From the pebble data collected in the area, an attempt was made to reconstruct or to ascertain the direction from which the material comprising the basal conglomerates (MdB) was derived. In Figure 24, page 212 the mean long axis of the 10 pebbles measured at each sample locality is listed in one column, while the long axis of the largest pebble, also from each locality, is listed in another column. In general, the mean long axis measurements of the pebbles from the area around the outer arc of the Eureka Syncline are either equal to, or less than, the mean long axis dimensions of the pebbles along the southern limb of the Eureka Syncline between Fig Tree Creek and Honeybird Creek. Similarly the long axis measurements of the largest pebbles from the southern limb are generally equal to, or longer than, the long axis measurements of the pebbles from the outer arc of the fold. It has already been demonstrated that the pebbles along the outer arc of the fold have suffered the most intense flattening, yet the elongated pebbles from these areas do not yield higher long axis measurement values than the pebbles from the relatively undeformed areas. It must therefore be concluded that even although deformation has affected the size and shape of the pebbles in the conglomerates, one can, nevertheless, obtain some indication of the original dimensions of the constituents prior to the tectonic overprint.

Bearing in mind the limitations of sampling, and the density of observations, the writer considers that the data available indicates that the material comprising the Moodies basal conglomerate was brought into the basin of deposition mainly from the southeast or east-southeast. However, it would seem that sediments were also being derived from the northern and northwestern regions because the conglomerates developed along the outer arc of the Eureka Syncline appear to contain more granitic and quartz and felspar porphyry material than do the conglomerates from the southern limb. This statement is, however, based purely on the writers' visual impressions, there being no quantitative or modal analysis available of the various components of the conglomerates.

G. MINERALIZATION IN THE EUREKA SYNCLINE

Although a large number of gold workings occur in the Eureka Syncline only a few of them are at present being mined. All of the reefs currently being exploited form sections of either the Fairview or the Sheba Gold Mines, and occur on the inner arc of the Eureka fold. The localities of most of the more significant mines are plotted on the geological map of the Sheba Hills (see Figure 13, in pocket). All of the known mineral deposits in the Eureka Syncline owe their origin to structural control with faulting, in particular, playing the dominant role in determining the locations of the ore bodies. In an earlier section dealing with faults it was shown that a great number of radial tension fractures occur right the way around the arcuate structure. It is in most of these tension fractures that gold-quartz veins have been exploited in the past.

Also associated with the arcuation of the Eureka Syncline are numerous fractures that roughly parallel the Sheba Fault. These occur mainly on the southern and eastern limbs of the Eureka fold, particularly in the core of the structure between the Fairview Mine and the Sheba group of mines. The origin of these fractures has already been explained as being due to concentric shearing, resulting from strike-slip movements between the folded bedding units. The concentric shear surfaces, coupled with overthrust movements from the southeast, produced suitable structures that were subsequently invaded by hydrothermal mineralizing solutions containing essentially free gold and vein-quartz, with only small amounts of sulphide material.

Almost every mineralized deposit in the Eureka Syncline is to be found in the hard, competent quartzite horizons, where faulting and fracturing is best developed. Mining operations in the Fairview Mine have shown that fractures, strongly developed in the quartzites, do penetrate into the surrounding shale horizons but that invariably, they are hairline-breaks occupied, only sometimes, by thin quartz stringers that are generally poorly mineralized (van Rensburg, verbal communication).

(a) Mineralized Occurrences on the Outer Arc of the Structure

Only a few mines occur around the outer, or convex, edges of the Eureka Syncline, the largest being the Clutha Gold Mine southeast of Noordkaap. The mine consists of four separate workings. The main fractures in the Central Section are bedding plane shears in slaty quartzite (MdQ1). In addition there are numerous oblique shear fractures that are well-mineralized. These fractures generally make acute angles of 30°-45° with the main bedding shears (Strauss, 1948). The movement direction of the shears may have had a vertical component, but it is clear from drag and displacement of other fractures and dykes that horizontal movement was the most important. The bedding plane shear locally referred to as the "Clay Seam" extends throughout the length of the mine in a NE-SW direction and dips steeply to the southeast. Oblique fractures diverging from this parent shear generally localized the gold at the intersection of the fractures. The intersection of the two fracture planes create linear ore-shoots in which quartz, free gold, and arsenopyrite occur together. Away from the fracture intersections mineralization rapidly dies out.

The Belfast and Republic Gold Mines occur near the Fairview Mine offices in shear zones parallel to the bedding in the MdQ3 quartzite horizon, while just south of Joe's Luck Siding is situated the Thistle Gold Mine at the contact between the calcareous quartzite (MdCq) and the felspathic quartzite (MdQ1). All these mines just mentioned, as well as the Woodstock, Victoria and Mazeppa workings are situated adjacent to, or within short distances from, the major Lily Fault.

(b) Mineralized Occurrences on the Inner Arc of the Structure

Most of the remaining mines in the Eureka Syncline occur on the southern or eastern limbs of the structure. Away from the fold axial plane there is a progressive increase in the number of mineralized occurrences towards the Sheba Fault. In the MdQ3 quartzite horizon no notable gold deposits have ever been found. In the MdQ2 quartzite, mines of note, extending from south to north, include the North Star, Victory Hill, Thomas, and Joe's Luck, while in the MdQ1 quartzites, between the Fairview Mine and Fig Tree Creek, there are a great number of scattered workings. In this area some of the more important mines include the Golden Quarry, Bonanza, Lochiel, Great She, and Margaret, the two last-mentioned still being mined on a small-scale. In addition a great number of tension fractures are being worked as part of the Fairview Mine. Of the last-mentioned group, the Kimberley-Sheba, Strydom, Blue Rock, Kidson, Little Kent and Equifa reefs, to name but a few, all occur in the hard massive Moodies quartzites adjacent to the Sheba Fault.

The Golden Quarry, one of the "fabulous finds" of the early gold rush days, occurs just adjacent to the Sheba Fault and was mined in later years as part of the Sheba Mine. In the area of the Golden Quarry numerous workings are to be found. Some of the main deposits include the Nil Desperandum, Oriental, Annie's Fortune, Mamba, Margaret, Tit Bits, Eureka, King Solomon's Mines, and Agatha workings. The region where all these mines occur has suffered possibly the greatest amount of structural disturbance in the entire Eureka Syncline. The Sheba Fault caused considerable disruption of the successions very early in the history of the area. Subsequently, during the arcuation of the Eureka Syncline the inner arc was subjected to intense compression as well as thrusting from the southeast, as arcuation and overriding of the Ulundi Syncline progressed. The Sheba Fault underwent several phases of reactivation, there being evidence of thrust and wrench faulting in addition to the numerous second-order structures that can be ascribed to the parent dislocation (Anhaeusser, 1965).

Away from the Sheba Fault, yet presumably still strongly influenced by it, is the Bonanza Gold Mine. The geology of the mine, which occurs along a shear zone that parallels the strike of the MdQl quartzites for several miles, has been described in detail by van Vuuren (1960), and Voges (1961). Considerable structural disturbance has been caused between two parallel longitudinal faults that are linked by second-order flat fractures. The mineralization, which consists essentially of quartz, gold, arsenopyrite, and pyrite, occurs in and adjacent to the fractures. A similar shear zone, to the south-east of the Bonanza workings, is responsible for the location of the Lochiel Gold Mine.

In the formations of the Eureka Syncline to the east of Fig Tree Creek there are no known occurrences where gold has actually been mined, although there are numerous prospect shafts and trenches throughout the entire region.

* *

CHAPTER 6

FACETS OF THE GRANITIC ASSEMBLAGE ON THE NORTHWEST FLANK OF THE BARBERTON MOUNTAIN LAND

A. INTRODUCTION

Granitic rocks form an integral part of the geology of the Barberton Mountain Land, being directly responsible for many of the profound changes that have taken place throughout the geological history of the area. It was for this reason, therefore, that attention was paid to the granitic assemblages along the northwest flank of the early Pre-cambrian greenstone belt. A review of previous work on the granites of the Barberton Mountain Land, and, in particular, the area north of Barberton, has already been outlined in Chapter 1, so that only the new findings will be presented in the following sections. The granites are now classified in accordance with their tectonic style, together with their macroscopic, microscopic and petrochemical characteristics.

B. THE NELSPRUIT GRANITE

(a) The Louw's Creek-Consort Mine-Kaapsehoop Granite Contact

The granites along the contact with the supracrustal rocks of the Swaziland Sequence, between the Consort Mine and Louw's Creek, have been divided into two characteristic types (Anhaeusser, 1964; 1966A; and Viljoen, 1964). These are firstly, a migmatitic- or gneissic-type the dominant variety, and secondly, a homogeneous type of granite, intrusive along the immediate contact zone as well as present throughout a widespread area north of the contact. The intrusive granites have been subdivided into foliated granites, and pegmatitic and aplitic granites.

(b) Migmatitic and Gneissic Granites

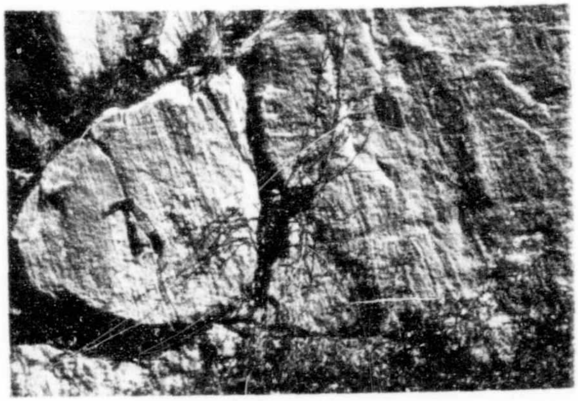
These rocks are essentially light-grey, biotite-rich granites or granodiorites with gneissic banding invariably highly contorted and folded. There is, however, a tendency towards parallelism of the axial planes of the flowage folds in some localities, particularly as the granite contact zone is approached (see Plate 17A, page 218). Although van Eeden (1941) noted the occurrence of numerous bodies of dark amphibolite, well within the granite outcrop area, no such xenoliths were encountered in the contorted gneisses of the area examined. Instead, the hornblende amphibolite xenoliths are always surrounded by a homogeneous intrusive granite-type.

