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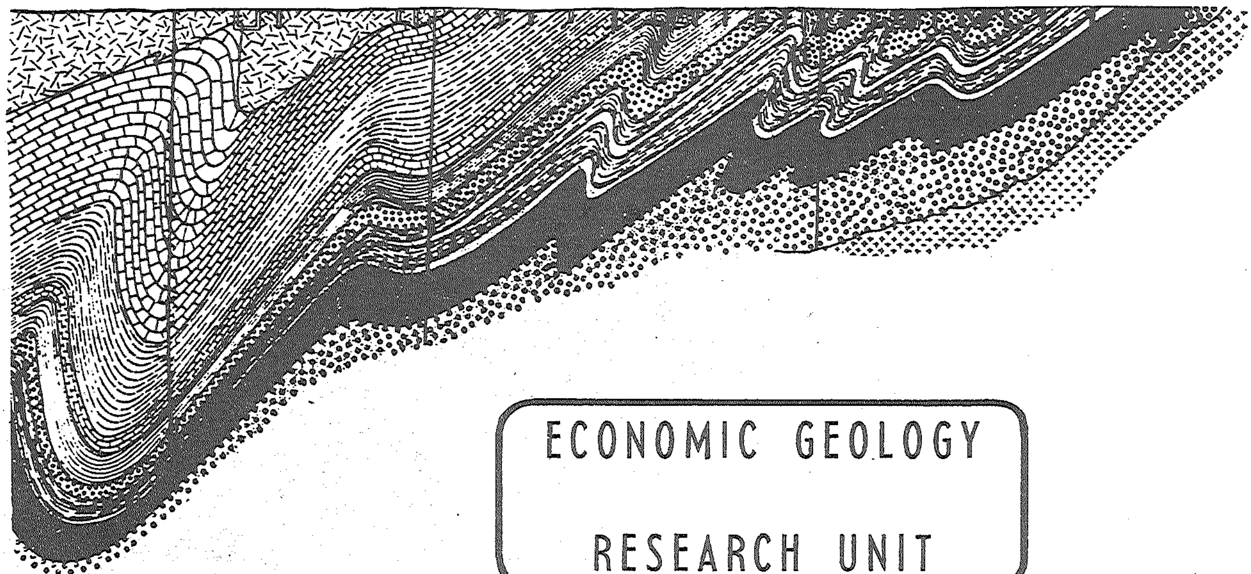

ECONOMIC GEOLOGY

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

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by

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

ABSTRACT

These notes are an attempt at an orderly arrangement of geological data and ideas related to the granitic terrain north of Barberton.

The Nelspruit Granites have been divided into two characteristic types. The first is a migmatitic or gneissic type, and the second a homogeneous intrusive granite that is mainly confined to the immediate contact zone with the rocks of the Swaziland System. The intrusive granites have been further subdivided into foliated granites and pegmatitic and aplitic varieties. The Nelspruit gneisses and migmatites are considered to represent a completely granitized pre-Swaziland System succession which, at a much later date, acted as the basement upon which the layered rocks of the Mountain Land were deposited. The remobilised intrusive border-phase of this migmatite was largely responsible for the contact metamorphism around the periphery of the Mountain Land, and for the late hydrothermal solutions which resulted in the mineralization of the area. In addition, the intrusion of the homogeneous phase took place more-or-less synchronously with the Main Phase deformation. The intrusive, coarse-grained pegmatitic granites near Consort Mine appear to be confined to the areas on either side of the northwesterly projection of the axial plane of the major F3 fold of the Eureka Syncline (Consort Trend). A relationship appears to exist between structure, mineralization, and pegmatite intrusion in this area.

A comparison of the relative percentages of the soda- and potash-felspar content of the Nelspruit Granites was undertaken by means of samples collected along a two-mile section in the Kaap River near Honeybird Siding. Staining procedures were employed, and a grain count revealed that the potash content of the granites increases as the contact, or intrusive, phase is approached.

In the Jamestown Schist Belt, rocks formerly mapped as intrusive tongues of Nelspruit Granite were found to consist of highly sheared and altered siliceous schists that represent part of the stratiform succession in the Onverwacht Series of the Swaziland System.

The Kaap Valley Granite was studied on the northern, northeastern, and eastern contacts of the intrusive pluton. In the Caledonian Siding area, the granite displays 'lit-par-lit' injection into the Main Phase cleavage and schistosity of the basic rocks of the Onverwacht Series. To the north, cross-cutting intrusive relationships were noted in the Jamestown Schist Belt. The granite pluton has, in the areas studied, a distinct contact foliation that everywhere parallels the adjacent formations. It is considered that the Kaap Valley Granite pluton was emplaced later than the intrusive phase of the Nelspruit Granite and the Main Phase of deformation of the Mountain Land. Its emplacement was largely responsible for the formation of the northwest-trending (Consort Trend) folds near the Consort Mine. The distinctive composition and texture of the Kaap Valley Granite is believed to have been brought about by the assimilation of much of the basic material of the Onverwacht Series into which the granite intruded. Metamorphism associated with the granite intrusion was generally of a low grade, although locally high-grade contact metamorphic effects were noted.

Also present in the Jamestown Schist Belt are several smaller bodies of porphyritic granite often accompanied by the local development of talc deposits. There appear to be two ages of porphyritic granite. The one variety is considered to represent intrusive tongues associated with the Kaap Valley Granite, whereas the other porphyritic granite occurrences are confined to the Middle Onverwacht succession, and do not appear to be related to the Kaap Valley Granite.

Pebbles of granitic composition found in the basal conglomerate of the Eureka Syncline were examined. The most distinctive characteristic of these rocks is the remarkable development of graphic intergrowths of quartz and felspar.

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

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

INTRODUCTION

Recent geological investigations, embracing detailed structural, mineralogical and stratigraphical study and analysis, have been undertaken in the area north of Barberton.

The Nelspruit Granite contact with the rocks of the Barberton Mountain Land has been examined critically between Louw's Creek Station, and the Barberton-Nelspruit main road; a total distance of more than 20 miles (locality map, Figure 1).

The Kaap Valley Granite contact was also studied between Barberton, Caledonian Siding, and the Worcester Mine area. The total length of this contact was approximately 14 miles.

In addition to the Nelspruit and Kaap Valley Granite occurrences, other smaller acid intrusive bodies were noted in the neighbourhood of the Clutha Gold Mine, and in the schist belts to the west and south of Noordkaap.

Granite pebbles from the basal conglomerate of the Moodies Series in the Eureka Syncline were studied from excellent exposures of the conglomerate horizon on the road near Joe's Luck Siding, Ezzy's Pass, Sheba Siding and Eureka Siding respectively.

The purpose of this paper is to describe some of the more important features noted with respect to the granites themselves, and their relationship to the adjacent rocks. A few locally detailed descriptions and observations, relating to the granites, have also been included.

NELSPRUIT GRANITE

A. THE LOUW'S CREEK - CONSORT MINE GRANITE CONTACT

The granites along the contact with the basic schists of the Swaziland System, between Consort Mine and Louw's Creek, have been divided into two characteristic types (Anhaeusser, 1964, 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.

The intrusive granites have been subdivided into foliated granites and pegmatitic and aplitic granites.

(a) Migmatitic or Gneissic Granites

These rocks are essentially light-gray, biotite-granites with the gneissic banding invariably highly contorted and folded, apparently in a confused manner. On closer examination, however, the parallelism of the axial planes of the flowage folds, in some localities, becomes more marked as the granite contact is approached. (Plate 1, Figure 1). Chemical analyses of the Nelspruit Granite (Geological Survey - Visser, et. al., 1956) showed it to be grano-dioritic or quartz-dioritic in composition.

7 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 Consort area. Viljoen (1964), never found sharp contacts between the gneissic granites and the black, contact-type of amphibolite, although darker-coloured zones, and also irregular patches of nearly pure femic minerals (mainly biotite with some hornblende), were found to be fairly plentiful in the folded gneiss. The migmatitic-gneiss is cut in many areas by intrusive granite veins, pegmatites and aplites.

(b) 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 System. The actual width of this zone is very variable and difficult to demarcate precisely, but, on average, it appears to be about 1200 feet wide. Later pegmatites, aplite veins and bodies, are intruded into this granite, as well as into amphibolite xenoliths and the contact amphibolite schists.

(i) 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 gray, 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. The intrusive granites are often coarse-grained and pegmatitic in character where they cut the sediments. At the same time, biotite and other ferromagnesian minerals occur only sparingly in this granite, which is predominantly a potash- and soda-rich variety.

(ii) 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, the area flanking the axial plane of the F3 folds of Ramsay (1963) and Viljoen (1964). (The Consort Trend discussed by Roering, 1965). It is in this area to the north of the Eureka Syncline that possibly, the most intense fold deformations of the entire Barberton Mountain Land took place. It is here 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.

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. The majority of pegmatites in the area generally consist of the following mineral combinations (Viljoen, 1964) :

quartz-albite-microcline-orthoclase

or,

quartz-albite-muscovite-microcline-orthoclase

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-gray 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.

(c) <u>Granite Structure</u>

The most striking feature occurring in all the intrusive granites 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 (Viljoen, 1964). 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 occur immediately north of the Joe's Luck Siding rail bridge, while the second is located at the road bridge near Honeybrid Siding. Folding of the intrusive granites, can also be observed at this locality. (Plate 1, Figure 2). The lineation in the granites is 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 (1963) and Viljoen (1964), found evidence that the sheared and mylonitized granites, themselves, has been strongly folded by third structures (F3). 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 the F2 fabrics, whereas, in the areas to the west of here, the F2 fabrics were deformed by the Consort fold trend (F3). Ramsay (1963), 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.

(d) Metamorphism Produced by the Nelspruit Granite Intrusion

Heat from the intrusive, mobilized, border-phase of the Nelspruit Granite caused much of the thermal metamorphism responsible for the mineralogical and textural reconstruction of the rocks themselves, and their fabric, thereby producing a thermal aureole of contact metamorphism. By examining the mineral assemblages in successive stages, away from the granite, it was possible to subdivide the area into three distinct facies of contact metamorphism. (Anhaeusser and Viljoen, 1965). Starting at the granite contact and moving progressively away from it, these facies are :

1. the hornblende-hornfels facies
2. the albite-epidote-amphibolite facies
3. the greenschist facies.

Along the immediate contact zone there occurs a mineral assemblage characteristic of the hornblende-hornfels facies, as defined by Turner and Verhoogen (1960). The distinctive minerals are dark hornblende and plagioclase of intermediate composition, together with garnet, diopsidic pyroxene, and sillimanite. At one locality within the high temperature aureole, substantial amounts of corundum, together with sillimanite, and tourmaline were noted (Viljoen, 1964). The presence of sillimanite, and bands of diopsidic-pyroxene within the hornblende amphibolites, was confined to the area between the Consort Mine and Joe's Luck Siding. Here, it appears that temperatures were locally high enough to have formed minerals characteristic of the higher grade pyroxene-hornfels facies of Turner and Verhoogen (1960).

