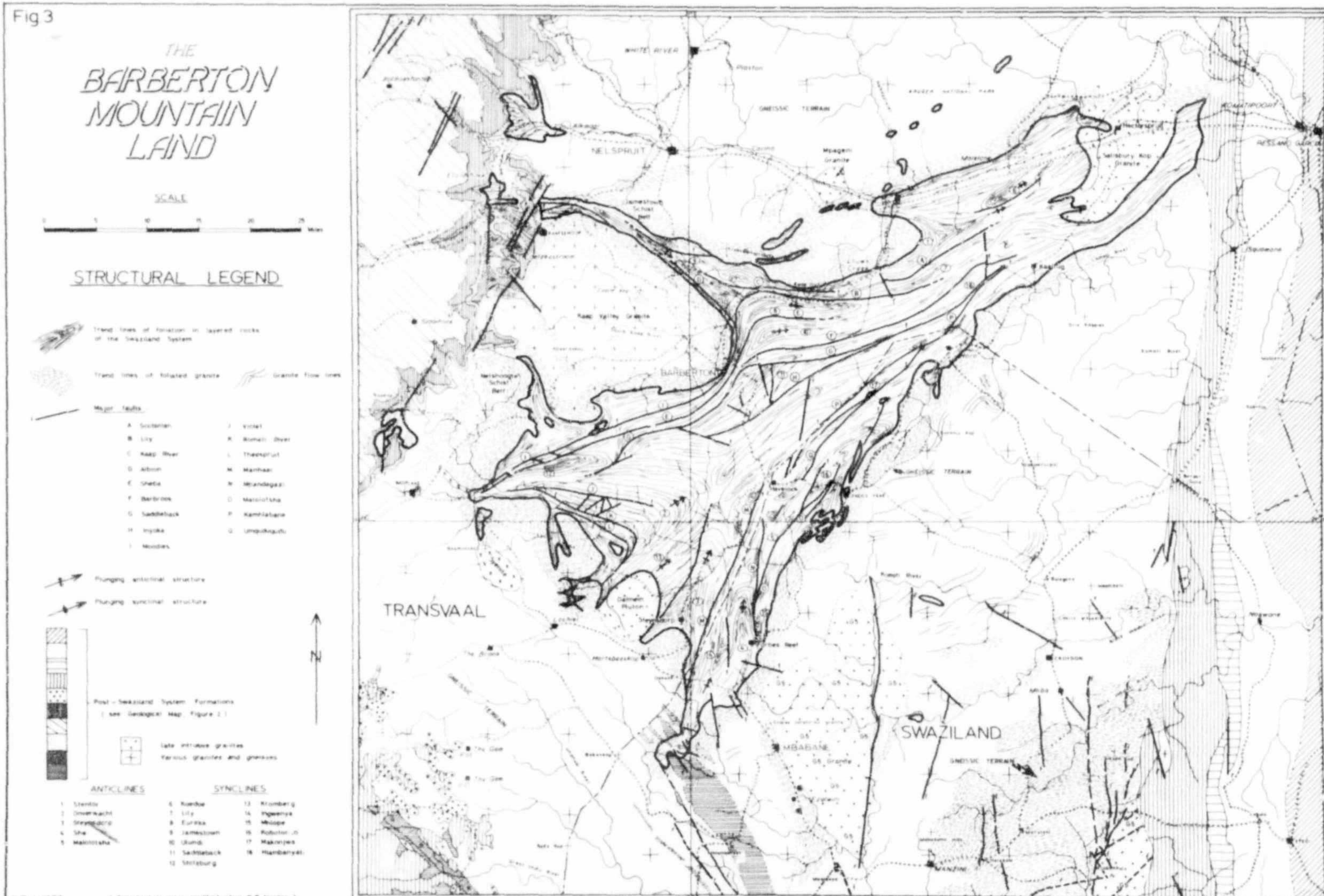

THE
BARBERTON
MOUNTAIN
LAND
SCALE
0
5
10
15
20
25
Miles
STRUCTURAL LEGEND
Trend lines of foliation in layered rocks
of the Swaziland System
Trend lines of foliated granite
Granite flow lines
Major faults
A Scotsman
B Lily
C Kaap River
D Albion
E Sheba
F Barbrook
G Saddleback
H Inyoka
I Moodies
J Violet
K Komati River
L Theespruit
M Manhaar
N Mtandegazi
O Malolotsha
P Kamhlabane
Q Umqubuqubu
Plunging anticlinal structure
Plunging synclinal structure
Post - Swaziland System Formations
(see Geological Map Figure 2)
late intrusive granites
Various granites and gneisses
N
ANTICLINES
1 Stentor
2 Onverwacht
3 Steynsdorp
4 She
5 Malolotsha
SYNCLINES
6 Koedoe
7 Lily
8 Eureka
9 Jamestown
10 Ulundi
11 Saddleback
12 Stolzburg
13 Kromberg
14 Ingwenya
15 Mhlope
16 Robutor Jn
17 Makonjwa
18 Hlambanyati
C.R.A. 1967
(Swaziland granites modified after D.R. Hunter)
WHITE RIVER
NELSPRUIT
BARBERTON
GNEISSIC TERRAIN
Mpageni Granite
Kaap Valley Granite
TRANSVAAL
SWAZILAND
MBABANE
Fig 3

series of well-developed, predominantly tight, synclinal folds (see Figure 3, page 51). These trend in a general northeasterly direction, and have steeply dipping limbs, often overfolded to the northwest. The axial planes may be locally folded or warped, as in the case of the Eureka and Ulundi synclines. Other prominent, northeast-trending synclines include the Saddleback, Stolzburg, and Kromberg synclines. One major exception is the Jamestown synclinorium which trends northwest (parallel to the superimposed axial plane of the inflected Eureka and Ulundi synclines). This synclinorium occurs in the largest arcuate schist belt in the Mountain Land.

Anticlinal structures between major synclines are generally absent, having been faulted out in many cases. Where anticlines are present, they are generally very poorly developed in comparison to the adjacent synclines. Two conspicuous anticlines are the Steynsdorp Anticline, in the Komati River Valley and the Stentor Anticline, to the southeast of Kaapmuiden. A large, anticline, referred to as the Onverwacht Anticline, forms a major structural feature in the southern part of the Mountain Land. This broad, open fold is flanked on the east and west by the isoclinal structures of the Stolzburg and Kromberg synclines.