Not much is known about the complex migmatite and homogeneous granite terrain as no specific study of the area has yet been undertaken. The writer has, however, carried out a limited amount of reconnaissance work in the area. Generally, the migmatites and gneisses are heterogeneous rocks and include a number of phases varying considerably in texture and composition. In the Krokodilpoort hills the migmatites are not continuously developed throughout the entire area but occur as patches, surrounded and intruded by more homogeneous, leucocratic granites. Absolute ages of 2.99 ± 0.07 b.y. were obtained by de Gasparis (1967) for the Nelspruit migmatites, using the Rb-Sr total rock method. His sampling of the Nelspruit Granite terrain was directed at collecting as many different rock phases as possible, and for the final isochron, he used samples comprising migmatites, homogeneous contact phase granites, pegmatites, and a sample containing a felsic band with a "basic behind". The geochronological studies were unsuccessful in delineating possible differences in age between the migmatite, the contorted phase granites, or the pegmatites. Allsopp et al, (1968) also showed that the pegmatite data from the Consort Mine area yielded a Rb-Sr total rock minimum age of 3.00 ± .03 b.y.

PLATE 17

A

B



A. Strongly contorted migmatite or banded gneiss from the Nelspruit granite-gneiss terrain to the northwest of the Barberton greenstone belt. Darker, femic bands, consist predominantly of biotite and quartz, while the lighter coloured, felsic bands, consist of quartz, microcline, albite-oligoclase and some biotite.

B. Strongly foliated Kaap Valley Granite exposed along the Barberton-Havelock road near the schist belt contact. The hornblende granodiorite, or tonalitic diapiric pluton, generally displays a foliated and lineated peripheral contact phase with the enveloping schists. Mafic 'schlieren' (amphibolite) in these plutons are commonly found aligned parallel to the granite foliation and contacts.

C

D

C. Basin structure in Moodies shales and sub-greywackes of the Eureka Syncline, exposed on the road to the top section workings of the Fairview Gold Mine. Minor structures such as these are produced as a result of the interference of two sets of minor folds.

D. Dome-like structure in Moodies sub-greywackes near the top section workings of the Fairview Gold Mine, Eureka Syncline. Interfering dome and basin structures are produced by the superimposition of two generations of minor folds. Crossing anticlines produce dome-like structures while intersecting synclines form basins (Ramsay, 1963).

De Gasparis (1967) did, however, detect a marked difference in the Rb/Sr ratios between the migmatites and the contact phase granite. The reason for this might be related to a compositional variation noted by the writer, who found an increase in the ratio of potash to sodium felspar in the contact zone at Honeybird Siding (see later, page 225), and who proposed (Anhaeusser, 1966A) that the contact phase represents a late phase of the granitization cycle.

(c) Homogeneous Intrusive Granites

Along the immediate contact zone, there occurs a relatively narrow belt of granite, often intensely sheared, and clearly intrusive into the stratigraphic successions of the Swaziland Sequence. The actual width of this zone is very variable, and difficult to demarcate precisely, but, on average, it appears to be about 1,200 feet wide. Later pegmatite and aplite veins and bodies, are intruded into this granite, as well as into amphibolite xenoliths, and the contact amphibolite schists.

Further north, the Nelspruit migmatite-gneiss terrain also contains scattered patches of homogeneous granite but as the area has not been mapped the relative abundance, or the distribution, of this granite phase is not known. The homogeneous phase, from reconnaissance investigations, appears to build some of the more elevated terrain and in this respect may represent remnants of a possibly equivalent granite phase seen in the Badplaas-Lochiel-Oshoek area, southwest of the Barberton Mountain Land, and in the northwestern portion of Swaziland. In the Lochiel area, a homogeneous granite forms a "hood-zone" that caps the complex granite-gneiss terrain in the region and constitutes the elevated Lochiel plateau (Viljoen and Viljoen, verbal communication). In Swaziland, Hunter (1961, 1965) showed that a similar homogeneous granite (G4 or late-orogenic granite) is mostly confined to the highveld regions where it represents a hood, or sheet, generally giving way vertically downwards to a zone of nebulites, that is, in turn, underlain by gneissic granites.

(d) Foliated Granite

The granites are well-foliated along the immediate contact zone. The strong foliation planes are always parallel to the contact, and are invariably parallel to xenoliths which occur frequently within this granite. There is always a very sharp contact between the intrusive granitic and pegmatitic tongues, and the dark amphibolites. Viljoen (1964) distinguished two fairly distinct types of foliated granite. Firstly, a grey, well-foliated and often strongly lineated variety, which almost appears to be a fine-grained type of gneiss, and secondly, a porphyritic variety in which large, often rounded, felspar phenocrysts occur in a crystalline groundmass that has suffered intense shearing and mylonitization.

Practically all the mineral constituents in the granites of the contact zone are elongated, and aligned parallel to the foliation. Phyllosilicates (biotite and muscovite) sometimes occur in thin bands that give the intrusive material a distinctly gneissic appearance. Ferromagnesian minerals occur only sparingly and the granites are predominantly leucocratic, being rich in potash felspar (microcline, orthoclase, perthite).

The granite contact along the northern edge of the Jamestown Schist Belt, west of Noordkaap, exhibits many characteristics identical to those displayed in the area to the east of the Consort Mine area. The granites have a relatively narrow intrusive border-phase consisting of a strongly foliated, somewhat gneissic granite. In thin section, there is a strong alignment of minerals, particularly the phyllosilicates, muscovite and biotite (see Plate 19C, page 233). In some places the foliation is not evident and the rock is relatively homogeneous. No lineated contact granites were observed. Reconnaissance investigations northeast of Kaapsehoop indicated that there is a considerable amount of homogeneous granite present in the area. Gneissic granites, nevertheless, predominate and are invaded by several generations of pegmatitic and granitic material. The homogeneous material frequently occurs as narrow bands, often injected concordantly into the gneissic layering. The granitic fluids, in places, appear to have aided the assimilation of gneissic material and large areas consist of semi-homogeneous granites, containing partially digested gneissic material. Some of the homogeneous leucocratic granite probably represents completely altered gneisses.

In the area immediately north of the Schist Belt near Kaapsehoop, the Nelspruit Granite appears to be mainly a homogeneous-type, and at times resembles some phases of the Kaap Valley Granite. Outcrops seen in a road cutting between Kaapsehoop and Nelspruit display a homogeneous, weakly foliated granodiorite, containing numerous basic (amphibolitic) inclusions very much akin to the amphibolitic "schlieren" that occur prominently in the Kaap Valley Granite. The inclusions, unlike those in the Kaap Valley diapiric pluton, are not aligned but instead occur as randomly orientated xenoliths (see Plate 18D, page 222).

(e) Pegmatites and Aplites

Apart from narrow veins and dyke-like sheets, large pegmatite masses occur as irregular bodies of varying size. There is an abundance of intrusive, coarse-grained, granitic and pegmatitic material in the Joe's Luck area, and further west, in the valley of Dicey's Creek. In addition, large coarse-grained pegmatite bodies occur in, and around, the Consort Mine area. To the east, however, between Joe's Luck Siding and Louw's Creek, massive pegmatitic bodies were not encountered. Here, the pegmatite occurrences are mainly confined to small intrusive masses, and more particularly, to veins and dykes.

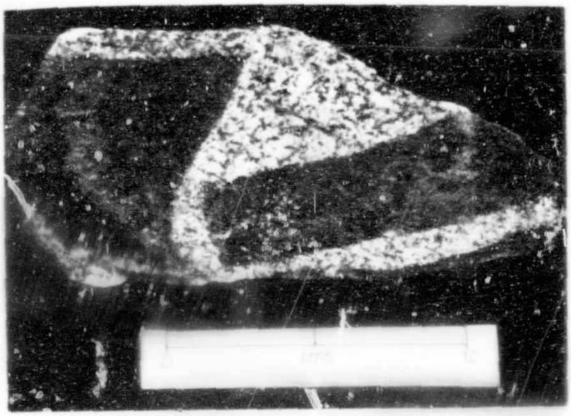
In the area northwest of Noordkaap, essentially the same characteristics were noted, viz. that the pegmatite occurrences, of the type found at the Consort Mine, were not developed more than about a mile to the west of the mine itself. Smaller veins and cross-cutting intrusive pegmatitic dykes do, however, occur along this contact. It can be seen, therefore, that most of the large bodies of very coarsely crystalline pegmatite appear to be localized, or confined to, an area north of the Eureka Syncline where, probably, the most intense fold deformations of the entire Barberton Mountain Land took place. It is in this area too, that the Consort Gold Mine, one of the richest and oldest mines in the entire district, is located.

It would appear that there is a relationship between the degree of deformation of the stratigraphic successions north of Noordkaap, and the occurrence of massive pegmatite bodies of the type described earlier. In addition, there is a clearly established relationship between the mineralization, and the structural deformation in the Consort Mine. Leading from these two premises, the possibility arises that there may be some relationship between structure, mineralization, and the granite and pegmatite intrusions in this area. It is significant that no additional gold mineralization of economic importance has yet been found elsewhere along the granite contact, either to the west or to the east of the Consort ore-body. This lack of mineralization may reasonably be explained by the non-development of one or more of the controlling factors listed above.