Southwards, away from the granite contact, an assemblage of lower temperature minerals was noted. These include tremolite and actinolite, biotite, diopside, garnet and andalusite - all typical of the albite-epidote-hornfels facies of Turner and Verhoogen (1960).

Still further from the granites, and extending south to the Eureka Syncline, the assemblage consists dominantly of carbonate-bearing talc and chlorite schists with minor occurrences of tremolite and actinolite. These minerals are characteristic of the greenschist facies as defined by Ramberg (1952).

South of this, the effects of contact metamorphism are invariably absent, or at the most, only very slight. Some retrograde metamorphic processes occur in the area but in general, they are largely confined to local zones of intense shearing.

B. THE JAMESTOWN SCHIST BELT AREA NORTHWEST OF THE CONSORT MINE

(a) The Nelspruit Granite and Siliceous-Schist Horizons

The granite contact, along the Jamestown Schist Belt west of Noordkaap, exhibited many characteristics identical to the area described earlier to the east of the Consort Mine. The granites have again, a relatively narrow, intrusive, border-phase that gradually reverts to massive-migmatite and gneissic granite. In some places, the intrusive border-phase consists of a strongly foliated, somewhat gneissic granite, while elsewhere, it is of a more homogeneous character. Exposures here were not always as clear as in the areas cut by the Kaap River between Joe's Luck Siding and Honeybird Siding. No lineated contact granites were observed. The foliated granites again parallel the fabric in the adjacent schists, and the metamorphism of the successions appears to be in accordance with that described earlier, only the boundaries of the various metamorphic facies were more difficult to define accurately.

The most noteworthy features in this area were, however, the so-called intrusive relationships of the Nelspruit Granite (Visser, et. al., 1956) on Lot 140, Riverside 245 JU, and Segalla 306 JU (locality map, Figure 1). Recent detailed mapping of the Jamestown Schist Belt has shown that these bodies, referred to as Nelspruit Granite by the Geological Survey, are in fact, highly sheared and altered siliceous-schist horizons that form part of the same stratigraphic succession found to the northeast of the Consort Mine. The rocks occur as relatively narrow bands, parallel to the foliation of the adjacent basic schists, and they represent a stratiform succession now grouped with the Onverwacht Series of the Swaziland System.

Apart from quartz-sericite schists, the siliceous-schist horizons include nodular varieties, almost identical to the sheared, sericitic, lustrous-rocks containing small cherty-quartz nodules that were found in the anticlinal divide between the Lily Syncline and the Eureka Syncline north of the Lily Gold Mine (Anhaeusser, 1964).

Another variation is a bright-green, fissile, quartz-sericite schistose rock, containing abundant chromiferous mica; fuchsite, which is a variety of muscovite. Whitmore, et. al., (1946) and Geijer (1963), found that the chrome micas are invariably the product of hot solutions of magmatic derivation, with the chromium having been introduced into the solutions either, as a result of the original fractionation of the volatile magma constituents or, secondarily, through the leaching of igneous rocks containing this element. Several examples are quoted where it appears that the chromium-bearing solutions emanated from a basic or ultrabasic magma. Fuchsite occurrences in the Jamestown Schist Belt are considered to be of this latter type, and were probably derived from the leaching of serpentinites and other basic rocks that envelop the siliceous-schist horizons.

That these siliceous schists represent bodies quite distinct from the Nelspruit Granite can be clearly seen on the farm Riverside 245 JU. Here, both rock-types occur close together, separated only by a narrow zone of talc schist. The siliceous schists in this instance contain an abundance of andalusite, with accessory amounts of staurolite present. Of considerable interest is the fact that Urie and Jones (1965), also reported andalusite-bearing schists in the high-temperature zone of their metasedimentary assemblage in northwestern Swaziland. As in the Jamestown Schist Belt, the Swaziland occurrences have a knotted appearance, resulting from the presence of anhedral crystals of andalusite. In the area north of the Consort Mine, sillimanite, occurring close to the granite contact in the siliceous horizons, has also been described by Hall

(1918), van Eeden (1941) and, more recently by Viljoen (1964). Microcrystalline quartz is invariably the sole remaining mineral in the rock, although sericite may occur in places to a greater-or-lesser extent.

The Nelspruit Granite, on the other hand, contains a greater assemblage of minerals, viz., quartz, plagioclase felspar, microcline, orthoclase, muscovite and biotite, apatite and magnetite. Both the granite and the siliceous schists have suffered intense deformation (Plate 2, Figures 1, 2).

It is significant, that the andalusite porphyroblasts in the siliceous schists have continuous trails through them of the matrix of microcrystalline quartz. This indicates that the poeciloblastic porphyroblasts were developed synchronously with the fabric in the rocks. In addition, many of the porphyroblasts are boudinaged and form almost disconnected crystals that show pressure shadows while, at times, micas are found developed in the zones of added compression. This evidence also points to flattening of the rock subsequent to the initial porphyroblastic development of the andalusite mineral grains. It is clear from evidence here, and from the Consort Mine - Louw's Creek area, that the fabric present in the schists was the direct result of stresses produced by the emplacement of the Nelspruit Granite, which provided the necessary heat-energy gradient for the observed contact metamorphic effects (Anhaeusser and Viljoen, 1965).

Apart from the strong foliation, the siliceous schists are extensively folded (Plate 3, Figure 1). In addition, a strong lineation is developed parallel to the fold axes of the minor crenulation and accordion folds. The lineation is not confined to the siliceous schists alone, but was found to be a regional structural feature, manifest throughout the Jamestown Schist Belt. The lineations plunge at moderate angles to the west, with the axial plane of the folds generally horizontal or slightly north dipping. Crenulation or accordion folds, of the type shown in the siliceous-schist horizons, were never observed in the contact granites throughout the entire area. Crenulation folds and kink bands are typically formed in brittle rocks, whereas, massive granitic rocks are unable to record this style of deformation. This fold event has been correlated with the vertical stress field found between Barberton and Louw's Creek (F4 structures of Viljoen, 1964, and Anhaeusser, 1964).

(b) <u>The Origin of the Siliceous Schistose Rocks</u>

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 disturbances have, in many instances, completely destroyed all evidence of the original mineralogical composition of the rocks.

The writer was shown almost identical rocks to these in the Steynsdorp Valley - Badplaas area by M. and R. Viljoen, who found similar siliceous-schistose rocks forming stratigraphic layers within the basic assemblages of the Lower Onverwacht succession. (see Viljoen and Viljoen, 1965, for a detailed account of the Onverwacht Series).

It appears likely, that these siliceous horizons in the Onverwacht Series originally represented acid extrusives such as tuffs or lavas, leptites, or even locally, some siliceous, aluminous sediments.

<u>NOTE</u>: A leptite is a metamorphosed supracrustal rock with approximately granitic composition which has a secondary grain-size between 0.03 mm and 0.05 mm (lowest limit). Relict grains may be larger. These rocks are generally derived from acid volcanic rocks (Geijer and Magnusson, 1944).

The aluminous sediments cannot have resulted from a de-alkalinization of granite tongues, as in most cases the compositional changes along strike are small — often insignificant. Also, it must be remembered that the metamorphism in the area is essentially of the contact-type — there being only scanty evidence of metasomatism, viz., in the form of isolated occurrences of boron (tourmaline) in schists adjacent to the granites. It is believed that the aluminous material was introduced into a siliceous sediment or precipitate, in the form of clay-mineral material of a finely crystalline or meta-colloidal nature.

C. 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 foot 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 felspars yellow, and plagioclases 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 to the surface of the slab, with glycerine, a fine dot pattern on 'Zip-A-Tone' transparent material.

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 1500 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 2), and the slabs examined, therefore, were regarded as representative of the changes that ensue 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, zircon and pyroxene. Norm calculations done on two samples, one of Nelspruit Granite and the other of M'pageni Granite (Visser, et. al., 1956), showed the rocks to be leuco-quartz-dioritic and normal alkali-granite respectively.

All the granite samples examined from the Kaap River traverse revealed twinned- and untwinned-plagioclase felspar, ranging from oligoclase to albite in composition. One exception was noted (Table I). Specimen H, a well-developed augen-gneiss, contained no potash felspar. Instead, the twinned- and untwinned-plagioclase felspar was found to be andesine.

TABLE I

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	41.00	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

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. In addition, Eskola (1914) showed that the oligoclase granite associated with plutometamorphism was followed by the 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.

From the results obtained near Honeybird Siding, it is apparent that a trend exists whereby the soda-rich granites and gneisses gradually give way to granites considerably richer in potash felspar. This progressive increase in the potash content of the granites was noted as the contact was approached. The late-phase or intrusive, marginal-granites are considered to be responsible for this influx of potash into the area.

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D. ORIGIN OF THE NELSPRUIT GRANITE

Very little detailed work has been attempted on the granites bordering the Barberton Mountain Land in the Transvaal. In Swaziland, on the other hand, extensive investigations of the granites have been undertaken by the Swaziland Geological Survey (Hunter, 1954, 1957, 1959, 1961, and 1965). Previous theories, ideas, and new evidence concerning the origin of the Nelspruit Granite were concisely outlined by Viljoen (1964), who indicated, that many of the earlier investigators were of the opinion that the Nelspruit gneisses represented the granitized equivalents of the formations comprising the Barberton Mountain Land. He quoted several of these earlier expressed viewpoints, viz., van Eeden (1941) who suggested that large quantities of Archaean System rocks, including also the Jamestown rocks (Onverwacht), had disappeared into the gneiss as a result of granitization. The homogeneous stock-like M'pageni Granite was regarded as a younger intrusion representing possibly, a deeper-phase of the Nelspruit Granite. Van Eeden concluded that the Nelspruit Granite comprised different phases, with the shallower portions being gneissic as a result of incorporation of older rocks, while the deeper portions were more homogeneous and representative of true magmas.

Read (1957) interpreted the Nelspruit Granite as being a product of the migmatization of semipelitic and more siliceous rocks. He suggested further, that the abrupt change from regionally metamorphosed gneiss to the low-grade sediments of the Fig Tree and Moodies Series, forming the core of the great Swaziland basin, might be due to the barrier of resistant basic and ultrabasic rocks that prevented the action of metasomatizing agents.

Hunter (1961), considered that Swaziland System rocks had been granitized and were responsible for many gneissic areas in Swaziland. In almost all the cases described by Hunter, the gneisses were found to be regular, conformably dipping rocks, gradational into the less intensely metamorphosed Swaziland System sediments. Viljoen (1964) could not verify the same relationships on the northern side of the Mountain Land. He found no evidence of a gradation from an intensely contorted gneiss of the type shown in Plate 1, Figure 1, to definitely Swaziland System sediments and firmly contended that no such relationship exists. He believed, therefore, that the contorted gneisses represented much older rocks — in fact, the original basement.