(d) Major Faults

The Barberton Mountain Land has a number of major east-northeast-trending faults. These extensive longitudinal strike faults divide the early Precambrian fold belt into a series of long, narrow blocks, trending east-northeastwards, parallel to the regional grain (see Figure 3, page 51). In addition, there are several other major faults which trend in directions other than that of the east-northeast grain of the Mountain Land. These include the Kaap River, and the Albion faults, north of Barberton and several others in the Komati River Valley east of Badplaas.

The faults, which appear to have originally been of the high-angled thrust type, often occupy positions between adjacent synclines. Many of the faults display evidence of having been reactivated by later phases of deformation (Anhaeusser, 1965). The faults are of great economic importance, often being closely associated with many gold deposits. Two such examples are the Sheba and Barbrook faults, northeast of Barberton.

Another type of fault, with which mineralization is also often associated, occupies the contact between zones of incompetent and relatively more competent rock-types. These are, in effect, zones of strong shearing, rather than major thrust dislocations. The Lily Fault and the Consort "Contact" in the north, and the Violet Fault in the southern part of the Mountain Land are examples of this type.

(e) Large-Scale Regional Structure of the Barberton Mountain Land and it's Environs

The existing gravity data (Smit et al, 1962) of the Barberton area was used to plot a Bouguer Isogal Map (Figure 4, page 54). From the gravity data, as well as from a knowledge of the behaviour of the more important internal structures of the Barberton Mountain Land (Figure 3, page 51), the Regional Structural Map (Figure 4, page 54) was constructed of the entire Barberton greenstone belt and its surroundings.

The Archean fold belt is surrounded by a low-gravity, granite-gneiss terrain, through which the main confining anticlinal axes, on the northwest and southeast flanks of the Barberton Mountain Land, have been drawn. The greenstone belt itself, is a broad regional downwarp, or downsag, that may be regarded as a major synclinorial structure. Broad anticlinal and synclinal axes can be drawn across the belt in two directions. The first, and most prominent trend, favours a NE-SW regional strike direction, superimposed on to which is a second regional NW-SE trend. There appears, furthermore, to be a systematic periodicity of the broad scale structures across the entire belt with antiforms and synforms regularly repeated. One of the most prominent synforms in the Mountain Land is that which follows the trend of the Jamestown Schist Belt, about which more will be mentioned in a later section.

* *

CHAPTER 3

THE GEOLOGY OF THE JAMESTOWN HILLS AREA

A. INTRODUCTION

To the north of Barberton, and forming a wedge between the Nelspruit gneisses and migmatites on the one side, and the Kaap Valley Granite in the south, lies a long, narrow tract of country referred to generally as the Jamestown Hills or the Jamestown Schist Belt (see locality map, Figure 4, page 54). The Belt is approximately 5 miles wide near Noordkaap in the east, tapering gradually westwards to a width of just over 2 miles where it disappears beneath the younger cover of the Escarpment formations. At its narrowest point, near the centre of

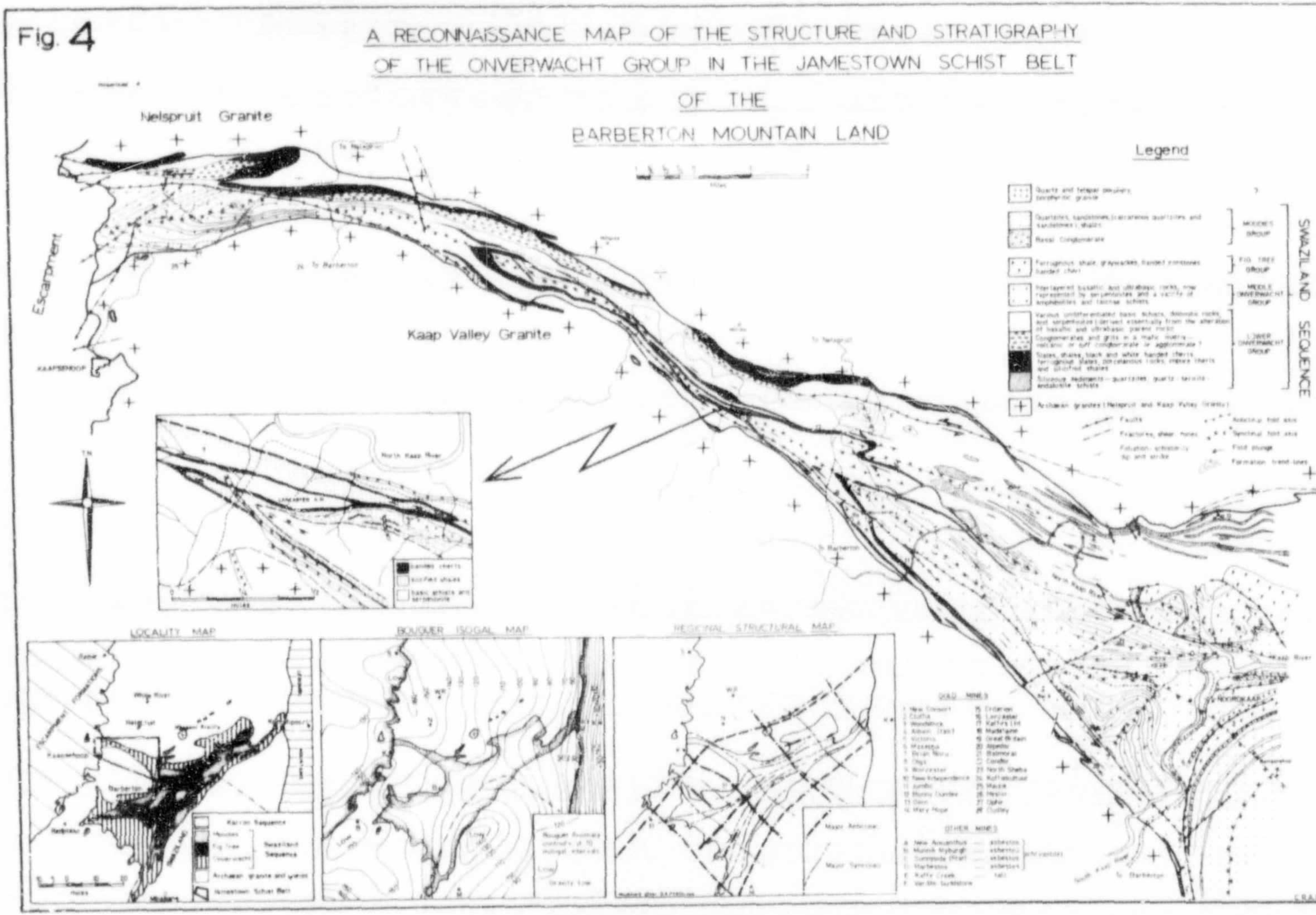


Fig. 4 A RECONNAISSANCE MAP OF THE STRUCTURE AND STRATIGRAPHY OF THE ONVERWACHT GROUP IN THE JAMESTOWN SCHIST BELT OF THE BARBERTON MOUNTAIN LAND

the Schist Belt, it is only three-quarters of a mile wide. The total length of the Belt, from Noordkaap in the east to Kaapsehoop in the west, is approximately 22 miles.