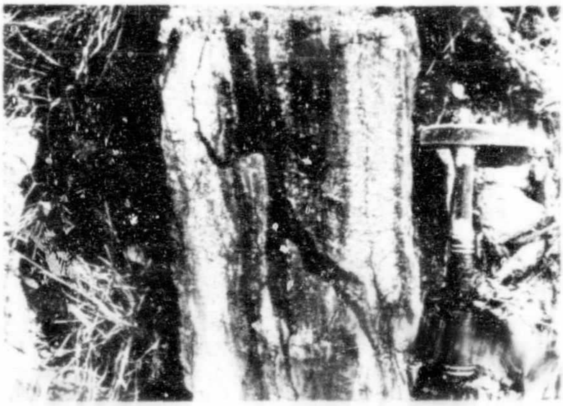
In the Consort Mine the pegmatites clearly intrude the Onverwacht and Fig Tree strata and also transect the mineralized Consort "Contact" (Gribnitz, 1964). Five muscovite bearing pegmatites cut across and displace the ore-bearing rocks. The widest pegmatite measured is about 300 feet across, and all the bodies strike NE-SW and dip towards the northwest at approximately 80 degrees. Allsopp et al, (1968) carried out Rb/Sr isochron dating of a large number of samples of these pegmatites and established a "most reliable" age of 3.00 ± 0.03 b.y. These authors also found evidence, however, of a 500 m.y. younger event when they obtained an isochron age of 2.48 ± 0.03 b.y. for biotite-tremolite schists, also in the Consort Mine. These lower ages of ~ 2.5 b.y. are interpreted as evidence of widespread Sr isotope mobility due to heating and/or hydrothermal activity associated with the last recognizable granite cycle in the area, with which was associated the emplacement of the M'pageni Granite pluton.

PLATE 18

A



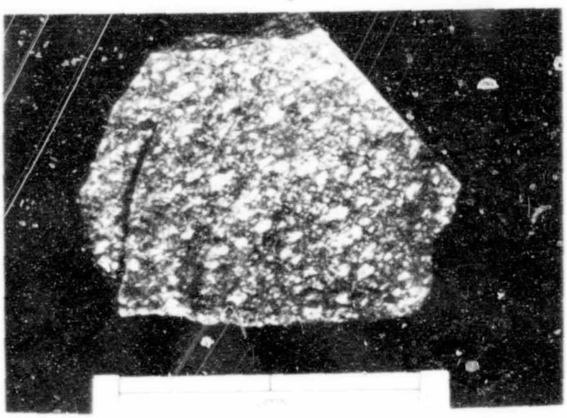
B



A. Specimen showing the intrusive, cross-cutting relationship of the Kaap Valley Granite with dark hornblende amphibolite from the farm Thornylea 588JT, southeast of the Worcester Mine.

B. Outcrop displaying 'lit-par-lit' injection of Kaap Valley Granite into the amphibole schists of the Onverwacht Group, west of Caledonian Siding.

C



D

Quartz-felspar porphyry showing an alignment of felspar phenocrysts. Specimen obtained from a porphyry body intruded into differentiated ultramafic and mafic assemblages on the farm [illegible].

Amphibolite inclusions randomly orientated in a relatively homogeneous phase of the Nelspruit Granite. Locality - Kaapsehoop-Nelspruit road, north of the Jamestown Schist Belt.

Thus the pegmatites are generally the youngest granitic rocks, and are found cutting the gneissic granite and the foliated intrusive granite. Several ages of pegmatites were noted. Very coarsely crystalline pegmatites often transgress earlier formed, more finely grained pegmatite bodies, and the majority of them generally consist of the following mineral combinations :

quartz-albite-microcline-orthoclase

or

quartz-albite-muscovite-microcline-orthoclase

Partial analyses (K_2O and Na_2O) of two pegmatites from the Consort Mine are listed in Table 22(d), page 249.

Aplites are less common than pegmatites and only occur as narrow veins and dykelets. They too, are confined to the immediate contact zone. The aplites, generally composed of quartz and oligoclase, with small biotite shreds, are invariably fine- to medium-grained and usually have a light-grey to yellowish-white colour. There are indications also, of strong shearing and mylonitization associated with these rocks. Locally there may be some alaskitic veinlets, together with granitic material containing only minor amounts of ferromagnesian minerals.

(f) Granite Structure

The most striking feature occurring in all the intrusive metagranites is the very strong foliation, always parallel to the metamorphosed layered sequence to the south. The foliation appears to be due, partly, to the strong alignment of mineral components under high pressure during cooling, coupled with a later, very intense, dynamic shearing event. The latter, led to a mechanical grinding up of the granitic material and must have occurred mainly after crystallization. The granites show a strongly preferred mineral orientation with the phyllosilicate constituents all lying parallel to the strong foliation.

The foliated granite itself, has been strongly folded and lineated. Excellent exposures of well-lineated, intrusive granite, can be seen at two places along the Kaap River. The first of these outcrops immediately north of the Joe's Luck Siding rail bridge (Viljoen, 1964), while the second is located at the road bridge near Honeybird Siding. Folding of the intrusive granites can also be observed at this locality (Anhaeusser, 1964). The lineations in the granites are clearly associated with minor fold axes and occur within a strong axial plane foliation. Once again, it is only in the contact granites that lineations are seen, and it would appear that their formation was connected with a process of mechanical deformation, which must have taken the form of intense shearing. This was apparently superimposed on a pre-existing schistosity, or primary foliation, formerly present in the granite. Mylonitization processes were also operative, and in many cases "augen" structures were noted in the sheared and deformed granite.

Viljoen (1964), visualized the entire process of deformation of the contact granites as being essentially a dynamic event which took place under "cold" conditions. He considered that although the newly intruded granitic material must have been under a fairly high temperature when the dynamic metamorphism was initiated, it was not in a plastic state. Both Ramsay (1963A) and Viljoen (1964), found evidence that the sheared and mylonitized granites themselves had been strongly folded by Ramsay's F3 deformation (the Consort Trend). The production of the mylonitic fabric, however, is believed to have been a late deformational event, synchronous with the development of axial plane cleavage of the folds in the intrusive contact granites. The writer (Anhaeusser, 1964), was able to establish that the fabric in the mylonitic granites in the Honeybird Siding area differed from Ramsay's F2 fabrics, whereas in the areas to the west of here, the F2 fabrics were deformed by the Consort fold trend (Ramsay's F3 deformation).

Ramsay (1963A) considered there was a strong argument suggesting that the granite emplacement, and the production of the fabric, were related in time. This he believed because of the structural conformity of the slaty cleavage with the schistosity in the phyllites, and even within the granites themselves. Events are considered, however, to have been broadly synchronous at this time because there is evidence, north of Eureka Siding, of a granitic or aplitic vein cross-cutting and, therefore, post-dating the lineations occurring in a quartz-sericite schist horizon (Anhaeusser, 1964). These lineations were probably formed early on in the history of the granite emplacement, and the vein seen intruding the quartz-sericite schist very likely represented a later-phase intrusive. A further late-phase event was probably manifest in the folding of the granites along the contact. This folding, clearly seen in the Kaap River cutting near Honeybird Siding, was responsible for the production of lineations that appear to be confined solely to the contact zone. The folding, seen here, is thought to have been produced in the granites and amphibolites while the intrusives were in a semi-plastic state.

