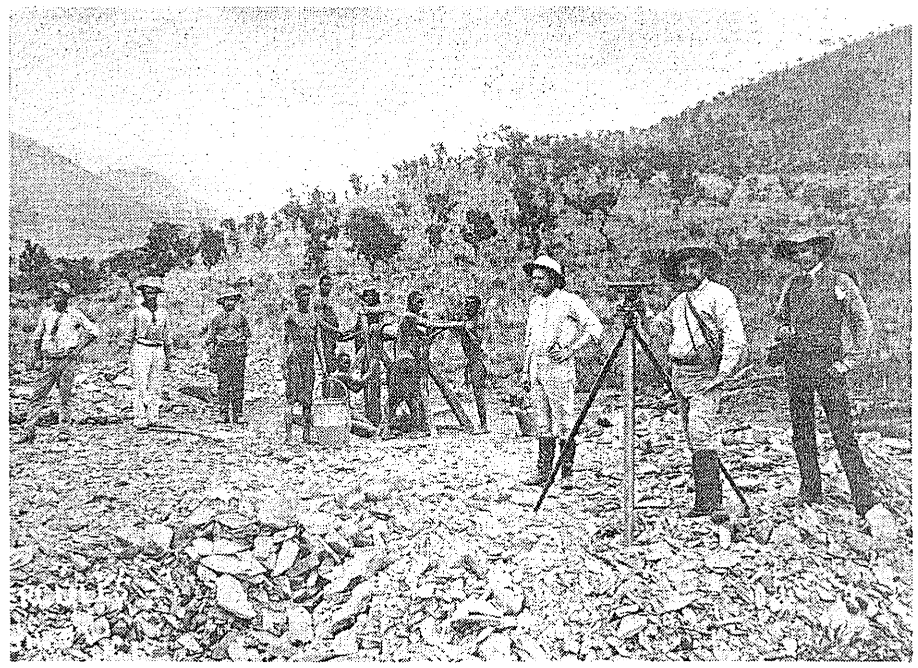
PLATE 5

A



WATER RACE AND 10 STAMP BATTERY SITUATED NEAR CALEDONIAN SIDING, EASTERN END OF THE JAMESTOWN SCHIST BELT - CIRCA 1887

B

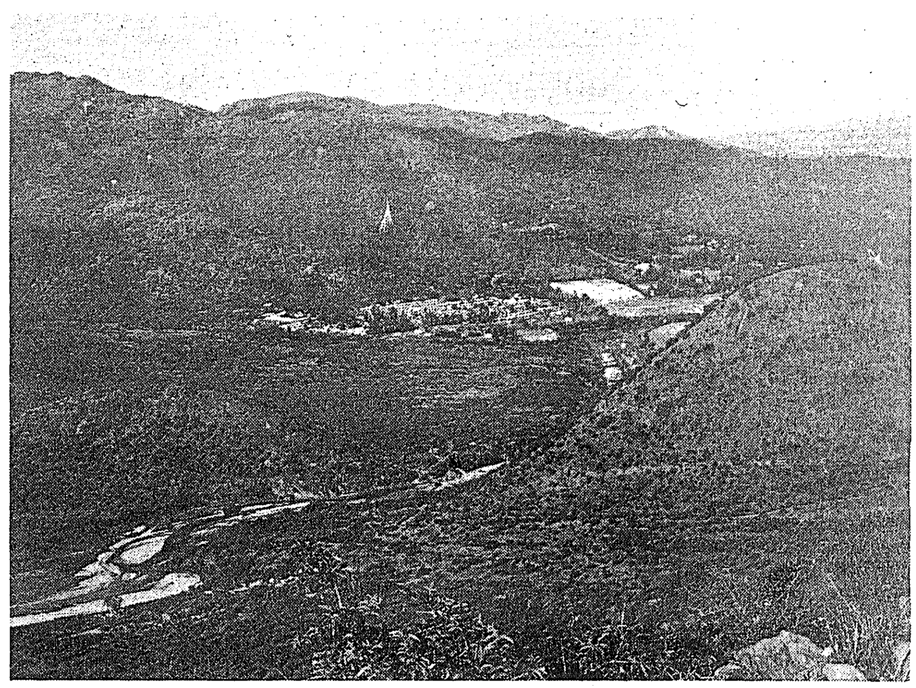


SURVEYOR AT WORK AT THE HERCULES GOLD MINE. LOT 100, SECTION D, KAAP BLOCK, IN THE JAMESTOWN SCHIST BELT - CIRCA 1887

C

EARLY GOLD MINERS AT THE CONSORT GOLD MINE NORTH OF NOORDKAAP - CIRCA 1890

D



VIEW OF THE NEW CONSORT GOLD MINE AT THE EASTERN END OF THE JAMESTOWN SCHIST BELT, PHOTOGRAPHED FROM NEAR THE MARBESTOS CRYSOTILE ASBESTOS WORKINGS - 1968