The Jamestown Schist Belt is almost entirely underlain by rocks of the Onverwacht Group of the Swaziland Sequence. In the eastern part of the belt, however, near the New Consort Gold Mine, the Onverwacht rocks are overlain by Fig Tree Group sediments. These rocks, in turn, are overlain by the arenaceous assemblage of Moodies Group sediments.

Reconnaissance mapping, using 1:12,000 scale aerial photographs, was undertaken throughout the entire Belt and a map of the structure and stratigraphy was prepared from this survey (see Figure 4, page 54). The eastern half of the Belt was mapped in detail on 1:6,000 scale aerial photographs and a final map, with a scale of 1:10,000, was produced. A photographically reduced version of this map is included in this thesis (Figure 5, in pocket). Particular attention was paid to the structural and metamorphic aspects of the geology because of their considerable influence and control on the distribution of the mineralization in the area.

It is intended, in this chapter, to describe and classify the rock-types and to indicate their distribution, to outline the structure of the Jamestown Schist Belt, and to report on the mineralization in the area.

B. GENERAL GEOLOGY OF THE CONSORT MINE - WORCESTER AREA

(a) Classification and Distribution of Rock-Types (see geological map, Figure 5, in pocket)

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 characters they may originally have possessed.

Along the northern half of the Schist Belt the successions, as they appear in the area north of the Consort Mine, continue westwards, some carrying on for an undisclosed distance, but most of them apparently folding back on themselves in the vicinity of the Kaffir Creek Talc Mines. The assemblages involved in this part of the 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.

The southern half of the Schist Belt is 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 complete absence of interlayered siliceous or acid material but, like the Komati Formation, with which it has been correlated, a feature of the succession is the presence of numerous intrusive bodies of quartz and felspar porphyry. The Komati Formation, as developed in the Jamestown Schist Belt, does however, differ considerably from its essentially volcanic southern counterpart in that the succession appears to have originally constituted both intrusive and extrusive ultramafic and mafic material. The intrusive assemblage gave rise ultimately to a succession of layered differentiated ultramafic rocks such as the Handsup and Mundt's Concession bodies, immediately west of Noordkaap.

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 4, page 54). These siliceous sedimentary horizons and their enveloping mafic and ultramafic schists probably form a part of the succession included with the Theespruit Formation.

In the eastern part of the Jamestown Schist Belt the Onverwacht rocks are overlain by Fig Tree Group assemblages, particularly in the area of the Consort Mine, north of Noordkaap. 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 a succession 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 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 Syncline and the Lily Syncline, respectively. In addition, a small, isolated, fault-bounded block of Moodies conglomerates and quartzites occurs in the area southwest of the Consort Mine and probably represents a remnant of the western extension of the Lily Syncline.

(b) 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 Belt is made up of a number of major folds and faults, the nature of which are best demonstrated in Figure 4, page 54. 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.

Two major disharmonic fold structures were recorded, the first, and 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 on the Barberton-Nelspruit main road, about 9 miles northwest of Noordkaap. 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.

Because of the lack of marker horizons and continuous exposure in the isoclinally folded mafic and ultramafic assemblages, the 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 structure techniques of mapping were employed in this and other areas of the Belt and it was possible to establish at least four recognizable phases of deformation.

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 15 miles 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 the Lily Syncline in half. 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 under discussion. Only in a few cases were cross-faults noted, and these are to be found mainly in the Mundt's Concession anticlinal structure.

(c) Metamorphism

The Jamestown Schist Belt has suffered extensive dynamo-thermal metamorphism that owes its origin 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 includes also the pegmatite invasion.

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 a minor structural analysis of the rocks.

(d) Mineralization

Practically all of 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, the one superimposed on the other, giving rise to the mineralized zone comprising the Consort ore bodies.

Further gold deposits occur scattered throughout the Belt but it is clear that the Albion Fault has played a part in causing the localization of 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 quartz and felspar porphyry bodies. The Kaffir Creek Talc Mines, just over 5 miles 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, are several occurrences of the semi-precious mineral verdite, and an ornamental stone often associated with it, known as buddstone.

C. DETAILED 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.

For the purpose of simplicity of description and understanding the rocks 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 assemblage and then the Moodies, the last two of which occur only locally in the eastern part of the Belt.

The complete stratigraphic column in this area is difficult to determine 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 column as it appears in the Jamestown Schist Belt.

The Onverwacht Group has been subdivided into a lower division and middle division corresponding to the lower and middle divisions of the Onverwacht Group as established in the Komati River Valley. The lower division has many similarities with the Theespruit Formation and the middle division is similar to the Komati Formation. No upper division of the Onverwacht appears to be developed anywhere in the northern portion of the Mountain Land. No thicknesses of the various units will be given because these are not truly representative of their original state, having now been greatly exaggerated or reduced by the folding and attenuation suffered by the rocks. A simplified stratigraphic column of the Schist Belt is presented in Table 1, page 61.

(b) The Onverwacht Group

(i) Theespruit Formation

Dark contact amphibolites containing hornblende or actinolitic hornblende are found along a narrow zone on either side of the Jamestown Schist Belt where both the Nelspruit and Kaap Valley Granites are intrusive into the Onverwacht Group. These rocks have a distinctive appearance, being either totally black in colour or at times containing sufficient plagioclase fèlspar to give the rock a dark greyish-black colouration. The contact amphibolites are best developed in the area to the north and northwest of the Consort Mine where, in addition to the mobilized 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 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 in one isolated occurrence on the western part of the farm Segalla 306 JU, approximately three-quarters of a mile 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. Why the grade of metamorphism in this area should be locally higher than that in the adjacent areas is obscure, there being no evidence on the surface of a heat source such as might be provided by a pegmatite body.