(g) Potash-Soda Relationships of the Nelspruit Granite near Honeybird Siding

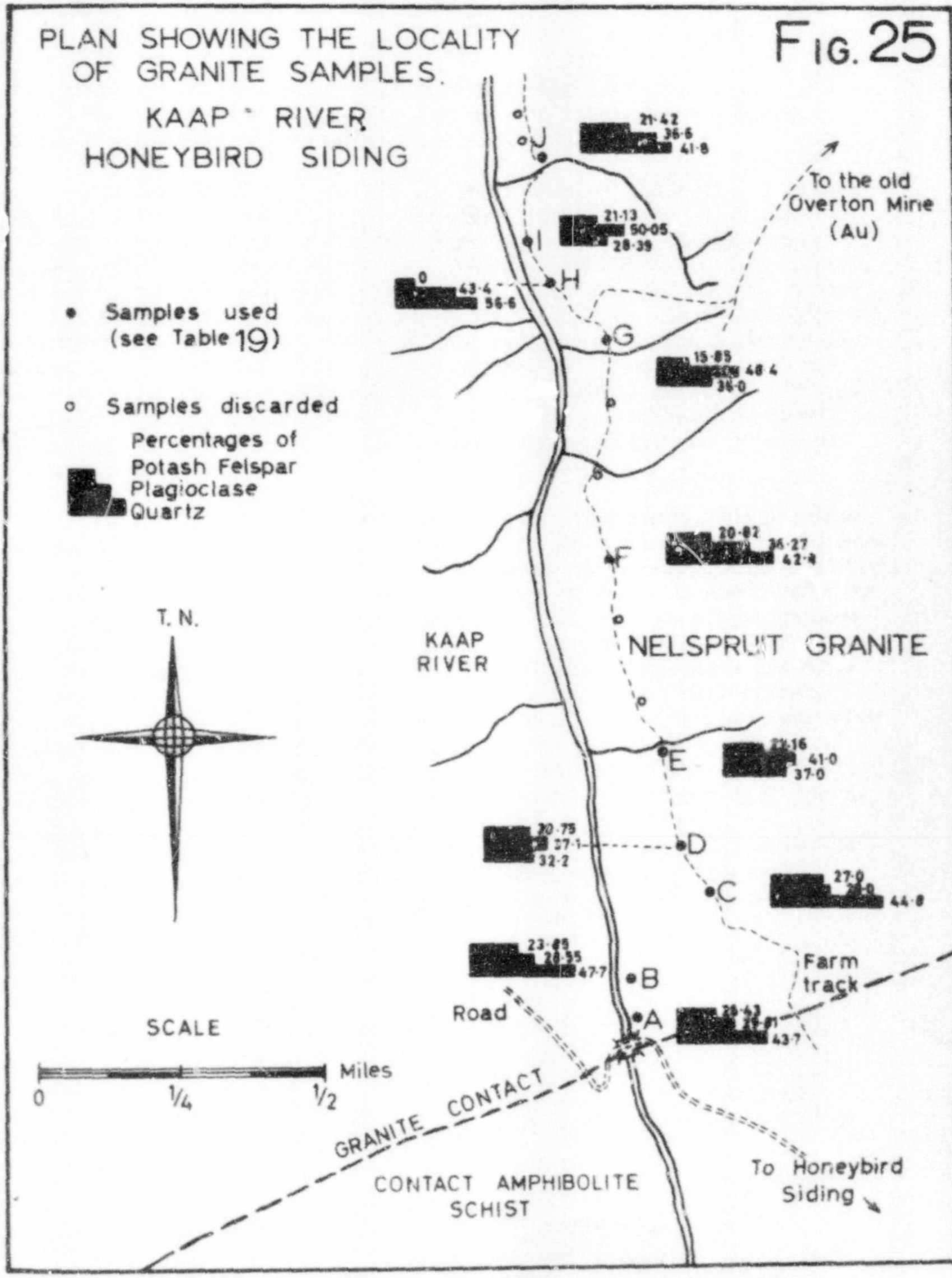
During the examination of thin sections of the Nelspruit Granites, it was noticed that there existed an apparent increase in the amount of microcline felspar in the granites bordering on the contact. In order to gain some quantitative data on the relative percentages of the soda- and potash-felspar content of the granites, a traverse, extending approximately two miles northwards into the Nelspruit Granite, was undertaken along the Kaap River near Honeybird Siding. Samples were collected at approximately 600 feet intervals. In selecting each sample, an attempt was made to obtain a specimen that could be regarded as "average" for the particular locality. This was not always easy in the strongly gneissic granites where variations in composition were found to be manifest, even over short distances. However, the samples finally chosen were considered to be broadly representative of each area.

Thin sections were prepared from the specimens collected and, in addition, slabs of the granite were cut and stained after methods described by Chayes (1952), and Bailey and Stevens (1960). These methods selectively stain potash felspar yellow, and plagioclase red, enabling a modal analysis to be undertaken with comparative ease. After staining the slabs, the surfaces were sprayed with a protective coating of clear plastic. The counting of the various constituents in the granite was aided by sticking a fine dot pattern on "Zip-A-Tone" transparent material to the surface of the slabs.

The method of computation was similar to that described by Chayes (1949), but instead of small blocks on a superimposed grid, the dot pattern was found to be more effective. In this way, the slab under investigation was covered by a bilaterally symmetrical grid of points 0.22 mm apart. Examination was carried out under low-power magnification with a binocular microscope, and for each slab, over 1,500 points were used in the calculation of the relative percentages of the three most important constituents, viz. potash felspar, plagioclase, and quartz.

Of the initial 17 samples collected, only 10 were finally used in the analysis. These were selected because of their ability to accept a good stain, and also for the uniformity of grain-size. All the samples analysed could be classed in the medium-to-fine grain-size category, with individual grains seldom exceeding 3 mm. in diameter. The elimination of the remaining samples did not affect the overall distribution along the two mile traverse (Figure 25, page 226) and the slabs examined were regarded as representative of the changes that ensue

Fig. 25


PLAN SHOWING THE LOCALITY OF GRANITE SAMPLES.
KAAP RIVER
HONEYBIRD SIDING
Samples used (see Table 19)
Samples discarded
Percentages of
Potash Felspar
Plagioclase
Quartz
T. N.
SCALE
Miles
0
1/4
1/2
To the old Overton Mine (Au)
KAAP RIVER
NELSPRUIT GRANITE
Farm track
Road
GRANITE CONTACT
CONTACT AMPHIBOLITE SCHIST
To Honeybird Siding
J
21·42
36·6
41·8
I
21·13
50·05
28·39
H
0
43·4
56·6
G
15·85
48·4
36·0
F
20·82
36·27
42·4
E
41·0
37·0
D
20·75
27·1
32·2
C
27·0
44·8
B
23·85
28·55
47·7
A
43·7

in the granite with increasing distance from the contact. The thin sections were used as a guide, and a check, on the results obtained from the counting of the constituents in the slabs.

As mentioned earlier the granites consist primarily of potash felspar, plagioclase and quartz. All other constituents occur only in accessory amounts and generally include one or more of the following minerals : phyllosilicates (biotite, sericite, muscovite, and chlorite), magnetite, ilmenite, and leucoxene, sphene, apatite, and zircon. From the results obtained near Honeybird Siding (see Table 19) it is apparent that a trend exists whereby the granites and gneisses show a progressive increase in the potash content as the contact is approached. All the granite samples examined from the Kaap River traverse revealed twinned- and untwinned-plagioclase felspar, ranging from oligoclase to albite in composition. Specimen H, a well-developed augen-gneiss, contained no obvious potash felspar.

Read (1957) showed that autochthonous and migmatitic granites were soda-dominant types, often granodioritic in character, with abundant oligoclase, whereas later granites of the same cycle were potash-dominant, with microcline in abundance. He quoted several examples where this was found to be the case, viz. Drescher-Kaden (1926), who long ago compared the soda-dominant 'injection-rocks' with the potash-dominant intrusives in the Friedeberg mass. Eskola (1914) showed that oligoclase granites were followed by microcline granites of the coast type, while Niggli (1946) found essentially the same features in classic Finnish areas with the granites again showing increasing alkalinity with time. Backlund (1943) elaborated the general rule and demonstrated in the Urgranites, a range of composition varying from granodioritic for the oldest rocks, to younger granites richer in potash. In the higher levels, the migmatitic aspect of the granite was found to be much reduced when the younger granite formed stronger mobilized intrusions. Still later granites, such as the Rapakivi, were found to be even richer in their potash content.

(h) Chemical Data

No new analyses are available for the granite, gneiss, and migmatite terrain north of Barberton. In Tables 21 and 21a, page 241 the existing chemical analyses and norm calculations (Visser, compiler, 1956, and van Eeden and Marshall, 1965) are listed for comparative purposes. Several partial analyses (K_2O and Na_2O) are listed in Table 22(b), page 248.

TABLE 19

TABLE COMPARING THE RELATIVE PERCENTAGES OF POTASH- AND SODA-FELSPAR WITH INCREASING DISTANCE FROM THE CONTACT ALONG THE KAAP RIVER, NEAR HONEYBIRD SIDING

Sample	Distance from Contact	Percentage Potash Felspar	Percentage Plagioclase Felspar	Percentage Quartz	K/Na Ratio
A	Immediate contact	26.43	29.81	43.70	0.88
B	100 yards north of A	23.85	28.55	47.70	0.83
C	0.25 miles north of contact	27.00	28.00	44.80	0.96
D	0.33 miles north of contact	30.75	37.10	32.20	0.83
E	0.50 miles north of contact	22.16	41.08	37.00	0.54
F	0.75 miles north of contact	20.82	36.27	42.80	0.57
G	1.25 miles north of contact	15.85	48.40	36.00	0.33
H	1.33 miles north of contact	---	43.40	56.60	0.00
I	1.50 miles north of contact	21.13	50.05	28.39	0.42
J	1.66 miles north of contact	21.42	36.60	41.80	0.58

C. KAAP VALLEY GRANITE

(a) Barberton-Caledonian Siding Area

The Kaap Valley Granite outcrops only sporadically along the six mile contact with the basic schists of the Swaziland Sequence between Barberton and Caledonian Siding. The best field relationships for the entire zone can be found along the South Kaap River, on Claremont Vale 312 JU, and in the area due east of Caledonian Siding, where fresh granite exposures can be studied in relationship to the Onverwacht schists, into which the former intruded.

Willemse (1937) referred to this granite as a quartz diorite and later the Geological Survey (Visser, compiler, 1956) defined it as a granodiorite. The writer suggests, however, on the basis of a classification scheme to be outlined later, that the Kaap Valley Granite be termed a tonalite. Petrographically the granite is a medium- to coarse-grained, even-textured, homogeneous rock with the principal rock-forming minerals being felspar, quartz, and hornblende. Accessory minerals usually include magnetite, pyrite, sphene, apatite, biotite, chlorite and zircon.

The granite is not everywhere in a good state of preservation, and very often chlorite, derived from the alteration of green hornblende and biotite, occurs as the principal femic mineral. The granite in the Caledonian Siding area is a coarse-grained, mottled, green and white rock consisting mainly of green hornblende, often altered almost entirely to green penninite chlorite, albite-oligoclase plagioclase, and large interlocking quartz crystals with accessory amounts of magnetite, zircon, and sericite, derived from the saussuritization of the felspars. In addition, there is often a considerable amount of carbonate present in the contact granites. This carbonate is considered to be mainly of a secondary nature and was probably introduced after the granite had consolidated. The carbonate is assumed to have been derived from the Onverwacht Group rocks along the contact zone.

The Kaap Valley Granite along the Barberton-Caledonian Siding contact, does not display cross-cutting intrusives relationships with the schists but, instead, exhibits a kind of 'lit-par-lit' injection parallel to the contact and conformable with the foliation or schistosity of the adjacent basic assemblages (see Plate 18B, page 222). The contact granite shows the same coarse texture seen elsewhere in the pluton, and has no obvious chill-phase.