NOTE: Hunter (1965) in Swaziland, subsequently re-examined the granite contact relationships with the Swaziland System and found that the gneisses were faulted against the rocks of the Mountain Land, and that they had suffered a period of deformation earlier than that recorded in the rocks of the Swaziland System. He referred to these granodioritic gneisses as the Ancient Gneiss Complex, the formation of which, he believed, marked a synorogenic period of granitic activity during an orogeny pre-dating the deposition and deformation of the Swaziland System.

Ramsay (1963) expressed the view that much of the Nelspruit gneiss, as well as the gneisses of Swaziland, formed a fundamental basement complex on which the layered Archaean System rocks were later deposited. He believed that the contact phenomena and local metamorphism around the periphery of the Mountain Land, was due to another younger granite intrusive.

The ideas expressed by Ramsay (1963) are firmly supported by the findings of Viljoen (1964), and Anhaeusser (1964), in the area between the Consort Mine and Louw's Creek. The writer also found further support for these views, to the west of Consort, in the Jamestown Schist Belt.

Viljoen (1964) explained the intrusive granites as being material representative of the most mobilized part of the re-heated and plasticized Nelspruit basement migmatite, and that the presence of the strip of granite along the immediate contact zone, as well as the fabrics developed in it, were all features related to the updoming of the main body of migmatite. A further possibility that should be considered is the effect of the force which produced the main deformation of the Mountain Land. This force acted essentially from the south-southeast and may have been responsible for the strong shearing and mylonitization along the contact belt. The deformation may also have instituted the generation, and mobilization, of the intrusive granites along the periphery of the Mountain Land in the area to the north of Barberton.

Viljoen (1964) considered that the Nelspruit Granite suite bore a marked similarity to Read's Granite Series (Read, 1957), with the majority of the folded and contorted gneisses and migmatites grouped with his autochthonous granites. Viljoen was also of the opinion that many of the migmatitic granites had been mobilized to some extent, and had probably moved upwards, corresponding more closely to Read's parautochthonous granites. Furthermore, the mobilized, intrusive, border-phase would thus mark the development of high-level granite plutons, representing the final stage of the Series. Read's Granite Series, however, cannot fully be applied to the Nelspruit Granites north of Barberton. The Granite Series, as envisaged by Read (1957), is the direct result of orogeny, with the granites being generated in the axial zones of mobile belts. There is an anomalous situation with regard to the granites surrounding the Barberton Mountain Land. These granites are the cause — not the effect — of the orogenic disturbances in the area.

Thus, the Nelspruit gneisses and migmatites, believed to be products of granitization of a pre-Swaziland System assemblage, are probably the equal of Read's autochthonous granites that formed at great depths. These granites also possess variable and nebulitic textures. In the Barberton Mountain Land the gneisses and migmatites are in juxtaposition with relatively unmetamorphosed successions of the Swaziland System. Separating the gneisses from these sedimentary and volcanic assemblages is the narrow, intrusive contact granite described earlier. This mobilized belt, often not wider than 1000 feet, cannot conceivably be identified with the remaining subdivisions of Read's Granite Series. The intrusive granites along the contact are very likely the result of plastic deformation of the granitization granites themselves. Orogenic compression, generated by the rising granites, gneisses, and migmatites, presumably created a magma or something like it which invaded the granitized material and the neighbouring rocks alike. At the same time, this magma was responsible for the contact metamorphic aureole around the periphery of the Mountain Land.

The evidence, near Honeybird Siding, of the compositional changes of the Nelspruit Granite as the intrusive border-phase is approached, is in accordance with a universal trend where there appears to be a tendency for the late granites to be more potassic than the earlier occurrences. The significance of the chemical variation is not fully understood. Read (1957) quotes firstly, Backlund's suggestion that the variation results from differential mobilization and secondly, the magmatists views, that it arises during the normal course of crystallization differentiation. Another proposal suggests that the potash is derived from the sediments undergoing granitization. Raguin (1965) considered the "alkaline influx" to be derived from neighbouring eruptive rocks formed, and consolidated earlier, or also possibly from tuffaceous sedimentary rocks, arkoses or even from evaporites. He further suggested that some of the alkalis might have arisen from a mobilization of alkalis pre-existing in place.

Before ending this discussion on the origin of the Nelspruit Granite, some final remarks are extended as the writer has recently had occasion to inspect some of the granites far removed from the contact area. A reconnaissance examination of the Nelspruit Granite mass in the Krokodilpoort Range, between the Consort Mine and Nelspruit as well as in the area northeast of Kaapsehoop, indicated that there is also a considerable amount of homogeneous granite developed in the predominantly gneissic terrain of this region. Clearly, detailed mapping of the area is necessary to establish the extent, and nature of, the various granite-types before a final synthesis of the complexities can be attempted.

Several gneissic granite outcrops were found to consist invariably of intensely folded and contorted felsic and femic bands, the nature of which suggests that granitization took place probably at great depths. The gneissic granites are invaded by several generations of pegmatitic as well as granitic material. Striking is the fact, that many outcrops display a considerable amount of homogeneous granitic material, not unlike that found along the intrusive contact with the basic schists of the Barberton Mountain Land. This homogeneous material occurs as narrow bands, often injected concordantly into the gneissic layering. The granitic fluids, in places, aided the assimilation of gneissic material and large areas consist of semi-homogeneous granites, containing partially digested gneissic material. In addition, small bodies of homogeneous leucocratic granite, possibly representing completely altered gneisses, occur scattered throughout the region.

The impression gained, from the few exposures studied, suggests that the invading granitic ichors very often infiltrated into the gneisses along what appear to have been either pre-granitization bedding planes or a pre-granitization rock fabric. The invading granitic ichors could also have conceivably aided the upward migration of the bulk of the gneisses and migmatites, and the buoyant action may have elevated the material to its present day juxtaposed position with relationship to the formations of the Barberton Mountain Land.

In the area immediately north of the Schist Belt near Kaapsehoop, the Nelspruit Granite appears to be mainly of a homogeneous-type, and at times resembles some phases of the Kaap Valley Granite. Outcrops seen in a road cutting between Kaapsehoop and Nelspruit displayed a homogeneous, somewhat foliated granodiorite, containing numerous basic (amphibolitic) inclusions very much akin to the amphibolitic "schlieren" that occur prominently in the Kaap Valley Granite.

Briefly summarizing, and concluding the abovementioned views, the folded and contorted gneisses are envisaged as having formed at great depths by the granitization of a pre-Swaziland System assemblage of rocks. These gneisses were later invaded in situ, by a widespread period of magmatic fluid permeation and injection. This event culminated in the generation of partial, as well as completely homogeneous granite bodies. In addition, it is not inconceivable that the larger diapiric plutons that practically everywhere surround the Mountain Land, including for example, the Kaap Valley Granite, could have represented a final pulse of this period of granite development.

An even later generation of granite was to invade the gneissic area subsequent to this, thereby complicating the picture even further. This event was the emplacement of the coarse, homogeneous body of M'pageni Granite to the east of Nelspruit.

It would appear from reconnaissance investigations, that a rigorous study of the granites might reveal more of the homogeneous varieties than was at first realized. The spatial distribution of these granites, as opposed to the more gneissic Nelspruit Granites, may prove significant for a full understanding of the tectonics of the Barberton Mountain Land. It appears that the granites have, in places, been locally responsible for structural disturbances which cannot readily be incorporated into the overall synthesis of the structural evolution of the entire Barberton Mountain Land. Thus, it would appear essential that a greater knowledge of the granites should be available before any attempt be made on a regional correlation of structural parameters, or periods of deformation.

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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 System 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.

The Kaap Valley Granite is, petrographically, more a granodiorite than a granite (Visser, et. al., 1956). It is characteristically a medium- to coarse-grained, even-textured, homogeneous rock with the principle 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 principle 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 remarkable amount of carbonate present in the contact granites. This carbonate is considered to be of a secondary nature and was probably introduced after the granite had consolidated. The carbonate is assumed to have been derived from the Onverwacht Series which is represented by a strongly metamorphosed sequence of original basic and ultrabasic lavas, together with carbonate-rich sediments, siliceous schists and cherty shale horizons (Anhaeusser and Viljoen, 1965).

The Kaap Valley Granite along the Barberton-Caledonian Siding contact, does not display cross-cutting intrusive 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 assemblage (Plate 3, Figure 2). The intrusion of the Kaap Valley Granite took place along the Main Phase cleavage planes in the area west of the Eureka Syncline. 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, there is also a strong mineral lineation. 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 Series. The lineation extends even further into the Eureka Syncline and can be clearly seen in the middle quartzite horizon (MdQ3) exposed in Elephant's Kloof near the roasting stack at the Fairview Mine plant.

The Geological Survey (Visser et. al., 1956) reported that on the farm Bickenhall 346 JU, several small bodies of Kaap Valley Granite intruded the basic rocks as well as the sediments of the Moodies Series. Thin section study of the bodies 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 that intruded the sediments. The dyke has a variable composition ranging from a peridotite, containing olivine and some labradorite with 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 acid intrusives referred to formerly as intrusive tongues of Kaap Valley Granite, might, in fact, represent late-phase differentiates of massive dyke-like bodies that reacted with some of the Moodies sediments through which the dykes were injected.

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 of felspathic tfuffs, and may form part of the stratigraphic succession of the Onverwacht Series, 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.

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 successions. 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 this area is not restricted to concordant tongues as, in addition, many examples of cross-cutting injective veins can be seen (Plate 4, Figure 1). 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, with large, well-developed, zoned-felspar phenocrysts.

The cross-cutting relationships of the Kaap Valley Granite are interesting, not only from the point of view that they afford proof of the injection of the granite into the schists, but also, because they cross-cut the regional fabric in the area. If the planar fabric of the Jamestown Schist Belt was produced contemporaneously with the Main Phase deformation, the intrusion of the Kaap Valley Granite may then be envisaged as a late event in the structural evolution of the district. It was shown earlier that between Caledonian Siding and Barberton the Kaap Valley Granite intrudes Main Phase cleavage planes. Therefore, as Roering (1965) has intimated, it does not appear unreasonable to conclude that the northwest (Consort) fold trends were intimately associated with the emplacement of the Kaap Valley Granite pluton.

In the area south of the Albion 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 Mine. This exposure also provided fresh samples for study. Thin sections revealed that the granite here 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 (Plate 4, Figure 2). This phenomenon implies that the temperature/pressure conditions of the granite magma was in a state of continuous change at the time of emplacement.

Shear zones in the granite are invariably replaced by pale-green epidote. Pink microcline felspar was also noted near the joints and fracture planes in the granite.

C. METAMORPHISM PRODUCED BY THE KAAP VALLEY GRANITE

It is difficult to assess the full extent of the metamorphism produced by the Kaap Valley Granite in the Jamestown Schist Belt, due to the close proximity of the Nelspruit Granite. However, observations have shown that locally, fairly high grades of contact metamorphism, reaching into the hornblende-hornfels facies of Turner and Verhoogen (1960), are present in the immediate contact areas, but that this grade falls away rapidly to a more extensively developed lower range of the amphibolite facies or the greenschist facies. Near the Worcester Mine the effects of contact metamorphism associated with the Kaap Valley Granite are clearly displayed. In a traverse, not in extent of half a mile, the basic rocks of the Jamestown Schist Belt undergo changes from a very narrow zone of contact amphibolite of the hornblende-hornfels facies, through the albite-epidote-amphibolite facies to the greenschist facies. Thereafter, the grade of metamorphism once more increases as the Nelspruit Granite contact is approached.