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, pleochroic hornblende, plagioclase that varies in composition between albite and andesine, and some quartz. Locally the rock is composed almost exclusively of hornblende while elsewhere the

TABLE 1

STRATIGRAPHIC COLUMN OF THE JAMESTOWN SCHIST BELT

Lithostratigraphic Units	Rock-Types
Post-Moodies intrusives	- various dykes - Kaap Valley Granite and some porphyry bodies. Nelspruit Granite 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, pyroxenite, amphibolite, meta-gabbro) - talc-chlorite-tremolite-actinolite schists - meta-volcanics with pillow structures. - various carbonated greenschists, dolomitic rocks.
(Theespruit Formation)	- intercalated siliceous horizons (quartz-sericite schists, fuchsite, sillimanite, andalusite, chloritoid, staurolite schists, cherts, quartzites, shales) - serpentinites, talc-carbonate rocks, talc, talc-chlorite, talc-tremolite schists. Carbonate rocks. - meta-volcanics with pillows and spherulites. - dark contact amphibolites

Granitic or migmatitic basement in part ?

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. Garnets develop in these rocks only where the bulk composition was suitable for their formation, and they are not restricted by the distance from the granites, although many of them do form in amphibolites adjacent to the contacts. Epidote is fairly common in places and appears to be the result of the breakdown of the plagioclases by the process of saussuritization. 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 contacts the dark colouration of these rocks decreases and they become greenish in colour. This is reflected in the mineralogy of these rocks by the development of actinolite or chlorite, depending on the distance from the granites. Everywhere these rocks have a schistose texture with a strong mineral alignment. Frequently the schistosity is intensified in the many shear zones occurring in the Schist Belt. The shear zones are often marked by the presence of a quartz vein, or, 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.

1. Chemical Data Relating to the Contact Amphibolites

Two chemical analyses of the contact amphibolites in the Jamestown Schist Belt are included in Table 2, together with the norms and modal analyses of these samples. According to Barth (1962A) the CIPW norm was meant for igneous rocks and should be restricted in its use to them alone. A different method of calculation in metamorphic petrology was therefore suggested by him to take into account the chemically more complicated metamorphic minerals encountered in these rocks. Barth (1962A) stated that in regional metamorphism there are three main groups of rock :

(i) Catarocks centering around the granulite facies

(ii) Mesorocks centering around the amphibolite facies, and

(iii) Epirocks - those centering around the greenschist facies.

The catametamorphic rocks correspond in their mineral content so closely to those of igneous rocks that the CIPW norm can be used for both. However, the contact amphibolites in the Jamestown Schist Belt are of amphibolite facies grade and have, therefore, been calculated according to the mesonorm method devised by Barth (1959, 1962 A and B). The mesonorm takes into account any minerals foreign to the standard or catanorm, viz. hornblende, biotite, a variety of garnets, sphene and others.

TABLE 2

CHEMICAL ANALYSES : CONTACT AMPHIBOLITES

	Hydrous		Anhydrous	
	CAA1	CAT79	CAA1	CAT79
SiO_2	52.30	49.00	53.53	51.07
Al_2O_3	14.15	14.25	14.48	14.85
Fe_2O_3	1.48	2.12	1.51	2.20
FeO	9.44	8.04	9.66	8.38
MgO	6.06	8.33	6.20	8.68
CaO	10.66	9.88	10.91	10.29
Na_2O	2.15	1.75	2.20	1.82
K_2O	0.21	1.63	0.21	1.69
H_2O+	1.89	2.60	-	-
H_2O-	0.09	0.17	-	-
CO_2	0.11	0.61	-	-
TiO_2	0.95	0.70	0.97	0.72
P_2O_5	0.063	0.048	0.06	0.05
MnO	0.24	0.18	0.24	0.18
Total	99.79	99.31	99.97	99.93

All the chemical analyses included in this thesis have been recalculated anhydrous and their values placed alongside the full analyses. Anhydrous values are used in almost all the calculation procedures employed throughout the text. The modal analyses of these contact amphibolites as well as others included elsewhere in this report were carried out using a Swift point counter and the results are expressed as volumetric and weight percentages.

TABLE 2a

CATION PERCENTAGES, CATANORMS AND MESONORMS : CONTACT AMPHIBOLITES

Cation Percentages			Catanorms			Mesonorms		
	CAA1	CAT79		CAA1	CAT79		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 2b

AVERAGE MODAL ANALYSES OF CONTACT AMPHIBOLITES

Sample CAA1:	Volume per cent	Weight per cent
Quartz	17.43	15.50
Hornblende	60.49	64.80
Plagioclase	21.95	19.50
Opaque minerals	0.10	0.20

TABLE 2b (Continued)

Sample CAT79	Volume per cent	Weight per cent
Quartz	1.76	1.50
Amphibole	70.35	71.60
Plagioclase	0.58	0.50
Sericite	16.00	14.40
Epidote	10.94	11.50
Opaque minerals	0.35	0.60

Descriptions and locations of chemically analysed samples listed in Table 2 :

CAA1 Dark contact amphibolite. Nelspruit Granite contact northwest of the New Consort Gold Mine, eastern end of the Jamestown Schist Belt.

CAT79 Dark contact amphibolite. Kaap Valley Granite contact approximately 6 miles northwest of Caledonian Siding on the farm Thornylea 588 JT.

2. Origin of the Amphibolites and Other 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 ultramafic 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 evidence in support of this contention. 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 of original volcanic origin. Viljoen and Viljoen (1967) 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).

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, and spherulites had been preserved, some examples of which can be seen in Plate 4, page 67. Many other pillow volcanics were subsequently found in the far western part of the Jamestown Schist Belt by N.D. Harte (verbal communication, 1967).