Structurally the granite is interesting, for, apart from the strong foliation in the immediate environment of the contact (see Plate 17B, page 218), there is also a strong mineral lineation (see Plate 13A, page 183). This lineation plunges north at approximately 50 degrees, and lies in the plane of the foliation. The attitude of the lineation is identical to a similar lineation in the neighbouring schists, and to a marked pebble elongation in the basal conglomerate of the Moodies Group.

The Geological Survey (Visser, compiler, 1956) reported that on the farm Bickenhall 346 JU, several small bodies of Kaap Valley Granite intrude the basic rocks as well as the sediments of the Moodies Group. Thin section study of the bodies found within the Eureka Syncline revealed, however, that the rocks were entirely structureless masses, with a composition approaching a quartz-diorite. In all these bodies, granophyric textures were noted. The rocks consist essentially of relict-hornblende crystals, mainly altered to chlorite, andesine, biotite, apatite, sericite, and quartz. Graphic intergrowths of quartz, and felspar were also observed. One body, in particular, was interesting in that the quartz-diorite and granophyric fraction appeared to be the acid differentiate of a massive basic dyke. The dyke has a variable composition ranging from a peridotite (containing mainly olivine and some accessory amounts of quartz, carbonate, sericite, magnetite, and some alteration products of olivine, viz. iddingsite and serpophite) to an olivine gabbro (containing labradorite, ortho- and clino-pyroxene, olivine, apatite, quartz, magnetite, and sericite). The range of the differentiated body continues through a gabbro, a diabase, a quartz-diorite and finally a granophyre.

Daly and Barth (quoted in Turner and Verhoogen, 1960), found granophyric rocks on marginal portions of diabase sills invading Karroo sediments. These granophyres were generally the result of gravitational differentiation, but some were formed by the reaction of diabase magma with the invaded siltstones, whose chemical composition happened to be suitable for conversion to granophyres. It seems, therefore, that these intrusives in the Eureka Syncline might, in fact, represent late-phase differentiates of massive dyke-like bodies that reacted with some of the Moodies sediments through which they were injected. In Table 20, a chemical analysis of the more mafic fraction of the dyke clearly demonstrates that the rock is not related to the Kaap Valley Granite (compare Kaap Valley Granite analyses in Table 21, page 241).

Other acid bodies occur as lenticular tongues within the schist belt between the Kaap Valley Granite and the Eureka Syncline. These acidic rocks are poorly exposed, due to heavy tallus covering the area, but they form a string of apparently disconnected lenses that may once have formed part of a continuous horizon. They are badly weathered and altered and contain plagioclase felspar (albite) of both the twinned- and untwinned-varieties. The felspars are mainly altered to sericite. The femic material present is green pleochroic chlorite, while the matrix is composed of a mosaic of microcrystalline quartz and felspar. These rocks probably represent acid bodies, such as quartz or felspar porphyries, or felspathic tuffs, and may form part of the stratigraphic succession of the Onverwacht Group, emplaced prior to the existence of the Kaap Valley Granite. On the other hand, however, they might well represent intrusive porphyritic off-shoots of the nearby granite pluton.

TABLE 20

CHEMICAL ANALYSIS : DIFFERENTIATED MAFIC DYKE INTRUDED INTO THE EUREKA SYNCLINE

Sample 135	Hydrous	Anhydrous
SiO_2	49.59	53.78
Al_2O_3	10.08	10.93
Fe_2O_3	7.48	8.11
FeO	-	-
MgO	15.18	16.46
CaO	6.92	7.50
Na_2O	1.67	1.81
K_2O	0.73	0.79
H_2O+	1.52	-
H_2O-	0.23	-
CO_2	5.08	-
TiO_2	0.21	0.22
P_2O_5	0.04	0.04
MnO	0.13	0.13
NiO	0.17	0.18
Totals	99.03	99.41

Description and Location of Sample 135 :

Olivine gabbro. Part of a differentiated dyke intruded into the Eureka Syncline on the farm Bickenhall 346 JU. (Average of 3 comparative X-ray fluorescence and chemical analytical results. Analysts : National Institute for Metallurgy, and Corner House Laboratories. The analysis is incomplete).

(b) Caledonian Siding-Worcester Mine Area

Northwest of Caledonian Siding, the Kaap Valley Granite abuts against rocks of the Jamestown Schist Belt. Again, the exposures along this contact were sporadic but several stream cuttings, in addition to an underground drive in the New Independence Gold Mine, were found to be instructive. The granite clearly displays intrusive relationships with the Jamestown Schist Belt assemblages. Many of the intrusive granite masses occur as lenticular bodies lying concordantly with the foliation of the schists. Numerous exposures of this type can be seen on the farms Thornylea 588 JT, and Claremont Vale 312 JU.

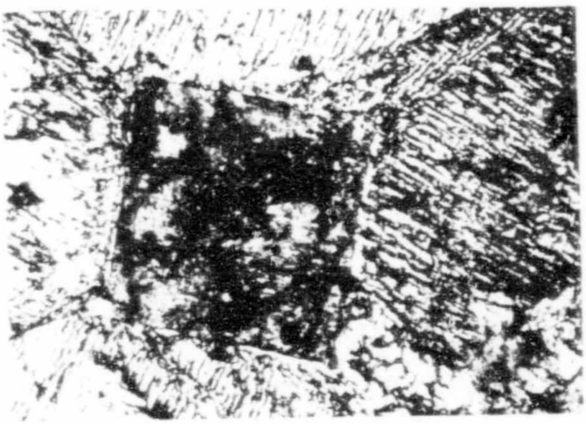
The intrusive nature of the granite in the area is not restricted to concordant tongues as, in addition, many examples of cross-cutting injective veins can be seen. In Plate 18A, page 222 a specimen of Kaap Valley Granite shows cross-cutting relationships with dark hornblende amphibolites. In the stream near the main road, south of the Worcester Mine, the Kaap Valley Granite cross-cuts the amphibolite schists and also occurs as narrow, concordant tongues parallel to the schistosity. Some of these tongues have chill-phase contacts where they abut against the schists. Further away from the contacts, the granite becomes porphyritic, containing large, well-developed, zoned-felspar phenocrysts.

In the area south of the Albion Gold Mine the Kaap Valley Granite shows a weak foliation near the contact. In addition, numerous small basic "schlieren" of hornblende amphibolite were found aligned parallel to the foliation and the granite-schist contact. Further "schlieren" of this type, could be seen in a fresh exposure along the Barberton-Nelspruit main road immediately south of the Worcester Gold Mine. This exposure also provided fresh samples for study. Thin sections revealed that the granite consists of green hornblende, magnetite, fairly abundant sphene, green chlorite, apatite, some accessory zircon, albite-oligoclase felspar, quartz, sericite, and some microcline. The most notable feature, however, was the display of almost perfectly zoned felspar crystals, an example of which is shown in Plate 19D, page 233. This phenomenon implies that the temperature/pressure conditions of the granite magma was in a state of continuous change at the time of emplacement, the zonation witnessing the instabilities during crystallization.

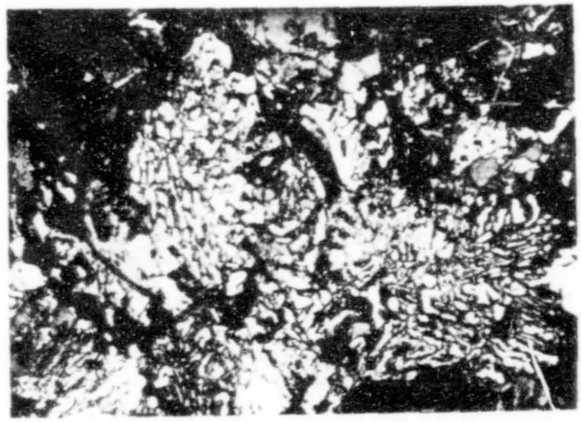
The Kaap Valley Granite is itself intruded by a great number of dykes that trend in two main directions, the one being NW-SE, and the other NE-SW. A less prominent direction, that of a north-south dyke set, is also evident. The dykes are particularly prominent in the granite and they generally end abruptly at the contacts with the surrounding schist. The reason for this is that the granites are massive, homogeneous, and relatively competent rocks that are prone to the development of tension joints and fractures, whereas the schists are incompetent rocks that tend to form compressive or shear surfaces. Dyke invasion is thus more

PLATE 19

A



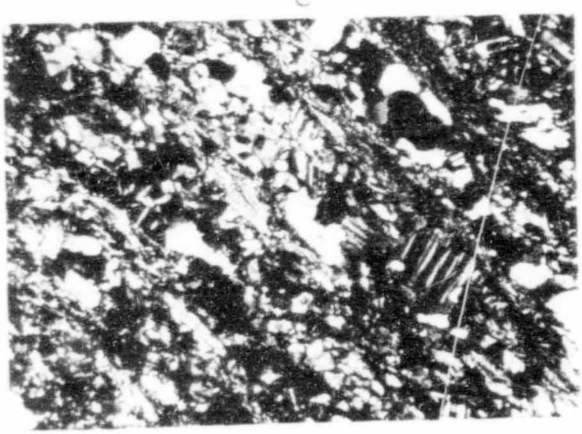
B



A. Photomicrograph of an euhedral felspar crystal surrounded by a fine graphic intergrowth of quartz and felspar. Microgranite pebble from the Moodies basal conglomerate in the Eureka Syncline - near Sheba Siding (crossed nicols X75).

B. Photomicrograph (crossed nicols X75) showing graphic intergrowths of quartz and felspar in a pebble of microgranite extracted from a relatively undeformed basal conglomerate exposure in the Eureka Syncline on the farm Lancaster 359JU (Crystal Stream area).