Between Barberton and Caledonian Siding the degree of metamorphism is such that the rocks in this zone can, at times, be placed in the upper-greenschist facies, or in the lower albite-epidote-amphibolite facies (Anhaeusser and Viljoen, 1965).

PORPHYRITIC GRANITE INTRUSIVES IN THE JAMESTOWN SCHIST BELT

Between the Clutha Gold Mine and the Barberton - Nelspruit main road, several intrusive porphyritic granite bodies occur in the basic schists. The largest of these masses is located between Clutha Siding and the Woodstock Gold Mine, where 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 granitic 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 granite and the dolomitic material could be established.

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. The mixed rocks 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.

The porphyritic granite occurrence near the Clutha Gold Mine was regarded by the Geological Survey (Visser, et. al., 1956) as an intrusive tongue of porphyritic hornblende granite, associated with the Kaap Valley Granite. Ramsay (1963) 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 Mine and again on Claremont Vale 312 JU, resemble the porphyritic granite near the Clutha Mine.

Further occurrences of porphyritic granite 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 granite 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 basic country rocks by the action of hydrothermal solutions emanating from the intrusive porphyritic granites. The metamorphic effects accompanying these intrusive tongues and bodies do not appear to be great. Invariably, talc is formed immediately adjacent to the intrusive bodies, but metamorphic minerals of a higher grade than tremolite or actinolite were never observed.

There appear to be two ages of porphyritic granite. The one variety can clearly be equated with injective tongues of the Kaap Valley Granite along the southern edge of the Jamestown Schist Belt. The other porphyritic granite occurrences were found within a zone of basic and ultrabasic rocks, classed with the Middle Onverwacht succession, that forms the synclinal core of the Schist Belt (Anhaeusser, Viljoen and Viljoen, 1966). Almost identical porphyritic granite 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 once again, were found to intrude the basic and ultrabasic lava assemblages of the Middle Onverwacht succession (Viljoen and Viljoen, 1965).

In both the northern and southern areas where porphyritic bodies occur in the Middle Onverwacht sequence they are far removed from the contact granites, and in no instance could they be directly connected with any of the granites surrounding the Mountain Land. This, however, was not the only criterion for suggesting more than one age of porphyritic granite. Critical examination of the two similar types indicated that the matrix material of the variety found in Middle Onverwacht sequence was dark, almost black in colour, with large, euhedral crystals of felspar, while the porphyritic granite tongues correlated with the Kaap Valley Granite possessed a lighter-coloured matrix in every case examined. Petrologically, however, no distinctive difference, other than the colour of the microcrystalline, predominantly quartz matrix material could be detected.

An additional feature and probably the most significant factor was that some of the felspar crystals in the porphyritic granites found in the Middle Onverwacht succession showed, at times, a preferred orientation and were often found aligned roughly parallel to one another (Plate 5, Figure 1). This could mean one of two things: firstly, that the porphyritic bodies had been in place prior to deformation, and had recorded the structural event in the form of mineral alignment and orientation or, secondly, that the felspars had grown with a preferred orientation that was influenced by some factor other than that of stress alone. The writer suspects the former alternative, but until further evidence is available no final conclusions can be drawn, apart from indicating the possibility of there being more than one age or generation of porphyritic granite in the Barberton Mountain Land.

THE ORIGIN OF THE KAAP VALLEY GRANITE

Again very little detailed work has been done on the Kaap Valley Granite body north of Barberton. Hall (1918) first described the granite and believed it to be of the same age as the Nelspruit Granite. The more basic character of the Kaap Valley Granite was ascribed by him, to manifestations of different conditions of consolidation, coupled with the assimilation of basic Jamestown rocks.

Most investigators believe the Kaap Valley Granite to be younger than the Nelspruit Granite. Among those who subscribe to this view are Hearn (1943), and Read (1957), who believed that the Kaap Valley Granite had all the characteristics of a pluton viz., shape and granite tectonics. In addition, he considered that the emplacement of the granite caused the folding of the adjacent metamorphic rocks. Ramsay (1963), basing his conclusions entirely on structural evidence, believed the Kaap Valley Granite was a relatively "high level" igneous pluton. Viljoen (1964) considered that the Kaap Valley Granite was either emplaced, or domed-up, in some way during the 3rd. phase of deformation of the Barberton Mountain Land. The rising of the granite dome, he believed, played an important part in the deformation of the Consort Mine area.

In the north, the Jamestown Schist Belt is seen to envelop the Kaap Valley pluton up to a point where it disappears beneath the younger cover of the escarpment. Roering (1965) mentioned that the fold trends are all controlled by the shape of the Kaap Valley pluton, being aligned parallel to its outline. In addition, he stated that the regional fabric of the Jamestown Belt was formed either by the emplacement of the Kaap Valley Granite, which stoped its way in and shouldered away the rocks on its margin, or, by the movement of an already crystallized pluton towards the Nelspruit Granite. He drew the conclusion that the emplacement of the Kaap Valley Granite and the formation of the northwest folds (Consort trend) were intimately associated. Cooke (1965) could not find any evidence in the area north of the Moodies Hills, i.e. southwest of Barberton, to support the idea that the granite was comagmatic with the basic rocks of the Jamestown Complex. He suggested also that the Kaap Valley Granite was a separate intrusion, emplaced late in the orogenic history of the Barberton Mountain Land.

Van Eeden (1941), the Geological Survey (Visser, et. al., 1956) and van Eeden and Marshall (1965), are at variance with the interpretations thus far expounded by the above-mentioned investigators. They contend that the Kaap Valley Granite is the older of the two granites and was already a solid, resistant block at the time of major folding. Van Eeden (1941) acknowledged that the Kaap Valley Granite was responsible for the marked change in strike of the various rocks which surround it, but he considered that there was only one major period of deformation, with stresses directed from the southeast, during which time the hornblende granite body acted as a buttress around which the formations were folded.

The Geological Survey (Visser, et. al., 1956) also expressed the view that the Kaap Valley Granite is related to the basic rocks of the Jamestown Complex in the same way as the Bushveld Granite is related to the Bushveld Gabbro, i.e. comagmatic. The Kaap Valley Granite, according to this idea, represents the later, acid-phase of the parent magma that gave rise to the Jamestown Igneous Complex as a whole. This view cannot seriously be subscribed to by the writer following the recent investigations of the Kaap Valley Granite and surrounding rocks north of Barberton. There is also much evidence questioning the existence of the Jamestown group of rocks. Observations and conclusions, drawn from all sides of the Mountain Land, collectively suggest that the basic suite of rocks formerly regarded as belonging to the Jamestown Igneous Complex are, in fact, part of the earliest formations classified with the Onverwacht Series.

Investigations of the Kaap Valley Granite between Barberton, Caledonian Siding, and the Worcester Mine support the view that the granite is a diapiric mass that was intruded into the Mountain Land at a late stage in the tectonic history of the region. Firstly, there is evidence in the form of 'lit-par-lit' injection of the granite into the Main Phase cleavage, and secondly, there are cross-cutting tongues of granite that post-date the metamorphic and structural fabric that was initiated earlier by the intrusion of the Nelspruit Granite border-phase. Furthermore, the foliation and the "schlieren" or inclusions in the granite were found to be parallel to the contact, and to the fabric in the adjacent schists. The inclusions around the fringe of the pluton are aligned with their 'ab' planes parallel to the foliation, as would be expected in a diapiric body.

Between Barberton and Caledonian Siding, the basic schists, together with the Fig Tree and Moodies sediments of the western limb of the Eureka Syncline, were all found to dip away from the granite contact, i.e. to the east. Along the Caledonian Siding - Worcester Mine contact, the schists were found to be vertical or steeply north-dipping. Clear underground exposures in an adit of the New Independence gold workings, showed the dip of the schists to be away from the Kaap Valley Granite contact. Cooke (1965) found the Kaap Valley Granite foliation to be steeply-dipping to the south, in the area southwest of Barberton. The adjacent schists were also found to dip away from the granite contact in most instances where they could be measured. (structural map prepared by R. Cooke for E.T.C. Mines Limited, Barberton, 1962). Furthermore, Roering (1965) showed stereoplots of the bedding attitude in the Fortuna Mine area, also southwest of Barberton. The regional dip of all the formations was again shown to be away from the granite. Thus, the structural relationships of the rocks encircling most of the Kaap Valley Granite adds support to the late upward emplacement of the granite body.

The Kaap Valley Granite, is now believed, to have intruded into the northern portion of the Mountain Land as a diapiric mass causing the local F3 (Consort Trend) phase of deformation. In addition, the Kaap Valley Granite influenced, considerably, the rocks in the schist belts surrounding the pluton, and in many cases amplified the structure and fabric trends already imposed by the Main Phase deformational event, which is related to the intrusion of the Nelspruit Granite.

The metamorphic grade of the rocks surrounding the Kaap Valley Granite has been used as evidence against those who regard the granite body as a late intrusive. Raguin (1965), discussing the effects of granite emplacement, stated that "contact metamorphism is often irregular, being very pronounced at one point on the border of a granite and almost non-existent at another". He also believed that the emplacement of a granite mass need not necessarily be accompanied by the establishment of a contact aureole.

This apart, however, it can still be shown that quite appreciable metamorphic effects exist in the immediate environs of the pluton. A contact metamorphic aureole can be demonstrated in the basic schists near the Worcester Mine where a temperature gradient, resulting from the emplacement of the Kaap Valley Granite, has been established. Apart from the local development of mineral assemblages ranging into the hornblende-hornfels facies of contact metamorphism, the schist belts surrounding the pluton contain large tracts of serpentinous material and other basic schists, ranging from amphibolites to talcose rocks.

It may be advisable to consider the view, expressed by Turner and Verhoogen (1960), that peridotite bodies may become serpentinized through the activity of aqueous solutions or vapours derived, for the most part, from the surrounding geosynclinal sediments or, from intrusive bodies of granitic magma. A look at the distribution, in the Mountain Land, of serpentinites and their later, steatized derivatives is also instructive. It can be seen that these occurrences are well grouped around the Kaap Valley Granite pluton. It is not suggested that all the serpentinites in the Mountain Land are the result of the emplacement of the Kaap Valley Granite. To the author the implication here, merely reflects that where basic and ultrabasic successions of the Onverwacht Series were influenced by the Kaap Valley Granite or any other intrusive granites, optimum conditions for the production of serpentinous material prevailed. No doubt the earlier intrusion of the Nelspruit Granite also played a role in the alteration of the ultrabasics to serpentinous bodies. The extensive development of serpentinites in the northeastern portion of the Mountain Land may owe their origin or formation to the late emplacements of the nearby M'pageni or the Salisbury Kop granite masses.