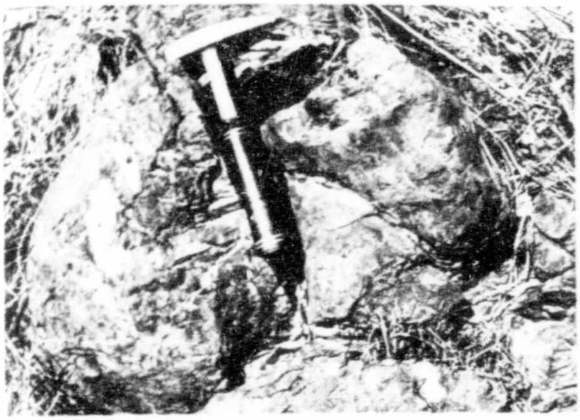
The original nature of the amphibolites and other mafic schists appears now to have been established. Most of the rocks in the Jamestown Schist Belt may be classified as ortho-amphibolites. The writer, in making this statement, does not, however, preclude the possibility that some of these rocks are, in fact, para-amphibolites. Para-amphibolites may be 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.

3. Serpentinites in the Theespruit Formation

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

PLATE 4

A

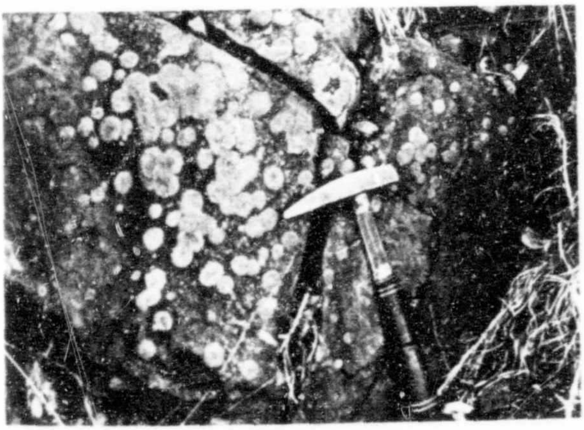


B

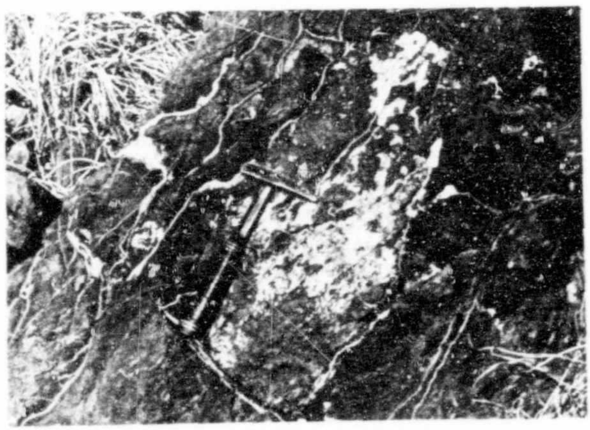
A. Pillow structure in meta-basalts of the Onverwacht Group in the eastern part of the Jamestown Schist Belt near the Brian Boru Gold Mine. The pillows have suffered metamorphism obliterating most volcanic structures but here the interstitial pelagonitic calcareous parting between the pillows has been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



D



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 spherulites.

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

thermal metamorphism and shearing, resulting in the production of a variety of schists. These include talc and tremolite schists in addition to carbonate-bearing rocks. These schists, when followed along strike, 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 sequences in the area 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 has not been entirely disrupted it can be seen that many serpentinized ultramafic horizons occur interlayered with meta-volcanic 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. Surface mapping, however, could not show conclusively that this was a fold. The serpentinite forms a large, bulbous body which trails off eastwards into a narrow band, ending near Kaffir Creek. The serpentinite mass 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, and pinch out along strike, only to reappear again as another bulbous mass further along strike.

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 can be found completely encompassed, at times, by economically exploitable talc deposits.

As has been mentioned, 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 region. The serpentinites are thus not regarded as later 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 previously existing interlayered ultramafic material was "squeezed" into its present position during the intense folding, thereby creating the impression of having been emplaced by separate intrusion.

The serpentinites are invariably the most massive rock-types present, 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, viz. Green Serpentinites, which they considered probably originated from highly 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.

Thin section examination of the various serpentinites found in the area showed that they all consist of practically identical mineralogy. Generally, the rocks are composed of a dense felted matt of antigorite, with the only other constituent being magnetite, the latter often occurring either, as individual grains or, as clusters or, fine dust-like aggregates. Very rarely were relict traces of the original mineral composition noted. In a few cases, however, small, strongly birefringent, olivine kernels were seen entirely surrounded by antigorite. Pseudomorphs of antigorite after olivine are common and very often the outline of the original olivines is 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 a talc-tremolite schist.

Other minerals encountered in the many thin sections of serpentinite 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 is seen surrounded by a highly birefringent, shredded mineral, thought to be altered pyroxene. Carbonate minerals, calcite and dolomite, are invariably present as well, giving 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.

4. 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. Here, both rock-types occur close together, separated by a narrow zone of talc schist. The siliceous schists, in this instance, contain an abundance of andalusite, chloritoid, and staurolite.

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).

Apart from quartz-sericite schists, the siliceous-schist horizons include nodular varieties, almost identical to the sheared sericitic, lustrous schists, containing small cherty-quartz nodules, or 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, quartz-sericite schistose rock, containing abundant chromiferous mica known as fuchsite. Whitmore et al, (1946), and Geijer (1963), found that the chrome micas are invariably the product of hot solutions of magmatic derivation, with 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 emanated 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 that envelop the siliceous-schist horizons.

Thin-section analyses of these rocks show that they are very variable in texture, and form, but that they nevertheless consistently display almost identical mineralogy. The rocks may vary from friable, almost white-coloured quartz-sericite schist to quartzitic rocks and even cherts. This variation may be seen to take place along strike. The mineralogy of the rocks is relatively uncomplicated with quartz and sericite generally making 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. Apart from 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 assisted considerably with the correlation of the early members of the Onverwacht Group. 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, has been described by Hall (1918), van Eeden (1941) and, more recently, by 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).

Apart from the strong foliation or schistosity developed in the siliceous rocks 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.

The quartz-sericite schists converge, forming a fold closure on Lots 135 and 137, immediately east of Tokenhouse Farm. 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 just 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) found that many of the interlayered siliceous horizons were capped by chert. This relationship has proved useful in strongly folded areas where the direction of younging has been in doubt. Invariably it was found that the development of a cherty capping to the successions indicated the termination of a particular depositional cycle and hence the younging direction could always be ascertained.

In the Jamestown Schist Belt detailed structural mapping of the major fold in the quartz-sericite schist horizons in the Kaffir Creek Talc Mine area could not 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 must, in fact, be a syncline.