C



D

C. Photomicrograph of deformed Nelspruit Granite from the contact zone on the farm Riverside 246JU, north of the Jamestown Schist Belt. Note the strong alignment of minerals, particularly biotite and muscovite. Other minerals in the rock include quartz, albite, microcline, orthoclase, magnetite and apatite.

D. Photomicrograph (crossed nicols X20) of euhedral, well-zoned, felspar crystals from the Kaap Valley granite south of the Jamestown Schist Belt, near the Worcester Gold Mine.

easily facilitated in the granitic rocks. The considerable amount of jointing and fracturing of the granites has also aided the saussuritization processes in the rocks whereby the original plagioclase felspar has been altered to epidote and sericite. Pale green epidote is thus commonly seen in, or adjacent to, the joint planes.

(c) Chemical Data

One new analysis and several existing chemical analyses of Kaap Valley Granite are presented in Table 21, page 241 together with norm calculations (Table 21a) and Niggli values (Table 21c). Several partial analyses (K_2O and Na_2O) are listed in Table 22(a), page 248

D. LATE INTRUSIVE GRANITES

Two separate bodies of granite, classified by Anhaeusser et al, (1967) as late intrusive granites, occur on the northwest flank of the Barberton Mountain Land. These are the M'pageni and Salisbury Kop Granites respectively (see Figure 3, page 51). The M'pageni Granite occurs as a discordant pluton in the Nelspruit gneisses and migmatites, about five miles west of Kaapmuiden. It is characteristically a coarse-grained granite somewhat similar to the post-orogenic granites described by Hunter (1965). Its superior resistance to erosion results in this granite building country which is topographically distinctive. An excellent section through the centre of the pluton can be seen in the new road cutting parallel to the Crocodile River between Nelspruit and Kaapmuiden. This river has eroded a spectacular gorge through the centre of the pluton, exposing to view, massive peaks and elevated tors of pinkish-red granite.

No detailed study of this pluton has been made, but cursory investigations indicate that it is typically a homogeneous, non-foliated, granite. The Geological Survey (Visser, compiler, 1956) noted a few inclusions of gneiss within the granite and two prominent sets of joints, orientated at right angles to each other. The new road cutting indicates that, although the rocks are relatively coarse and homogeneous throughout, there are, nevertheless, phases of finer material as well as intrusive granite dykes. In the gneisses adjacent to the pluton, large pinkish microcline felspar porphyroblasts are developed, some measuring up to 2 inches square. Thin sections of the typical coarse-grained granite reveal that the rock is composed mainly of quartz, microcline, orthoclase, perthitic intergrowths, oligoclase-albite, and lesser amounts of muscovite, sericite, and biotite. A chemical analysis of this rock and norm calculations, carried out by the Geological Survey (Visser, compiler, 1956), are included in Tables 21 and 21a, page 241. Partial analyses (K_2O and Na_2O) are listed in Table 22(d), page 249.

De Gasparis (1967) undertook Rb/Sr total rock geochronological studies on the M'pageni Granite and obtained an isochron age of 2.55 ± 0.09 b.y. These results are in accordance with the hypothesis advanced by Anhaeusser et al, (1967) that the M'pageni is a late granite, unrelated to the Nelspruit migmatites and gneisses.

The Salisbury Kop Granite situated at the northeastern end of the Mountain Land, near Hectorspruit, is very similar to the M'pageni Granite just described. It has no visible foliation, is medium-to-coarse-grained, and forms "castle koppies" or tors that outcrop prominently in the area. Van Eeden and Marshall (1965) described the granite and were of the opinion that it represented a reomorphosed equivalent of the basement on which the supracrustal rocks were deposited. Anhaeusser et al, (1967) suggested that this body is a younger granite pluton, similar to the M'pageni, and G5 (post-orogenic) granites described by Hunter (1961, 1965). The granite is typically homogeneous, and has a narrow chill-phase of aplitic and alaskitic granite around the edges, in contact with the Swaziland Sequence rocks (Viljoen and Viljoen, verbal communication). Furthermore, it truncates earlier formed trends in the supracrustal rocks (see Figure 3, page 51). A chemical analysis and norm calculations of this granite was undertaken by van Eeden and Marshall (1965) and are also included in Tables 21 and 21a, page 241. Geochronological studies are currently being undertaken on the Salisbury Kop Granite but no figures are yet available for publication. The ages obtained thus far do not, however, support the conclusions of van Eeden and Marshall (1965). (Oosthyzen, verbal communication, 1967).

E. QUARTZ AND FELSPAR PORPHYRY INTRUSIVES IN THE JAMESTOWN SCHIST BELT

Intrusive bodies of both quartz and felspar porphyry are well-represented in the area under discussion. There appear to be two ages of porphyritic material. The one variety can clearly be equated with injective tongues of the Kaap Valley Granite along the southern edge of the Jamestown Schist Belt, while the other occurrences were found within the zone of mafic and ultramafic rocks classed with the Komati Formation of the Onverwacht Group. Almost identical porphyry bodies have been reported from the area southwest of Barberton, on the farms Hooggenoeg 731 JT and Theespruit 156 IT, in the Komati River Valley. These porphyritic bodies were also found intruding the mafic and ultramafic assemblages of the Komati Formation (Viljoen and Viljoen, 1967). In both the northern and southern areas, where porphyritic bodies occur in the Komati Formation, they are far removed from the granite contacts and in no instance could they be directly connected with any granite bodies.

The granites surrounding the Barberton Mountain Land are clearly responsible for the deformation in the area and the discovery of porphyry pebbles in folded Moodies conglomerates suggests that some porphyry bodies were present very early in the area's history, and certainly before the emplacement of the diapiric Kaap Valley Granite. An additional factor, suggesting that many of the porphyry bodies found in the Jamestown Schist Belt had been intruded very early, is that some of the felspar crystals in the porphyries show a preferred orientation and are found aligned roughly parallel to one another (see Plate 18C, page 222). This could mean that either, the felspars had grown with a preferred orientation, conditioned by a stress field operating in the area or, as the writer sees it, the porphyritic bodies had been in place prior to deformation, and had subsequently recorded the structural event in the form of mineral alignment and orientation.

Quartz and felspar porphyry bodies were observed on the farms Handsup 305 JU, Clarendon Vale 308 JU, and on Mundt's Concession, as far north as the Noordkaap River. It is interesting to note that many of these bodies appear to have been directly responsible for the local formation or control of small exploitable talc deposits. These deposits were presumably formed in the ultramafic assemblages by the action of hydrothermal solutions emanating from the intrusive porphyries. The metamorphic effects accompanying these intrusions do not appear to be great. Invariably, talc is formed immediately adjacent to them, but metamorphic minerals of a higher grade than tremolite or actinolite were never observed.

Along the southern contact of the Jamestown Schist Belt there are tongues and concordant bodies of porphyry material clearly related to the Kaap Valley Granite. Careful examination of these porphyry bodies indicated that the matrix material is generally lighter-coloured than the dark, at times almost black, porphyritic rocks found in the Komati Formation. Petrologically, however, no distinctive difference between the two varieties could be detected. The porphyritic granites, in general, contain large felspar phenocrysts, many over 5 mm in length. A few crystals over 1 cm in length were also measured. The rocks consist primarily of albite and oligoclase with some microcline, green hornblende and accessory amounts of green chlorite, apatite, muscovite, carbonate, magnetite, and other oxides of iron. These are set in a microcrystalline matrix of quartz, sericite, and chlorite. The green chlorite is presumably the alteration product of hornblende, although no direct evidence for this could be found. The felspar crystals are sometimes zoned but in most cases they have been almost entirely sericitized. Hybridized rocks in the Clutha area appear to be partly dolomitized granite porphyries. They contain much the same mineral assemblage as described above, although very often they are devoid of amphibole. The carbonate content varies considerably and, at times, the composition of the rocks approach that of a dolomite or marble. Several partial analyses (K_2O and Na_2O) of the porphyries are listed in Table 22(c), page 249.

The largest porphyry body lies in the area between Clutha Siding and the Woodstock Gold Mine, southeast of Noordkaap. Here, as has already been described, a coarse-grained porphyritic granite is intimately connected with dolomitic rocks. The porphyritic granite is, almost everywhere, entirely surrounded by a hybridized zone of rocks comprising various proportions of porphyry and dolomitic material. Surface weathering of these rocks has been intense and fresh rock exposures are poor. For this reason no clear relationships between the porphyry and the dolomitic material could be established.

The porphyritic granite occurrence near the Clutha Gold Mine was regarded by the Geological Survey (Visser, compiler, 1956) as an intrusive tongue of porphyritic hornblende granite, associated with the Kaap Valley Granite. Ramsay (1963A) also noted this thick, persistent sheet of deformed granite, and expressed the view that some of its features, particularly the porphyritic felspar crystals, seemed to resemble more closely those of the Nelspruit Granite. The writer, however, supports the Geological Survey suggestion as many of the intrusive concordant tongues of Kaap Valley Granite that occur in the Jamestown Schist Belt near the Worcester Gold Mine, and on Claremont Vale 312 JU, resemble the porphyry body near the Clutha Gold Mine. It has also been mentioned before that the porphyry body occurs in a zone of décollement, produced as a result of folding of the competent rocks of the Eureka Syncline and the underlying, less competent, Onverwacht schists. As this deformation was generated mainly by the emplacement of the Kaap Valley Granite, it is not unreasonable to suppose that a phase of this granite may have invaded the tensional environment that it, itself, had created.