Bodies of serpentinite that occur well within the Mountain Land can almost without exception be related to zones of strong dislocation or, are bounded by faults of great magnitude. These serpentinites are believed to have been tectonically "squeezed up" from the underlying Onverwacht succession that forms the base of the geosynclinal pile.

Fault planes also provided channelways allowing hydrothermal solutions to pass through original ultramafites thereby converting these rocks to serpentinites. Turner and Verhoogen (1960), indicated that serpentine could form at temperatures as high as 500°C, either by action of pure water on olivine-enstatite mixtures, or from olivine alone if the aqueous solution was rich in CO_2 and so was capable of removing magnesia from the system. Carbon dioxide is known to have been present in considerable quantities in the Barberton Mountain Land, accompanying the initial volcanic phases associated with the Onverwacht Series. Present day altered basic lavas and Moodies quartzites, together with other sediments, are frequently highly charged with calcareous material. The development, in places, of dolomites, marble, and talc-carbonate rocks may be due to the interaction of solutions rich in CO_2 with the ultrabasic assemblages containing a high percentage of magnesia. Other carbonates such as calcite, siderite, and magnesite are frequently encountered mainly in the Onverwacht Series.

Finally, the method of emplacement of the Kaap Valley Granite as envisaged by the writer, is depicted schematically in Figure 3. The first sketch (a) shows the broad regional trend of the Mountain Land after the southeast-northwest compression had been initiated (Main Phase deformation). The embryonic Kaap Valley Granite began intruding into the Onverwacht succession, which at this stage had a pronounced structural and metamorphic fabric derived from the effects of the Main Phase deformational event and the mobilized Nelspruit Granite contacts.

The second sketch (b) shows the start of the disturbance of the basic rocks around the pluton as it stoped its way upwards, prizing off, and assimilating, the various rock-types as well as forcing them aside radially from the granite periphery. The assimilation of essentially basic material caused a compositional change of the intrusive granitic material to that of a hornblende-granodiorite.

Sketch (c) shows the accentuation of the fabric of the basic rocks (schists) around the granite, and the influence the upward expanding pluton had on the neighbouring formations (e.g. the Eureka and Ulundi Synclines) which were at the same time being thrust northwestwards by the still-active stress from the southeast.

The fourth sketch (d) depicts the Mountain Land as it occurs today, with the Eureka Syncline inflected into a right angle fold with its axial plane trending northwest-southeast. The schists surrounding the Kaap Valley Granite possess a fabric that parallels the granite contact and dips outwards from the periphery. The granites themselves are also foliated and lineated along their immediate contacts.

GRANITIC PEBBLES IN THE MOODIES BASAL CONGLOMERATE

Deformed conglomerate pebbles of the Moodies Series occur at two localities north of Barberton. The first occurrence of conglomerate is at the base of the Lily quartzite horizon in the Lily Syncline and the second is the basal conglomerate of the Eureka Syncline.

The conglomerates are composed primarily of chert pebbles, with quartzitic and granitic pebbles occurring less frequently. In addition, the Geological Survey (Visser, et. al., 1956) noted pebbles of banded ironstone, red banded jasper, grit and quartz porphyry. They considered that the black chert and quartz porphyry were probably derived from the Onverwacht Series, while the banded ironstones, jaspers, and grits could have been derived from the Fig Tree Series. The granite pebbles they noted, "represent a parent-body which has hitherto not been recognized in outcrop in the Area".

The pebbles in both the abovementioned localities occur as flattened, elongated ellipsoids, in the planes of cleavage that Ramsay (1963) showed to be superimposed upon the first fold structures of the Barberton Mountain Land. It was possible to extract and measure deformed pebbles from their partly decomposed and weathered matrix. The dimensions of the deformed pebbles were compared with undeformed pebbles of Moodies conglomerate (Anhaeusser, 1964, 1966; and Viljoen, 1964).

The results of this study showed that the percentage deformation for chert pebbles was considerably greater than it was for granitic and quartzitic pebble-types. In the case of the deformed chert pebbles, the matrix and pebbles appear to have reacted almost as one, and probably represent an approximate amount of deformation suffered by the whole conglomerate zone. The more competent quartzitic and granitic pebbles were hardly affected, but a greater amount of deformation must have occurred in the incompetent matrix surrounding these pebbles. Thin sections of the granitic pebbles from the road cuttings between Joe's Luck Siding and Eureka Siding, were examined and compared with additional granitic pebbles obtained from the southern limb of the Eureka Syncline near the Royal Sheba 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 felspars include microcline, orthoclase, and perthitic intergrowths. Much of the felspar showed incipient alteration to sericite. The most striking feature about these rocks, however, was the abundance of graphic intergrowths of quartz and felspar. These intergrowths alone, distinguish these granites from any known granites in the area. In some sections, graphically intergrown quartz and felspar grains made up the entire rock with no accessory constituents present at all. Some remarkable textures were noted (Plate 5, Figure 2; Plate 6, Figures 1 and 2). In some cases, perfectly euhedral felspar crystals act as nuclei about which radiate fine, fern-like sprays of graphically intergrown quartz and felspar.

As yet, no source for this granitic material is known from rocks older than the Moodies Series. The writer has, however, twice observed identical graphic intergrowth textures in rocks found in the Barberton and Nelspruit Districts. The first of these occurred in each of three separate masses of granophyre and quartz-diorite mentioned earlier that intruded the Eureka Syncline immediately north of the Barberton-Havelock road, while 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 Series of the Karroo System.

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. These authors are also inclined to the view, that the Salisbury Kop Granite may be the oldest granite in the area, and that the Swaziland System was deposited on it. Should this view prove correct, then the Salisbury Kop Granite may have provided the source of the micropegmatitic and granitic pebbles in the Moodies conglomerates.

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

NOTE: The Salisbury Kop Granite has since been re-examined by M. and R. Viljoen who are now of the opinion (verbal communication) that this body is a late plutonic granite, similar in many respects to the M'pageni Granite. The granite is typically homogeneous and very coarse-grained, except for a narrow chill phase of aplitic and alaskitic granite around the edges, in contact with the Swaziland System rocks. The granite is also markedly similar to the late G5 granites described by Hunter (1961) in Swaziland.

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 the 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 microsolutions. Raguin (1965) also cites Ljuggren (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.

CONCLUSIONS

The Precambrian granitic terrain north of Barberton, displays several phases or varieties of granite development, each of which can be identified in the field by its own distinctive characteristic. The phases, or varieties, that have been identified are the gneisses and the migmatites, the intrusive homogeneous granites (some of which display a gneissocity due to the superimposition of a structural fabric) and the pegmatitic and aplitic as well as some alaskitic granite varieties.

The Kaap Valley Granite has always been regarded as a granite variety quite distinct in age, composition, mode of occurrence and overall character, from the Nelspruit Granite. However, some phases of the Nelspruit Granite strongly resemble the typical hornblende granodiorite of the Kaap Valley body. Thus, it would appear that these granites may, in some way, be linked genetically to one another. Furthermore, the former concept that these two granites represented distinct and separate events may have to be revised. For such a revision to take place there is an urgent need for a more thorough investigation of the granites necessitating, in addition, isotopic age measurements of the distinctive phases of granite development. Only then, can a reliable reconstruction be made of events related to the granites themselves, and to the rocks into which they intrude.

It has become clear from the recent researches being undertaken in the Barberton Mountain Land, that the structure of the Swaziland System rocks has greatly been influenced by the granites surrounding the ancient schist belt. That the granites were the cause — not the effect, of the Barberton orogeny is becoming more evident as additional data becomes available from widely separated areas around the Mountain Land.

The various granites, like those in Swaziland, require, it would seem, an initial subdivision into orogenic cycles and phases of synorogenic or post-orogenic magmatic activity. A detailed attempt at such a subdivision would possibly be premature at this stage but, on a broader basis, the Nelspruit gneisses and migmatites could be grouped with the Ancient Gneiss Complex as proposed by Hunter (1965). The Kaap Valley Granite, as well as the intrusive border-phase of the Nelspruit Granite, could be regarded as synorogenic, broadly contemporaneous emplacements, with finally the younger M'pageni Granite pluton being a post-orogenic event.

The Ancient Gneiss Complex would thus represent a granitized, pre-Swaziland System basement upon which the deposition of the volcanic and sedimentary rocks of the Barberton Mountain Land took place. The reactivated Nelspruit Granite, and the Kaap Valley Granite, probably resulted in synorogenic deformation of the geosynclinal pile. The synorogenic phase of plutonism produced most of the metamorphism, and was largely responsible for the gold mineralization of the area. The later, post-orogenic M'pageni Granite, probably represents an event that had only a token effect on the overall geological history of the Barberton orogeny.

* *

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List of References Cited

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

Anhaeusser, C.R., and Viljoen, M.J. 1965 The Base of the Swaziland System in the Barberton-Noordkaap-Louw's Creek Area, Barberton Mountain Land. Inform. Circ. No. 25, econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg.
also: Annex. Trans. geol. Soc. S. Afr., Vol. 68, (1965) (in press).

Anhaeusser, C.R. 1966 A Comparison of Pebble and Fold Deformations in the Nelspruit Granite Contact Aureole. Inform. Circ. No. 30, econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg.
also: Annex. Trans. geol. Soc. S. Afr., Vol. 68, (1965) (in press).

Anhaeusser, C.R., Viljoen, M.J., and Viljoen, R.P. 1966 A Correlation of Pre-Fig Tree Rocks in the Northern and Southern Part of the Barberton Mountain Land. Inform. Circ. No. 31, econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg.
also: Annex. Trans. geol. Soc. S. Afr., Vol. 68, (1965) (in press).

Backlund, H.G. 1943 Einblicke in das geologische Geschehen des Prakambriums. Geol. Rundsch. Vol. 34, p. 79.

Bailey, H., and Stevens, R.E. 1960 Selective Staining of K-felspar and Plagioclase on Rock Slabs and Thin Sections. Amer. Miner., Vol. 45, Nos. 9 and 10.

Chayes, F. 1949 A Simple Point Counter for Thin Section Analysis. Amer. Miner., Vol. 34.

Chayes, F. 1952 Notes on the Staining of Potash Felspar with Sodium Cobalti-Nitrite in Thin Sections. Amer. Miner., Vol. 37, pp. 337-340.

Cooke, R. 1965 The Pre-Fig Tree Rocks in and around the Moodies Hills, Barberton Mountain Land. Annex. Trans. geol. Soc. S. Afr., Vol. 68, (in press).

Drescher-Kaden, F.K. 1926 Uber granito-dioritsche Mischgesteine des Friedeberger Intrisivmasse. Neues Jahrb. f. Min. Beil.-Bd., Vol. 54A.

Drescher-Kaden, F.K. 1948 Die Feldspat-Quartz Reaktionsgefuge des Granites und Gneiss. Vol. 1, 259 S., Heidelberg.