5. Chemical Data Relating to the Siliceous Schists

Two samples typical of the siliceous schist horizons in the Jamestown Schist Belt were analysed in full by the National Institute for Metallurgy, and are included in Table 3. In addition, 5 other samples of similar rock-types were partially analysed for the writer by Anglo Transvaal Consolidated Mines Limited, the latter company being interested in the rocks because of their apparently high alumina content. The partial analyses consisted of SiO_2, Al_2O_3, and Fe_2O_3 determinations. The writer subsequently established the sodium and potassium contents of these rocks flame photometrically using a Zeiss PMQ 11 spectrophotometer with a flame attachment.

TABLE 3

CHEMICAL ANALYSES, SILICEOUS SCHISTS

	Hydrous		Anhydrous	
	J 13	J 14	J 13	J 14
SiO_2	79.53	78.28	81.00	77.78
Al_2O_3	12.76	17.52	12.99	17.40
Fe_2O_3	0.11	0.39	0.11	0.38
FeO	0.36	1.01	0.36	1.00
MgO	0.30	0.46	0.30	0.45
CaO	0.28	0.30	0.28	0.29
Na_2O	0.27	0.53	0.27	0.52
K_2O	3.86	1.48	3.93	1.47
H_2O+	1.74	0.88	-	-
H_2O-	0.23	0.20	-	-
CO_2	-	-	-	-
TiO_2	0.53	0.55	0.53	0.54
P_2O_5	0.18	0.11	0.18	0.10
MnO	tr	0.01	tr	0.01
Totals	100.15	101.72	99.95	99.94

TABLE 3a

CATION PERCENTAGES, CATANORMS, AND MESONORMS : SILICEOUS SCHISTS

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	1.19	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 3b

PARTIAL CHEMICAL ANALYSES : SILICEOUS SCHISTS

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	K_2O	Na_2O
90	80.28	15.14	0.66	1.62	0.28
162	74.32	16.66	1.06	1.00	1.73
171B	70.80	19.82	0.46	5.31	1.27
185	79.56	15.08	0.88	0.11	0.14
196A	82.56	14.63	0.66	0.21	0.07
J13	76.72	14.42	0.70	3.86	0.27
J14	76.44	17.99	2.00	1.48	0.53
Means	78.67	16.27	0.92	1.94	0.61

TABLE 3c

AVERAGE MODAL ANALYSES OF SILICEOUS SCHISTS

Sample J 13	Volume per cent	Weight per cent
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	[illegible]
Andalusite	38.94	42.50
Chloritoid	2.26	2.80
Opaque minerals	0.82	1.40

Andalusite-chloritoid-sericite schist; nose of fold in the area of the Kaffir Creek Talc Mines, Lot 137.

Descriptions and locations of the chemically analysed samples listed in Table 3 :

J 13 Quartz-sericite schist. Location: north bank of the North Kaap River on the farm Riverside 245 JU.

J 14 Andalusite schist containing sericite and chloritoid. Location: siliceous schist horizon immediately north of Sample J 13, also on the farm Riverside 245 JU.

Descriptions and locations of the partially analysed Al-rich quartz-sericite schists listed in Table 3b.

90 Andalusite-quartz-sericite schist; south bank of the North Kaap River, Lot 65.

162 Andalusite-quartz-sericite schist; Lot 64, immediately north of the river.

171B Andalusite-chloritoid-sericite schist; nose of fold in the

162 Andalusite-quartz-sericite schist; Lot 64, immediately

185 Quartz-sericite schist; same horizon as Sample J 13, but east of the latter on Lot 65.

196A Andalusite-sericite schist; north of the North Kaap River, and close to the Nelspruit Granite contact on the farm Riverside 245 JU.

From the anhydrous values (Table 3), the cation percentages, the catanorms, and the mesonorms were calculated. The partial analyses are listed separately (Table 3b) as are the modal analyses (Table 3c) of the two siliceous schists for which complete chemical determinations were made.

6. Origin of the Siliceous Schists

The origin of the siliceous schist horizons pose several problems, as the rocks seen in the field today have undergone extensive alteration from their original form. Metamorphism and structural disturbance have, in many instances, completely destroyed all evidence of the original mineralogical composition of the rocks.

As mentioned previously, siliceous quartz-sericite schist and aluminous schists have been located in a number of localities in widely separated parts of the Barberton greenstone belt. However, these rocks do not appear to be restricted to the Barberton area alone. Numerous reports of rocks answering to the description of these typical Al-rich siliceous schists are available in publications dealing with most early Precambrian or Archean successions, and particularly those of Western Australia, Rhodesia, and Canada. A study of the chemistry of these rocks shows immediately that they are particularly distinctive, being exceptionally rich in silica and alumina. Not infrequently, these two oxides together make up over 95 per cent of the total composition of the rock. In some cases the alkali elements, particularly K_2O, and the oxides of iron are the only remaining constituents of note.

The writer has, for the purpose of comparison, included a number of chemical analyses of metamorphosed siliceous schists from Western Australian greenstone belts as well as two from Rhodesian greenstone belts (see Table 4).

In Table 4a, the SiO_2, Al_2O_3, Fe_2O_3, K_2O, and Na_2O values have been abstracted from the total analyses to enable direct conparison to be made with the partial analyses listed in Table 3b, page 74.

TABLE 4

CHEMICAL ANALYSES : METAMORPHOSED ALUMINOUS QUARTZ-SERICITE SCHISTS FROM WESTERN AUSTRALIAN GREENSTONE BELTS

	1	2	3	4	5	6	7
SiO_2	82.74	80.52	75.35	82.30	70.76	74.28	71.24
Al_2O_3	14.84	12.68	11.35	16.50	14.83	21.91	19.58
Fe_2O_3	0.43	0.15	0.79	0.08	1.46	tr	0.76
FeO	-	0.86	1.76	0.10	3.09	0.54	0.26
MgO	abs	0.30	4.69	abs	1.99	0.33	0.46
CaO	0.09	0.03	tr	tr	0.36	0.12	0.07
Na_2O	0.40	0.42	0.30	0.18	0.47	0.38	abs
K_2O	0.26	3.66	2.06	0.12	3.50	0.30	5.62
H_2O+	0.17	0.87	3.10	0.48	2.70	0.51	2.27
H_2O-	0.03	0.08	0.10	abs	0.09	0.10	0.13
CO_2	-	0.02	0.03	0.01	-	0.02	-
TiO_2	1.33	0.28	0.51	0.23	-	0.10	-
P_2O_5	tr	0.01	0.07	0.08	-	tr	-
MnO	abs	0.08	0.12	abs	-	0.05	-
Totals	100.29	100.04	100.40	100.08	99.25	100.29	100.39

Description and locality of samples from Western Australia listed in Table 4 :

1. Andalusite-quartz schist Mt. Leonora, W.A.
2. Sillimanite schist. Westonia, W.A.
3. Quartz-mica schist. Mt. Kenneth, Yalgoo Goldfield, W.A.
4. Andalusite schist. Mt. Walton, W.A.
5. Quartz-sericite schist. Yilgarn Goldfield, W.A.
6. Andalusite schist. Yandanhoo Hills, W.A.
7. Sericite schist. Southern Cross, W.A.