The evidence north of Barberton suggests that there is more than one generation of quartz and felspar porphyry or porphyritic granite developed in the area. The early variety appears to be associated with the mafic and ultramafic assemblages of the Onverwacht Group in much the same way as quartz porphyry and quartz keratophyre bodies are associated with spilitic lavas. The second variety of quartz and felspar porphyry appears to have been emplaced much later and is probably a phase related to the Kaap Valley Granite diapiric pluton.

F. GRANITIC PEBBLES IN THE MOODIES BASAL CONGLOMERATE (MdB)

Among the varied pebble-types encountered in the Moodies basal conglomerate horizon (MdB) of the Eureka Syncline are pebbles of granite and quartz porphyry. The best and most accessible outcrops displaying these rock-types occur in the Joe's Luck Siding-Ezzy's Pass-Sheba Siding area. Here the pebbles, as mentioned earlier, have suffered a severe flattening deformation with the chert pebbles in the conglomerates being deformed to a far greater extent than the granite or the quartzite varieties.

The granite pebbles were described by the Geological Survey (Visser, compiler, 1956) who stated that they "represent a parent-body which has hitherto not been recognized in outcrop in the area". Thin sections of the granitic pebbles from the road cuttings between Joe's Luck Siding and Eureka Siding, were examined by the writer and compared with other granitic pebbles obtained from the southern limb of the Eureka Syncline near the Royal Sheba Gold Mine, and on the farm Lancaster 359 JU. This was done in order to ascertain whether the remarkable granophyric textures seen in the granitic pebbles from the deformed conglomerates, were due to a superimposed structural- or metamorphic-alteration effect. However, the relatively undeformed pebbles from Lancaster 359 JU showed identical textures, and it is considered, therefore, that the graphic intergrowths of quartz and felspar seen in these rocks are primary features.

The granitic rocks consist essentially of quartz and felspar with variable amounts of biotite, brown and green chlorite, zircon, and magnetite. Plagioclase felspar is at times fairly abundant and has an average composition ranging from oligoclase to albite. Some grains of plagioclase consist of untwinned albite. Other minerals include microcline, orthoclase, and perthitic intergrowths. Much of the felspar shows incipient alteration to sericite. The most striking features displayed by these rocks is, however, the abundance of graphic intergrowths of quartz and felspar. These intergrowths alone, distinguish these granites from any known granites in the area. In some thin sections, graphically intergrown quartz and felspar grains make up the entire rock, with no accessory constituents present at all. Some remarkable textures were noted (see Plate 19 A and B, page 233). In some cases, perfectly euhedral felspar crystals act as nuclei about which radiate fine, fern-like sprays of graphically intergrown quartz and felspar.

Micrographic intergrowths, according to Moorhouse (1959), are present in small amounts in some basic quartz-diorites, but occur more abundantly in aplitic granites as well as quartz and granite porphyries. He considers micropegmatites to be associated with near surface volcanism where they form acid differentiates of basic sills and lopoliths. Raguin (1965), on the other hand, associates the generation of perthitic exsolution phenomena, and the late albitization of granites, as well as myrmekites and micropegmatites, to the process of endometamorphism, which relates the final crystallization of granites to crystalloblastesis; that is to say, growth of crystals by metamorphism at the expense of other minerals already crystallized. Micropegmatitic granites, according to Raguin, are characteristically developed in the facies of granite passing over into granophyre. He quotes Drescher-Kaden (1948), who considered that micropegmatites result from a corrosion of potash felspars by quartz, giving rise to the "graphic-quartz" of pegmatites in general. This suggests, in other words, that the quartz in the micropegmatitic granite formed later than the potash felspar, by a process of corrosion of grains of felspar already formed, and by intergranular films probably occupied by micro-solutions. Raguin (1965) also cites Ljunggren (1954), who attributed some of the granophyric microstructures in gneisses from Central Sweden, to a corrosion of quartz grains by the birth of felspathic porphyroblasts.

As yet, no source for this granitic material is known from rocks older than the Moodies Group. The writer has, however, twice observed identical micropegmatite textures in rocks found in the Barberton and Nelspruit Districts. The first of these occurs in the differentiated dykes intruded into the Eureka Syncline on the farm Bickenhall 346 JU, north of the Barberton-Havelock road. Here micropegmatitic textures were noted in the granophyric phase of the dykes. The second occurrence was found at the Orpen Dam in the Kruger National Park. The latter rocks are probably related to the Lebombo rhyolites in the Stormberg Volcanic Group of the Karroo Sequence.

Recently, van Eeden and Marshall (1965) reported that a high percentage of micropegmatite was encountered near the boundaries of the Salisbury Kop Granite, which occurs to the northeast of the Barberton Mountain Land, near Hectorspruit. This granite, however, has been described by Anhaeusser et al, (1967) as a late plutonic granite that intrudes and truncates all the earlier formed trends in the area. The Salisbury Kop Granite therefore post-dates the Moodies deposition and cannot have acted as a source of supply of the micropegmatitic pebbles found in the conglomerates. Presumably, therefore, the source area that supplied these pebbles, and for that matter, the considerable amount of granitic material making up a large part of the Moodies assemblage, must have been stripped completely by erosion during Moodies times. It is interesting to recall here, once again, the preliminary age of approximately 4,000 m.y. reported by van Niekerk (verbal communication, 1968) for a granite pebble in the basal conglomerate of the Moodies Group.

There may, however, have been other sources from which the micropegmatitic material could have been derived. These sources may yet be found locally, either in acid extrusive horizons of the Onverwacht Group or, in early granitic or porphyritic granite bodies that intruded the lower members of the Swaziland Sequence.

(a) Chemical Data

Partial analyses (K_2O and Na_2O) of the granite pebbles are listed in Table 22(e), page 249.

G. CHEMICAL DATA RELATING TO THE GRANITIC ROCKS ON THE NORTHWEST FLANK OF THE BARBERTON MOUNTAIN LAND

All the available chemical data relating to the various granite-types north of Barberton have been extracted from two main sources, viz. publications of the Geological Survey (Visser, compiler, 1956), and van Eeden and Marshall (1965), and is included in Table 21, page 241. One new analysis, that of Kaap Valley Granite from the Prison Quarry at Barberton (sample KV1), is also listed. Norm calculations of the various analyses in Table 21 are given in Table 21(a), page 242. For comparative purposes the chemical analyses of four granite types have been included in Table 21(b), page 244. The analyses (after Nockolds, 1954) reflect the chemical differences between average tonalite, granodiorite, adamellite and calc-alkali granites.

Niggli values for these rocks are used to characterize the rock chemistry according to the "magma-type" classification devised by Burri and Niggli (Burri, 1964). The Niggli values are listed in Table 21(c), page 245.

The Kaap Valley Granite may be compared with the following range of "magma-types" listed by Burri (1964), see page 245 A.

TABLE 21

CHEMICAL ANALYSES : 8 SAMPLES OF GRANITIC ROCKS FROM THE NORTHWEST FLANK OF THE BARBERTON MOUNTAIN LAND

	1	3	7	KV1	6	2	4	5
SiO_2	65.19	65.28	62.62	66.27	68.83	72.30	71.50	71.26
Al_2O_3	15.18	15.35	15.44	15.81	14.25	13.15	14.22	15.10
Fe_2O_3	2.47	2.22	1.76	0.76	0.89	1.12	1.32	0.75
FeO	2.29	2.30	2.58	2.59	2.00	1.29	0.99	1.33
MgO	2.93	2.26	2.67	2.50	1.58	0.84	1.11	0.73
CaO	3.77	4.26	4.48	4.49	3.13	1.57	1.51	1.39
Na_2O	4.33	5.00	4.95	5.44	4.62	4.34	4.27	4.53
K_2O	1.89	1.91	2.55	1.16	2.42	4.23	4.99	3.63
H_2O+	1.35	0.24	1.20	0.83	0.36	0.20	0.40	0.44
H_2O-	0.08	0.28	0.24	0.21	0.04	0.24	0.05	0.06
CO_2	-	0.78	0.77	-	-	0.70	-	-
TiO_2	0.69	0.44	0.46	0.35	0.38	0.33	0.19	0.34
P_2O_5	0.24	0.15	0.19	0.13	1.55	0.13	0.08	0.09
S	-	-	-	-	0.04	-	0.04	-
MnO	0.05	0.04	0.04	0.04	0.02	0.05	0.05	0.05
Totals	100.46	100.51	99.95	100.58	100.11	100.49	100.72	99.70

Descriptions and localities of samples listed in Table 21 : (Sample localities plotted in Figure 26, page 243).

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

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

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

KV1 Kaap Valley Granite collected by the writer from the Barberton Prison Quarry (Analysts : National Institute for Metallurgy, Johannesburg.