Eskola, P.E. 1914 On the Petrology of the Orijarvi Region in Southwestern Finland. Bull. Com. geol. Finlande, No. 40.

Geijer, P., and Magnusson, N. 1944 De Mellansvenska Jarnmalmernas Geologi. Sv. Geol. Unders., Avh. ser. Ca. No. 35.

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

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

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

Hunter, D.R. 1954 The Geology and Petrology of the G4 (Usutu) Granite, Western Swaziland. Unpub. M.Sc. thesis, Univ. London. England.

Hunter, D.R. 1957 The Geology, Petrology and Classification of the Swaziland Granites and Gneisses. Trans. geol. Soc. S. Afr., Vol. 60, pp. 85-120.

Hunter, D.R. 1959 The Petrochemistry of Some Swaziland Granites. XX Int. geol. Congr. As. Serv. geol. Afric., pp. 99-121.

Hunter, D.R. 1961 The Geology of Swaziland. Geol. Surv. Swaziland.

Hunter, D.R. 1965 The Precambrian Granitic Terrain in Swaziland. Annex. Trans. geol. Soc. S. Afr., Vol. 68, (in press).

Ljunggren, P. 1954 The Region of Halia in Dalecarlia, Sweden. (These) Goteborg.

Moorhouse, W.W. 1959 The Study of Rocks in Thin Section. Harper and Brothers, New York.

Niggli, E. 1946 Die leukogranitischen, trondhjemitischen und leukosyenitgranitischen Magmen und die Anatexis. Schweiz. Min. Pet. Mitt., Vol. 26.

Raguin, E. 1965 Geology of Granite. Interscience Publishers, John Wiley and Sons Ltd., London.

Ramberg, H. 1952 The Origin of Metamorphic and Metasomatic Rocks. Univ. Press, Chicago.

Ramsay, J.G. 1963 Structural Investigations in the Barberton Mountain Land, Eastern Transvaal. Inform. Circ. No. 14, econ. Geol. Res. Unit, Univ. Witwatersrand, Johannesburg.

also: Trans. geol. Soc. S. Afr., Vol. 66 (1963).

Read, H.H. 1957 The Granite Controversy. Thos. Murby and Co., London.

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

also: Annex. Trans. geol. Soc. S. Afr., Vol. 68, (in press).

Turner, F.J., and Verhoogen, J. 1960 Igneous and Metamorphic Petrology. McGraw-Hill Book Co. Inc., New York.

Urie, J.G., and Jones, D.H. 1965 Metamorphic Zones of the Archaean Fold Belt in Northwestern Swaziland. Annex. Trans. geol. Soc. S. Afr., Vol. 68, (in press).

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

van Eeden, O.R., and Marshall, C.G.A. 1965 The Granitic Rocks of the Barberton Mountain Land in the Transvaal. Annex. Trans. geol. Soc. S. Afr., Vol. 68, (in press).

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

Viljoen, M.J., and Viljoen, R.P. 1965 A Reassessment of the Onverwacht Series in the Komati River Valley. Annex. Trans. geol. Soc. S. Afr., Vol. 68, (in press).

Visser, D.J.L. et. al. 1956 The Geology of the Barberton Area. Spec. Publ. No. 15, Geol. Surv. S. Afr.

Whitmore, D.R.E., Berry, L.G., and Hawley, J.E. 1946 Chrome Micas. Amer. Miner. Vol. 31.

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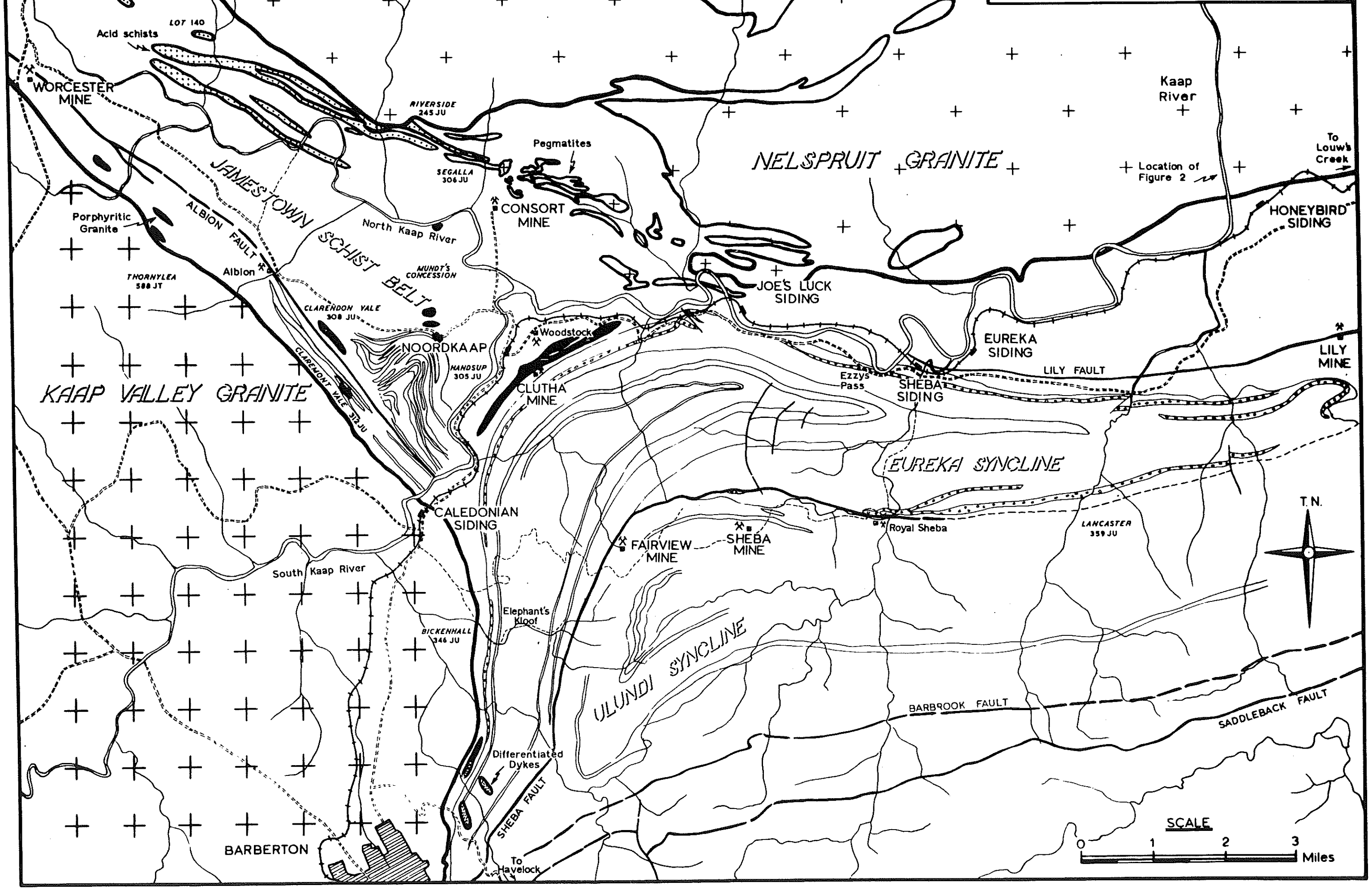
Key to Figures

Figure 1 Locality map showing the area dealt with in the paper. Map indicates both the Nelspruit and Kaap Valley Granite masses, the acid or siliceous-schist horizons in the Jamestown Schist Belt, the porphyritic granite bodies, and the differentiated dyke-like occurrences in the Eureka Syncline.

Figure 2 Locality map showing sample points and potash-soda relationships of the Nelspruit Granite in the Honeybird Siding exposures along the Kaap River.

Figure 3 Schematic diagram showing how the Kaap Valley Granite pluton is believed to have been emplaced, coupled with the dynamic events resultant on the up-doming and intrusion of the massif.