Reference : Joplin (1963)

TABLE 4a

PARTIAL CHEMICAL ANALYSES : WESTERN AUSTRALIAN SILICEOUS SCHISTS

Sample No.	SiO_2	Al_2O_3	Fe_2O_3	K_2O	Na_2O
1	82.74	14.84	0.43	0.26	0.40
2	80.52	12.68	0.15	3.66	0.42
3	75.35	11.35	0.79	2.06	0.30
4	82.30	16.50	0.08	0.12	0.18
5	70.76	14.83	1.46	3.50	0.47
6	74.28	21.91	tr	0.30	0.38
7	71.24	19.58	0.76	5.62	-
Means	76.74	15.96	0.52	2.22	0.31

TABLE 4b

CHEMICAL ANALYSES : RHODESIAN SILICEOUS SCHISTS

	BR 6	BR 23
SiO_2	71.75	58.12
Al_2O_3	14.73	24.45
Fe_2O_3	0.97	1.31
FeO	1.38	1.00
MgO	1.75	2.85
CaO	0.82	0.23
Na_2O	3.48	0.40
K_2O	3.55	7.92
H_2O+	1.04	3.34
H_2O-	0.17	0.13
CO_2	-	0.03
TiO_2	0.25	0.13
P_2O_5	0.09	-
MnO	0.04	0.06
Totals	100.00	99.95

Descriptions and localities of samples from Rhodesia listed in Table 4b.

BR 6 Mica schist; Montezuma Mine, Odzi Gold Belt, Rhodesia.

BR 23 Mica schist; 1 mile west of Montezuma Mine, Odzi Gold Belt Rhodesia.

Reference : Swift (1956)

TABLE 4c

PARTIAL CHEMICAL ANALYSES : RHODESIAN SILICEOUS SCHISTS

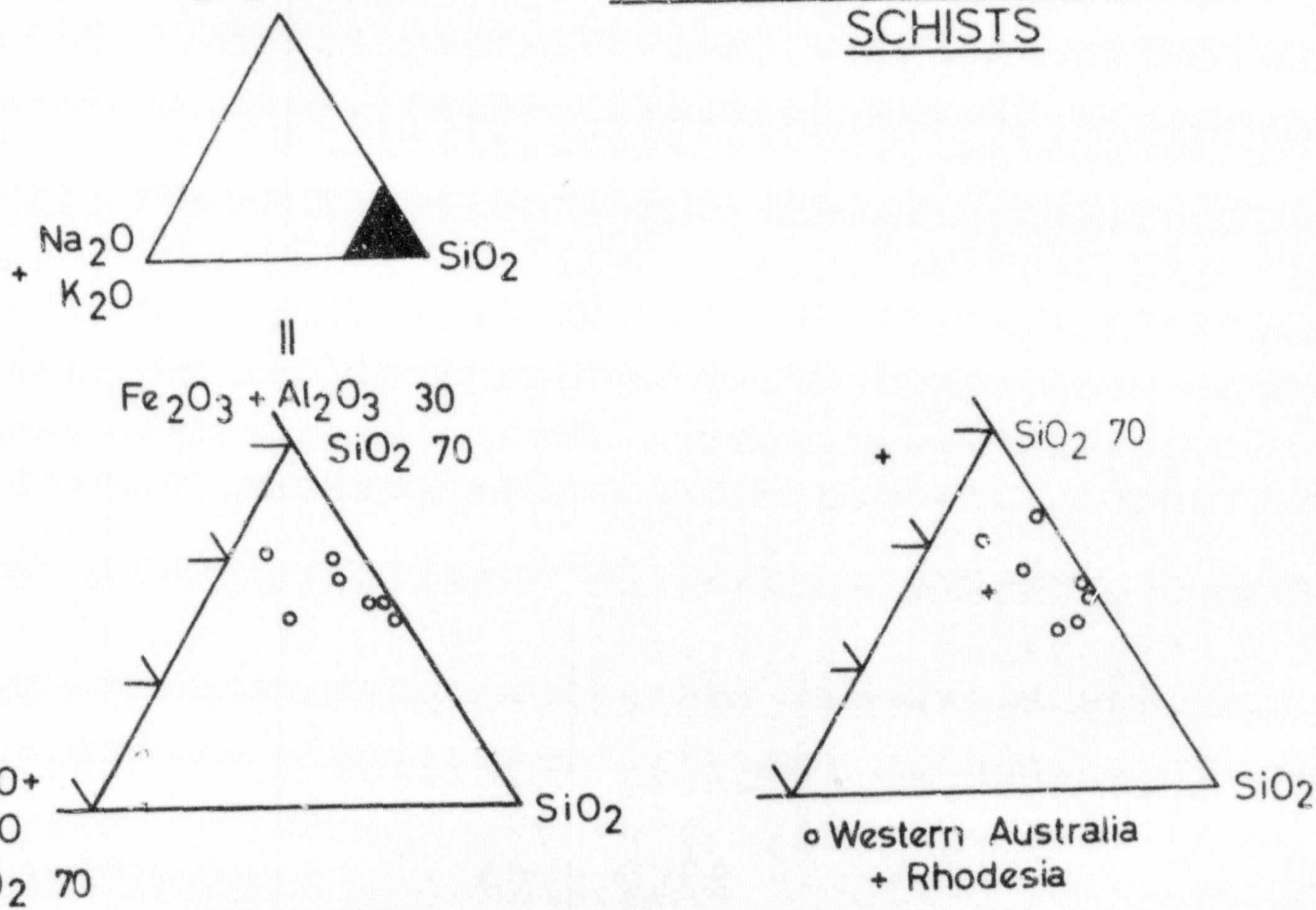
Sample No.	SiO_2	Al_2O_3	Fe_2O_3	K_2O	Na_2O
BR 23	71.75	14.73	0.97	3.55	3.48
BR 6	58.12	24.45	1.31	7.92	0.40
Means	64.94	19.59	1.14	5.73	1.94

Comparison of the mean values of SiO_2, Al_2O_3, Fe_2O_3, K_2O, and Na_2O in the Barberton and Western Australian greenstone belts (Tables 3b and 4a) shows a relatively high degree of correlation. This striking comparison is perhaps better demonstrated in a triangular diagram plot (Figure 6, page 80) of SiO_2 against the combined values of Fe_2O_3+Al_2O_3 and K_2O+Na_2O. Insufficient data is available from the Rhodesian greenstone belts but the analyses do show relatively high SiO_2 and Al_2O_3 values.