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

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

4. M'pageni Granite from Gorge Siding in the poort of the Crocodile River (Visser, compiler, 1956).

5. Salisbury Kop Granite - main road, near Hectorspruit (van Eeden and Marshall, 1965).

TABLE 21a

NIGGLI NORMS OF 8 GRANITIC ROCKS FROM THE NORTHWEST FLANK OF THE BARBERTON MOUNTAIN LAND

	1	3	7	KV1	6	2	4	5
Ap	0.34	0.04	0.04	0.30	3.70	0.04	0.34	0.04
Il	1.37	0.54	0.53	0.42	0.76	0.32	0.96	0.34
Or	11.12	14.49	19.32	6.85	14.46	29.31	29.47	26.67
Ab	36.68	55.22	53.98	48.35	38.77	43.63	36.15	47.91
An	16.40	9.22	8.04	14.23	5.28	1.55	4.73	3.79
Mt	3.71	2.05	1.61	1.42	1.39	0.97	1.86	0.65
Wo	-	0.32	1.12	4.26	-	-	-	-
En	-	3.68	4.30	6.92	-	1.27	-	1.12
Fs	-	1.16	1.68	1.76	-	0.56	-	0.96
Q	20.58	12.11	8.24	15.38	27.24	20.94	23.28	16.67
C	-	-	-	-	2.04	0.47	-	1.86
H_2O	1.43	-	-	-	0.40	-	0.45	-
Fes	-	-	-	-	0.20	-	0.94	-
Hy	7.69	-	-	-	6.01	-	2.46	-
Di	1.11	-	-	-	-	-	1.54	-
Cc	-	1.18	1.16	-	-	0.95	-	-

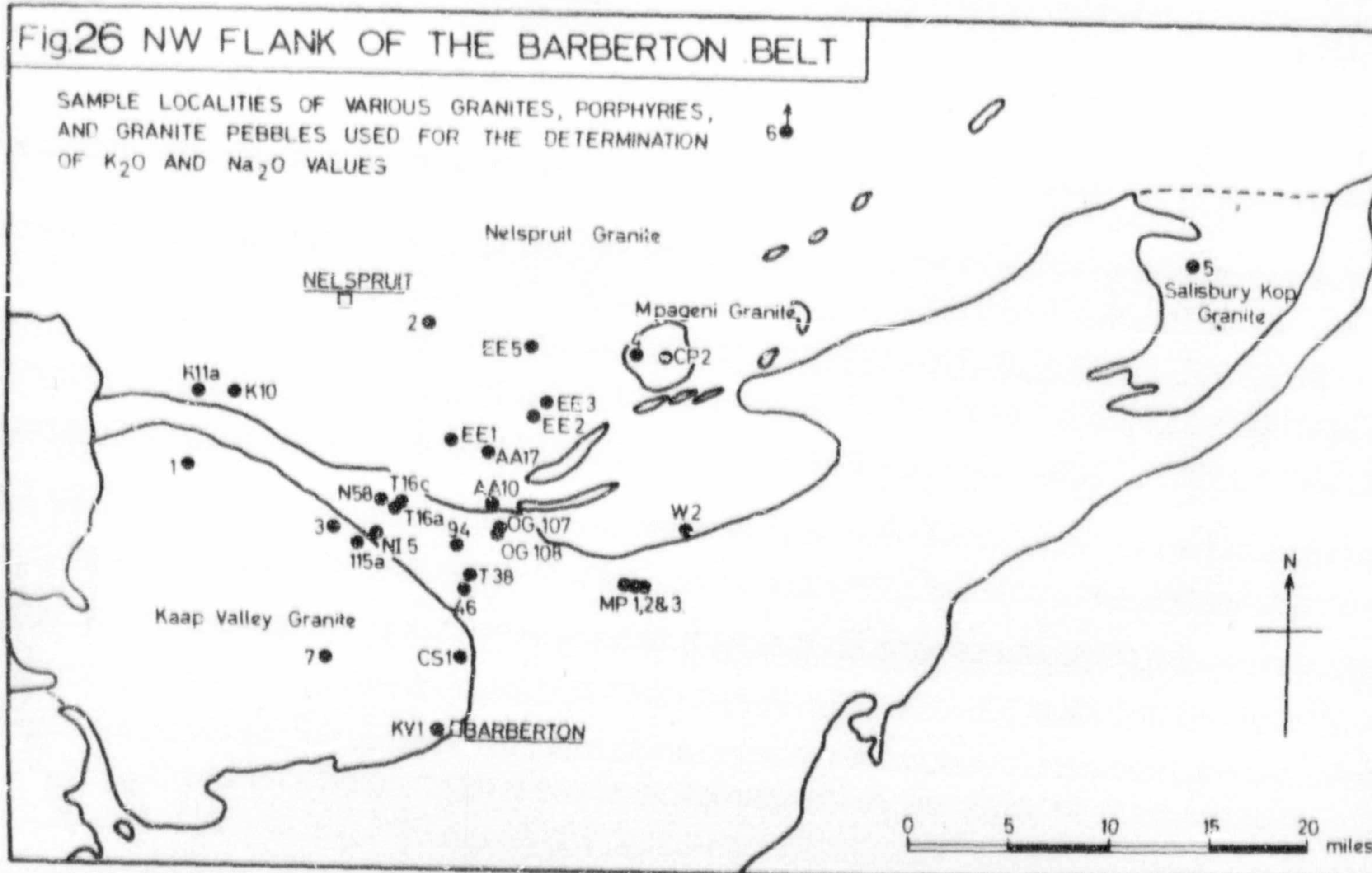


Fig.26 NW FLANK OF THE BARBERTON BELT
SAMPLE LOCALITIES OF VARIOUS GRANITES, PORPHYRIES, AND GRANITE PEBBLES USED FOR THE DETERMINATION OF K_2O AND Na_2O VALUES
Nelspruit Granite
NELSPRUIT
Mpageni Granite
Salisbury Kop Granite
Kaap Valley Granite
BARBERTON
6
5
2
EE5
CP2
K11a
K10
EE3
EE2
EE1
AA17
1
T16c
N58
AA10
T16a
3
94
OG 107
W2
NI 5
115a
OG 108
T 38
46
MP 1,2& 3
7
CS1
KV1
N
0
5
10
15
20
miles

TABLE 21b

CHEMICAL ANALYSES : COMPARATIVE MAJOR ELEMENT ANALYSES OF GRANITIC ROCKS

	1	2	3	4
SiO_2	66.15	66.88	69.15	72.08
Al_2O_3	15.56	15.66	14.63	13.86
Fe_2O_3	1.36	1.33	1.22	0.80
FeO	3.42	2.59	2.27	1.87
MgO	1.94	1.57	0.99	0.52
CaO	4.65	3.56	2.45	1.33
Na_2O	3.90	3.84	3.35	3.08
K_2O	1.42	3.07	4.58	5.46
H_2O+	0.69	0.65	0.54	0.53
TiO_2	0.62	0.57	0.56	0.37
P_2O_5	0.21	0.21	0.20	0.18
MnO	0.08	0.07	0.06	0.06

Description of samples and reference :

1. Average of 58 tonalites (Nockolds, 1954).
2. Average of 137 granodiorites (Nockolds, 1954).
3. Average of 121 adamellites (Nockolds, 1954).
4. Average of 72 calc-alkali granites (Nockolds, 1954).

TABLE 21c

NIGGLI VALUES : GRANITIC ROCKS FROM THE NORTHWEST FLANK OF THE BARBERTON MOUNTAIN LAND

	1	3	7	KV1	6	2	4	5
si	245	245	225	248	306	371	344	361
al	34	34	33	35	37	40	40	45
fm	31	26	27	25	21	16	17	14
c	15	17	17	18	15	9	8	7
alk	20	23	23	23	27	35	35	34
k	0.22	0.20	0.26	0.20	0.26	0.39	0.43	0.34
mg	0.53	0.48	0.52	0.60	0.49	0.39	0.48	0.39
ti	-	1	1	1	-	1	-	1

A.		si	al	fm	c	alk	k	mg
1.	granodioritic	280	39	22	17	22	0.45	0.40
2.	leucotonalitic	220	39	24	21	16	0.50	0.30
3.	leucopeleeitic	200	38	21	24	17	0.20	0.40
4.	quartz-dioritic	225	32	31	19	18	0.25	0.45

The Nelspruit Granites approximate the following range of "magma-types".

B.		si	al	fm	c	alk	k	mg
1.	trondjemitic	370	42	12	11	35	0.25	0.3
2.	leucoquartz-dioritic	300	42	17.5	13	27.5	0.25	0.4
3.	farsunditic	300	42	20	15	23	0.25	0.4

The late granites, viz. M'pageni and Salisbury Kop have their closest comparison, in the calc-alkali series, with the following "magma-types" :

C.		si	al	fm	c	alk	k	mg
1.	trondjemitic	370	42	12	11	35	0.25	0.30
2.	yosemitite-granitic	350	43	14	13	30	0.45	0.30
3.	engadinite-granitic	380	43	13	8	36	0.50	0.25

(a) Classification of the Granitic Rocks by Partial Chemical Analysis

The method of granite classification using Niggli values requires, in the first instance, full silicate analyses of all the major constituents of the rocks. Where a large number of specimens of granite are involved it is not only a slow, but also a costly, undertaking to have the rocks chemically analysed. Because of the high costs involved, geologists have had to resort to modal analyses similar to the one undertaken by the writer (see earlier and Table 19, page 228), or outlined by Chayes (1956), and Whitfield et al, (1959). These are time consuming operations and led to Harpum (1963) devising a relatively rapid method of quantitative granite classification to assist with the understanding of nearly 85,000 square miles of these rocks in Tanganyika (Tanzania). The method hinged around the partial analyses of the alkalis (K_2O/Na_2O) and lime (CaO). Modern instrumental techniques have facilitated a rapid, accurate, and economical method, using a flame photometer.

In Table 21b, page 244, listing average chemical values for a number of granite-types, it can be seen that many of the constituents show some variation, with the most significant changes being reflected in the values of potash and lime. This change in the K_2O/Na_2O value is reflected petrographically by a marked increase or decrease of potash felspar and plagioclase. Thus petrographical observation can be used as a primary basis for granite distinction and can be placed on a quantitative footing by partial analysis of the rocks to determine the alkali ratio.

With this aim in mind the writer collected a number of granite and porphyry samples from the northwest flank of the Barberton Mountain Land and undertook the task of partially analysing them for K_2O and Na_2O. A few values were already available from the major element analyses in Table 21. Two samples of pegmatite from the Consort Mine (OG107 and OG108) were supplied to the writer by Dr. H.L. Allsopp of the Bernard Price Institute for Geophysical Research. These samples were among those used to date the pegmatites in the Consort Mine. A