* *



LOCALITY MAP FIG. 1

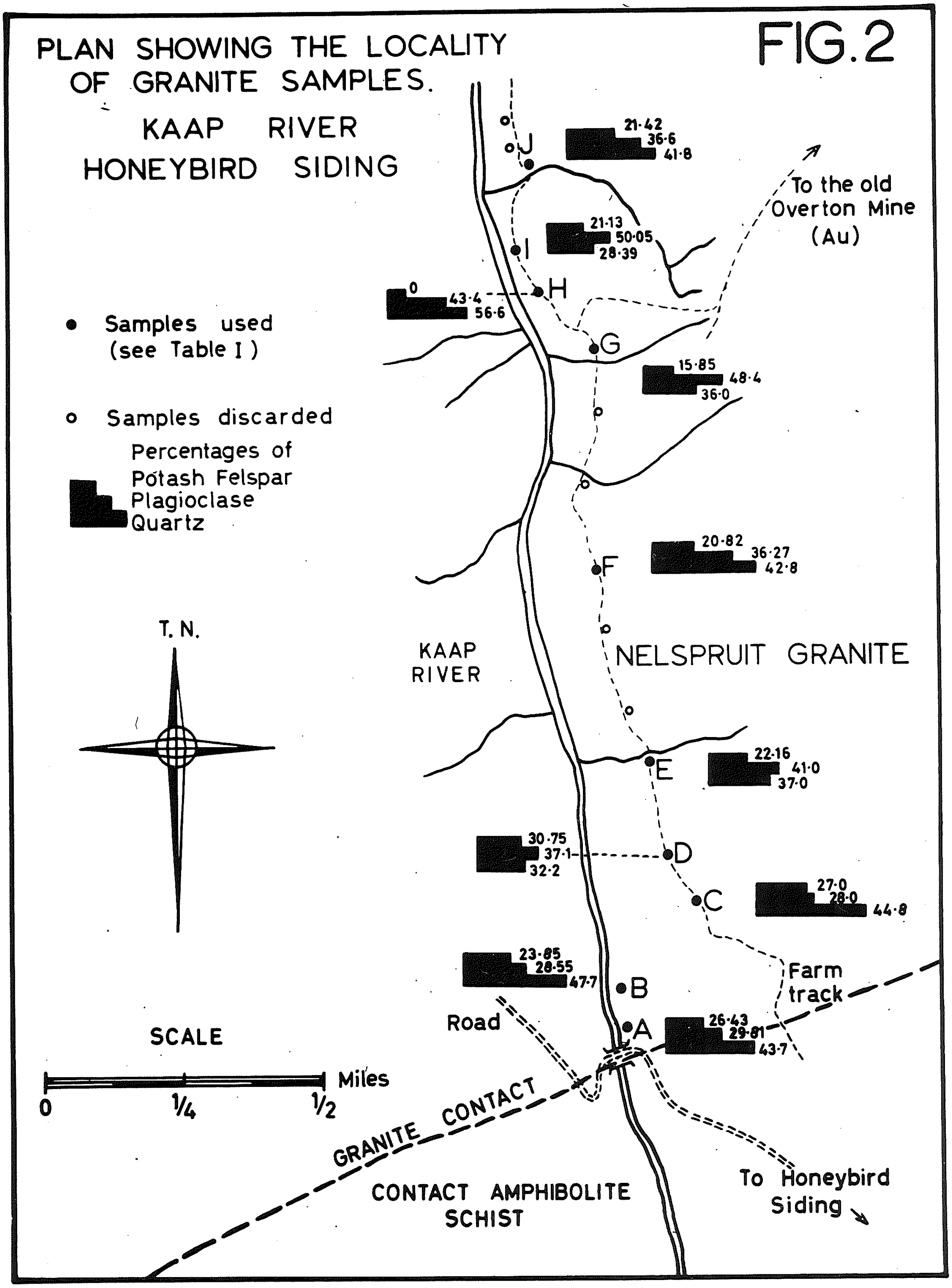
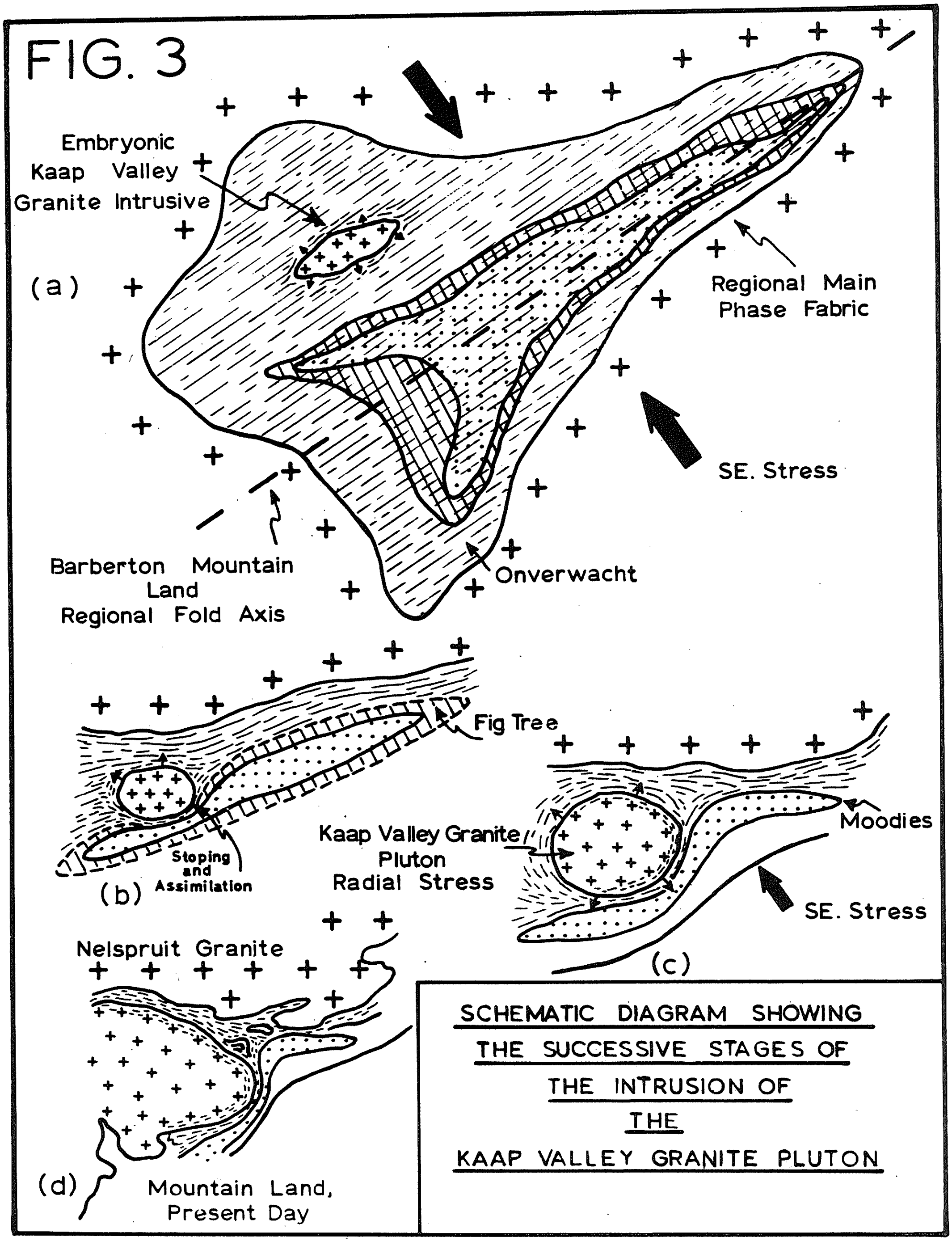

PLAN SHOWING THE LOCALITY
OF GRANITE SAMPLES.
KAAP RIVER
HONEYBIRD SIDING
Samples used
(see Table I)
Samples discarded
Percentages of
Potash Felspar
Plagioclase
Quartz
T. N.
SCALE
0
1/4
1/2
Miles
To the old
Overton Mine
(Au)
J
21·42
36·6
41·8
I
21·13
50·05
28·39
H
0
43·4
56·6
G
15·85
48·4
36·0
F
20·82
36·27
42·8
NELSPRUIT GRANITE
KAAP
RIVER
E
22·16
41·0
37·0
D
30·75
37·1
32·2
C
27·0
28·0
44·8
B
23·85
28·55
47·7
A
26·43
29·81
43·7
Farm
track
Road
GRANITE CONTACT
CONTACT AMPHIBOLITE
SCHIST
To Honeybird
Siding