The distinctive chemistry of the Theespruit Formation siliceous schists as well as the many other similar schists found characteristically in the lower successions of early Precambrian greenstone belts suggests that these rocks formed as a result of almost identical circumstances. The writer (Anhaeusser, 1966A) first considered that these siliceous horizons in the Onverwacht Group originally represented acid extrusives such as tuffs or lavas, leptites, or even locally, some siliceous aluminous sediments. These various possibilities were suggested before the renewed mapping had shown that these rocks were intimately associated with the vast amounts of mafic volcanic material near the base of the succession. Viljoen and Viljoen (1967) subsequently considered these rocks to have originally been salic tuffaceous agglomerates. This conclusion was drawn following the discovery of some large, macroscopically visible, angular fragments of rock in less deformed and altered schist horizons in the Komati River Valley.

FIG. 6

METAMORPHOSED PELITIC(?) SCHISTS



BARBERTON

The fact that the quartz-sericite schists occur so frequently with unequivocal volcanic assemblages is strongly suggestive that they too are of volcanic or pyroclastic origin. A sedimentary origin for some of them cannot, however, be ruled out entirely and the use of the term "pelitic schist" in Figure 6 may be partially justifiable. It can be argued that the presence of chert with the siliceous horizons is suggestive of their having formed as a sediment. This may be partly the case as the tuffaceous material could, very likely, have settled in water which became supercharged with silica as a result of all the volcanism. During waning phases of volcanic activity some of the silica may have had time to settle out or precipitate as chert, only to be interrupted again by resurgent volcanic activity.

The original composition of the effusive, tuffaceous material must have been distinctive in order to produce the commonly encountered Al-rich siliceous schists. Just what the original material consisted of is virtually impossible to ascertain due to the extensive alteration suffered by the rocks during later metamorphic events. Even in relatively well-preserved regions of the Barberton Mountain Land the siliceous schist horizons retain their obscure identity. The writer suggests, however, that these rocks may be altered tuffs, similar to the altered tuff deposits that have given rise to the vast bentonite clay beds in North America, described by Ross, (1955). These bentonite beds are the result of decomposition of volcanic ash beds. Other forms of alteration include silication and argillation. The bentonitic clay, is largely composed of montmorillonite, which is essentially a hydrous aluminous silicate. Dana and Ford (1958) suggest the following formula for montmorillonite, $(Mg,Ca).Al_2O_3.5\ SiO_2.n\ H_2O$, with $n = 5\text{-}7$. The chemistry of such a bentonitic ash bed would thus be ideal for the subsequent production of a wide variety of aluminous metamorphic minerals, such as are found in the siliceous schist horizons of the Onverwacht Group. Felspathic tuffaceous ash beds would presumably give rise ultimately to the vast quantities of sericitic mica so characteristic of the quartz-sericite schist horizons.

7. 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 variety of mafic and ultramafic schists described earlier. The cherty horizons are best developed in the central and western parts of the Schist Belt (see Figure 4, page 54), but several horizons can be traced eastwards into the area between the Worcester Gold Mine and Noordkaap (see Figure 5, in pocket). Many of the horizons also have thin intercalated slaty shales and impersistent bands of black, carbonaceous chert. Several black carbonaceous chert samples were collected by the writer for Dr. K.A. Kvenvolden of the Exobiology Division of the Ames Research Centre, Moffett Field, California, who is investigating the possibility that these rocks may contain early life-forms. His study forms part of the National Aeronautics and Space Administration programme and he is attempting to collect and establish a comprehensive record of primitive organisms throughout geological time. Recently, alga-like forms in amorphous carbonaceous matter were reported from sedimentary rocks of the Onverwacht Group by Engel et al, (1968). These finds were made in the Komati River Valley in rocks similar to those found in parts of the Jamestown Schist Belt.

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, however, are not developed in the eastern part of the Schist Belt but occur prominently in the areas approaching the escarpment. The Geological Survey (Visser, compiler, 1956) regarded the cherty and slaty horizons, just mentioned, as comprising part of the Fig Tree assemblage. These, as well as the conglomerate rocks, which they classed with the Moodies Group, they regarded as representing xenoliths, preserved in the invading rocks of the Jamestown Igneous Complex. The writer could find no evidence to support this contention. It became clear that the rocks in the area represent part of a conformable, alternating, and strongly folded meta-volcanic and meta-sedimentary succession.

Reconnaissance mapping (Figure 4, page 54) indicated that several of these cherty horizons form 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 using the same method as that described earlier, viz. the chert cappings to the horizons. However, as these siliceous horizons are made up of an abundance of cherty material it is not always possible to make a decision as to what constitutes the chert capping. In adjacent meta-basalts N.D. Harte (personal communication, 1967) noted pillow structures which he found could be used to indicate the younging directions. However, the intensely folded nature of the successions, to which should be added the complicating factor of faulting, makes these determinations suspect.

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 is on the farm Waterfall 461 JT, with other occurrences 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. Due to their brittle, competent nature, many faults and fractures developed during the deformation, thereby providing favourable structures into which mineralizing solutions could migrate.

(ii) Komati Formation

Rocks, correlated by the writer as constituting part of the Komati Formation of the Onverwacht Group, occur in the central core of the eastern half of the Jamestown Schist Belt, between the Barberton-Nelspruit main road in the west, and Noordkaap in the east.

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 4 miles before it trails out into a mass of ultramafic schists. The southern limb can be traced for a distance of nearly 6 miles, 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 vast amount of generally serpentinized ultramafic rock, together with a great 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 do, 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 serpentinized ridges