FIG. 2

FIG. 3



SCHEMATIC DIAGRAM SHOWING
THE SUCCESSIVE STAGES OF
THE INTRUSION OF
THE
KAAP VALLEY GRANITE PLUTON

PLATE 1

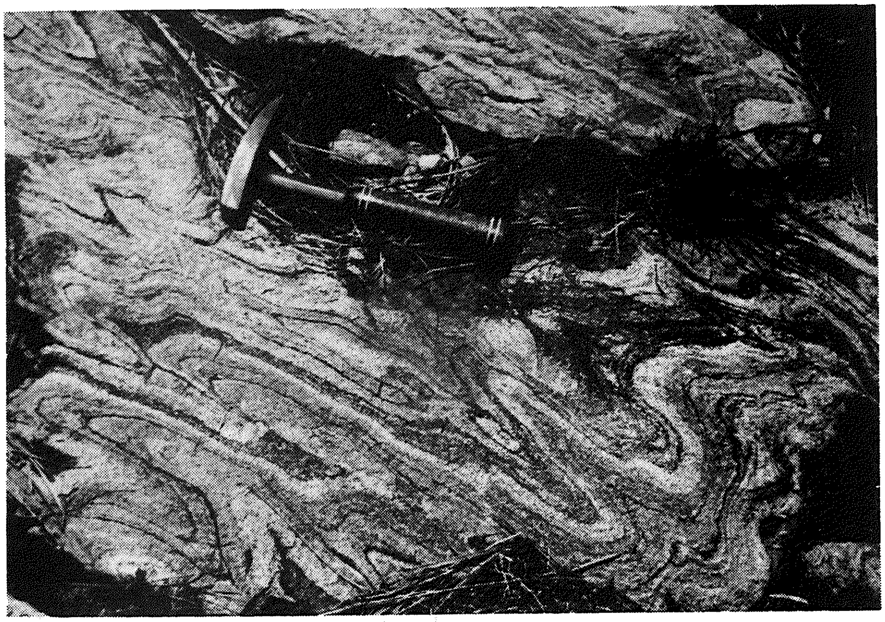


Fig.1

Fig. 2

PLATE 2

Fig.1

Fig.2

PLATE 3

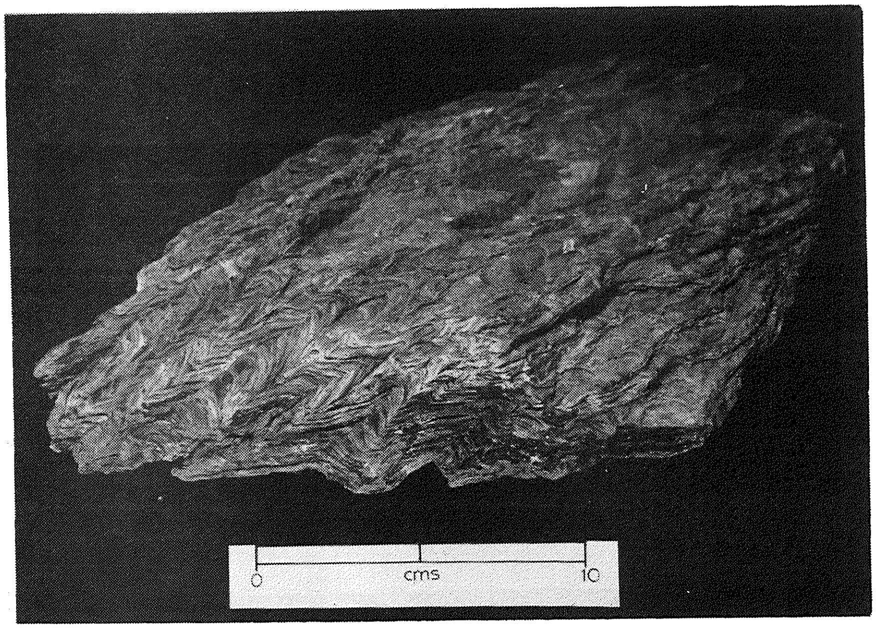


Fig. 1

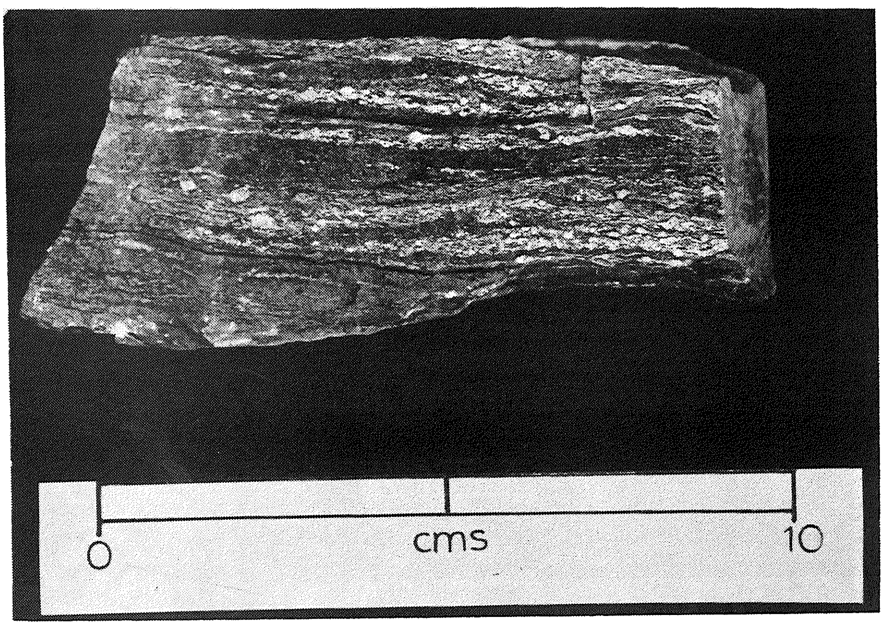


Fig. 2

PLATE 4

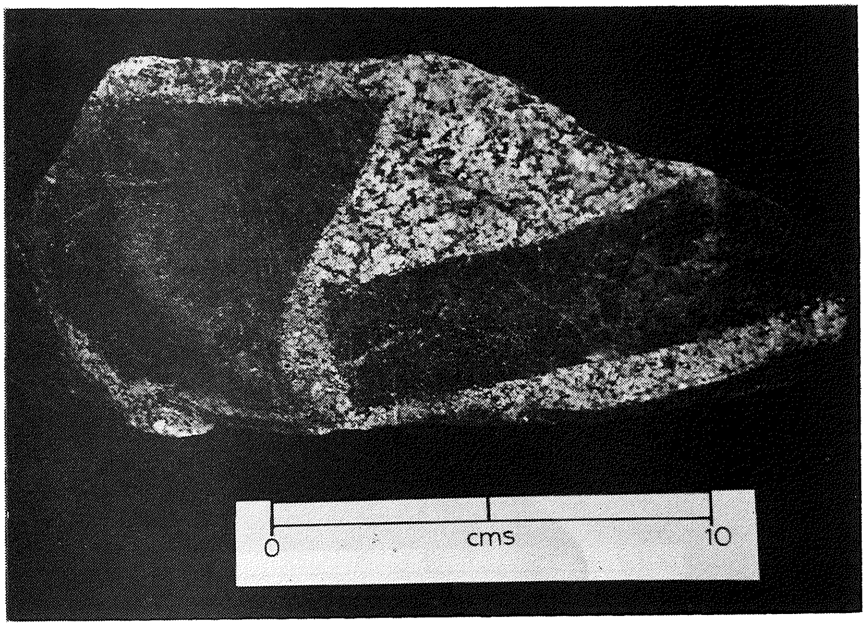


Fig. 1

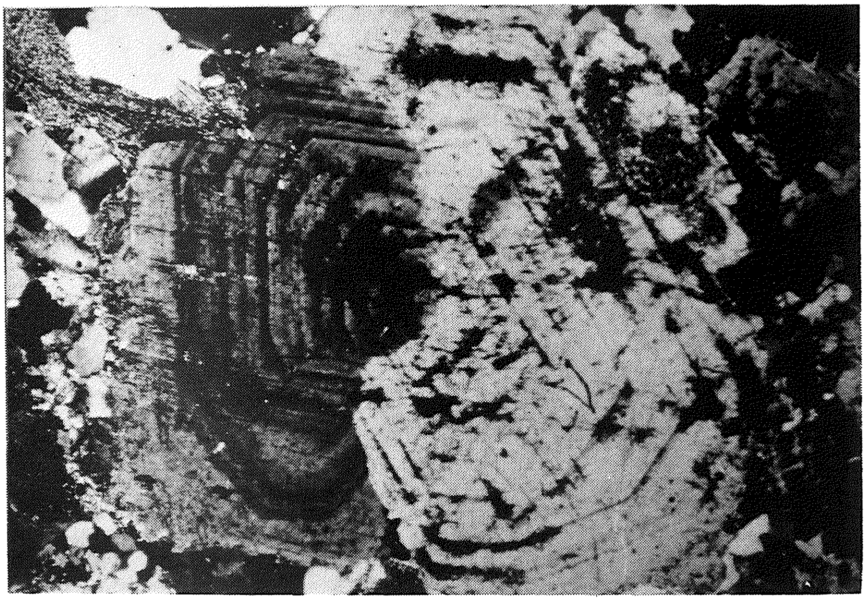


Fig. 2

PLATE 5

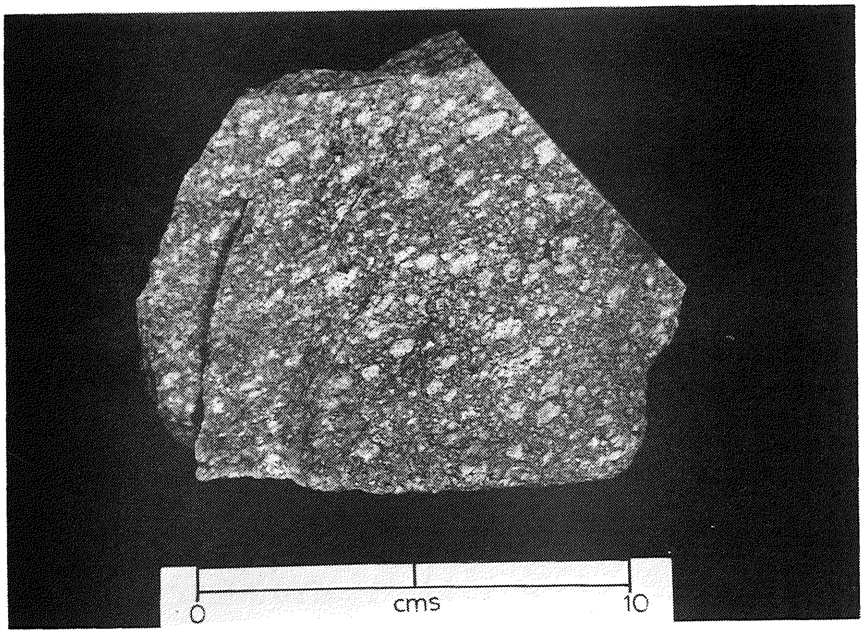


Fig. 1

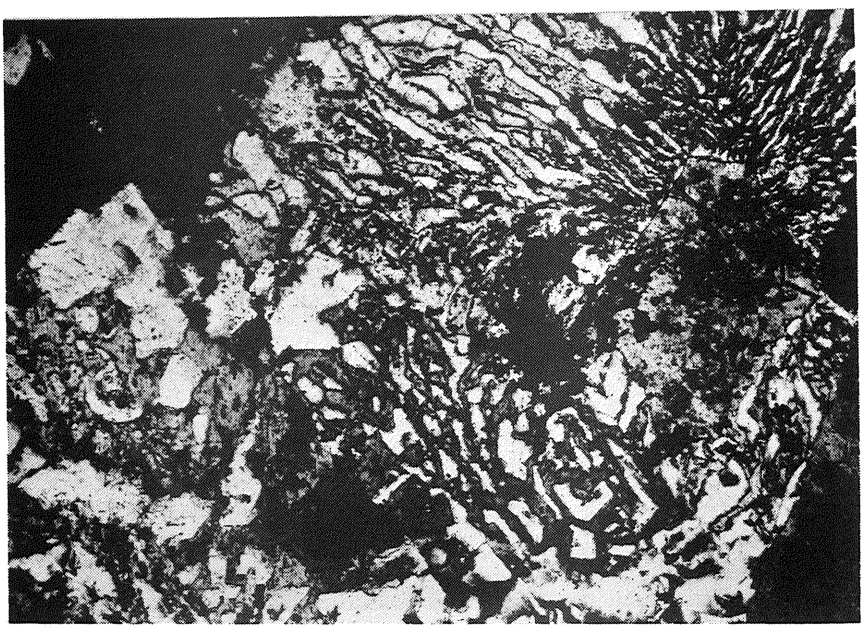


Fig. 2

PLATE 6

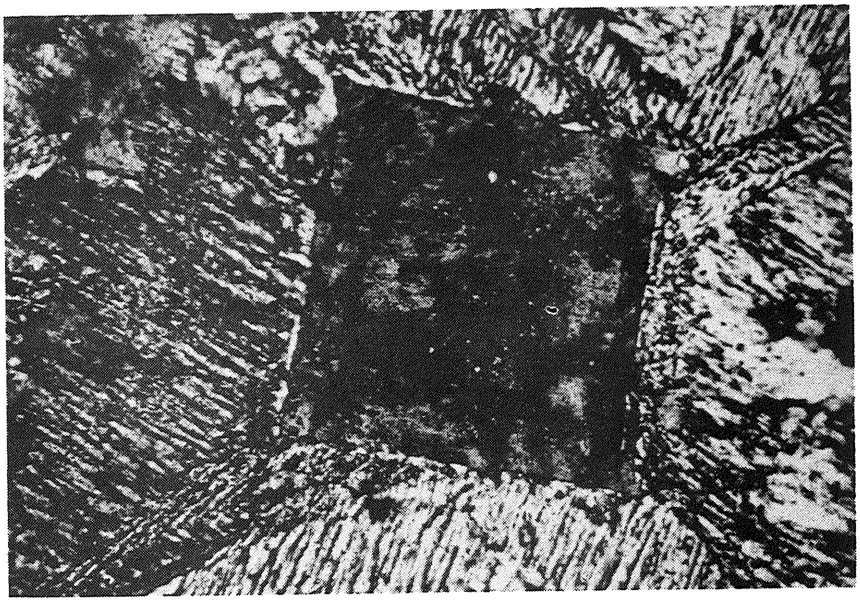


Fig. 1

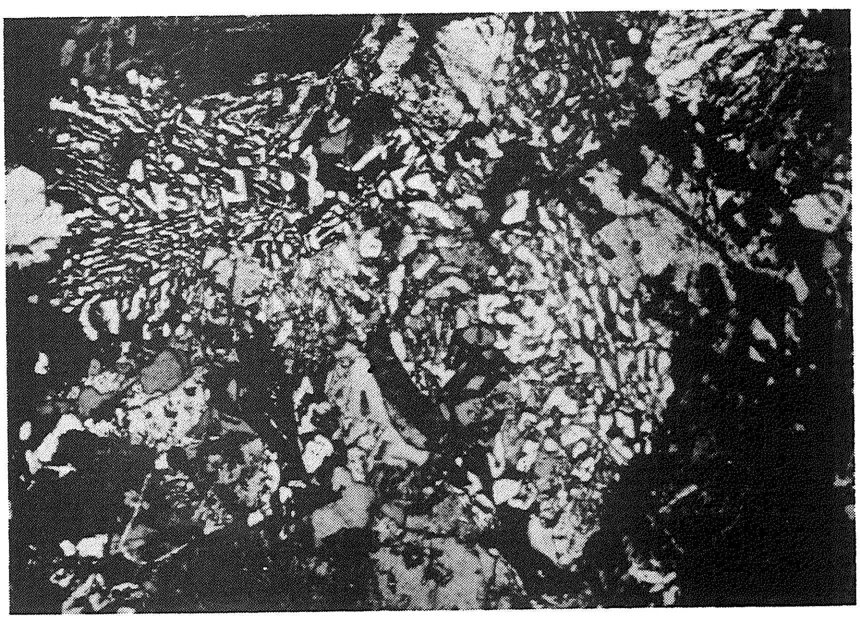


Fig. 2