COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1968 / 144

The Geology of the Pillara Range Precambrian Inlier, Noonkanbah 1:250,000 Sheet Area SE 51-12, Western Australia

by

J. Sofoulis, and D.C. Gellatly*
(Geological Survey of Western Australia)*

THE GEOLOGY OF THE PILLARA RANGE PRECAMBRIAN INLIER, NOONKANBAH 1:250,000 SHEET AREA SE/51-12, WESTERN AUSTRALIA.

by

J.Sofoulis* and D.C. Gellatly

RECORDS 1968/144**

* Geological Survey of Western Australia.

** Previously issued as Geological Survey of Western Australia Record 1968/10.

THE GEOLOGY OF THE PILLARA RANGE PRECAMBRIAN INLIER, NOONKANBAH 1:250,000 SHEET AREA, SE/51-12. WESTERN AUSTRALIA

by

J. Sofoulis* and D.C.Gellatly

RECORDS 1968/144**

Contents

* Geological Survey of Western Australia.

** Previously issued as Geological Survey of Western Australia Record 1968/10.

SUMMARY

The Pillara Range Precambrian inlier, an area of about 40 square miles, has been mapped on 1:50,000 scale. Most of the inlier consists of widespread biotite adamellite with small areas of associated granodiorite, tonalite, and aplite.

Along the south western margin fine-grained rhyolitic ash-flow tuffs (Whitewater Volcanics) and minor remnants of older pelitic schists (Halls Creek Group) flank the granitic rocks, and form a zone up to one mile wide.

The volcanics are a bedded sequence that trends northwest and dips steeply to the southwest. The intrusive rocks are mostly massive and structureless apart from localized foliation and jointing. Linear structures in the volcanics plunge consistently southwest and parallel those of the Halls Creek mobile zone to the east, rather than those of the nearby King Leopold mobile zone.

The Precambrian rocks are overlain unconformably by, and faulted against, Devonian limestone including reef, fore-reef, and black reef facies.

No economic minerals have been found in the area. Water supplies (mainly sub-artesian) are obtained from the overlying Devonian limestone reef complexes.

INTRODUCTION

An outcrop of Precambrian rocks, described here as the Pillara Range inlier is located between the Virgin Hills and the Pillara Range in the northeastern part of the Noonkanbah 1:250,000 Sheet area. The remainder of the Sheet area is occupied by Devonian and younger formations that form part of the Canning Basin.

The inlier was investigated in June 1967 by D. Gellatly (B.M.R.) and J. Sofoulis (G.S.W.A.) as part of a programme to complete the geological mapping of the Precambrian rocks in the West Kimberley region of Western Australia.

LOCATION AND ACCESS

The Precambrian inlier occupies some 40 square miles of country lying 20 to 30 miles southeast of Fitzroy Crossing. The Great Northern Highway, linking Fitzroy Crossing with Halls Creek, passes within half a mile of the northwestern end of the inlier.

Access to the area is by station track to No.2 outcamp bore (Gogo Station) which leaves the highway approximately 31 miles southeast of Fitzroy Crossing (and 23 miles from Gogo homestead), thence by a northeasterly route that crosses the inlier, and passes through Menyous Gap in the Pillara Range to Emanuel Bore (see Plate 1).

Further access through gaps in the Virgin Hills can be gained from a station track which parallels the Virgin Hills some 2 miles from the western Devonian--Precambrian boundary, and links No.2 outcamp bore with No.3 outcamp bore, Virgin Creek bore, and Bob bore.

Access by four-wheel drive vehicles is possible over most of the area of Precambrian rocks.

PREVIOUS INVESTIGATIONS

The geology of the Noonkanbah Sheet area has been described briefly by Thomas (1958). Further descriptions of the geology of the northern part of the Canning Basin (which includes the Noonkanbah Sheet area) are given by Guppy and others (1958) and Veevers and Wells (1961). Playford and Lowry (1966) give a detailed description of the Devonian reef complexes that flank the Precambrian inlier as well as providing a bibliography on the earlier work.

These previous investigations were concerned mainly with the Palaeozoic and Mesozoic sediments in the northern part of the Canning Basin, with particular reference to the stratigraphy, structure, and oil-bearing potential of the sedimentary strata. Until the present investigation, the Precambrian rocks were not examined in detail, and where specifically referred to, they were collectively assigned to the Lamboo Complex or were described briefly as a complex of igneous and metamorphic rocks.

PRESENT SURVEY

Mapping of the Precambrian inlier was carried out in two days. J. Sofoulis mapped the southwestern part and D. Gellatly the northeastern part.

Vertical air photographs scale 1:50,000, taken in 1949 by the W.A. Lands and Surveys Department, were used for plotting of geological information in the field. The accompanying map was compiled at photo scale by the W.A. Mines Department Drafting Branch.

PHYSIOGRAPHY

The Precambrian rocks of the inlier, mainly granite, occupy a broad depression approximately 12 miles long and 3 to 4 miles wide, rimmed by limestone ranges.

The Precambrian rocks are exposed mainly in interfluve areas as bare low hills, rock pavements, and stony rises, interspersed with spinifex-covered sandy pediments. General relief is seldom greater than 60 feet, although isolated granite tors reach 100 feet or more above drainage floor levels in the inlier's southern extension north of Home Range.

Limestone ranges which flank the inlier rise some 100 feet to 150 feet above it and comprise the prominent hilly belts of the Pillara Range, Home Range, Virgin Hills, Limestone Billy Hills, and Outcamp Hill. The edges of the limestone ranges are commonly flanked by flat, low-lying spinifex-covered, sandy pediments up to half a mile or more wide, formed on Precambrian rocks. These pediments abut steep rock faces of limestone but there is little limestone debris on their surfaces.

Streams draining the Precambrian rocks are tributaries of Christmas Creek. They have their headwaters in the limestone ranges and drain westerly across the Precambrian rocks and then southwest from near Outcamp Hill to join Christmas Creek.

All drainages flow only during the wet season. Springs which issue from the ranges (e.g. Virgin Spring, Mountain Home Spring, Melon Spring) are mostly permanent and are used as stock watering points.

GEOLOGY

The Precambrian rocks of the inlier consist of granites and acid volcanics of Proterozoic age, with subordinate schists (Halls Creek Group) of probable Archaean age (Bofinger, 1967). They have a west-northwest trend parallel to that of the King Leopold mobile zone to the north. The Precambrian rocks are overlain unconformably by a Devonian limestone reef complex (Playford and Lowry, 1966). Plate 1 shows the distribution of the Precambrian rocks and the various reef facies flanking the inlier.

Acid volcanics and granitic rocks similar to those of the inlier found elsewhere in the Kimberley region have previously been assigned to the Lamboo Complex (Matheson and Guppy, 1949) which is now regarded as being of Proterozoic age. From recent mapping in the adjacent Lennard River Sheet area, Gellatly and others (in prep.) have proposed an informal subdivision of the Lamboo Complex into an early Lamboo Complex consisting of pre-Whitewater Volcanic intrusives, a middle Lamboo Complex comprising the Whitewater Volcanics and associated high-level intrusives, and a late Lamboo Complex consisting of intrusives that post-date the Whitewater Volcanics.

The acid volcanics of this inlier area are accepted as being equivalent to the Whitewater Volcanics and are therefore assigned to the middle Lamboo Complex. The granitic rocks intruding these volcanics are assigned to the late Lamboo Complex.

Petrographical descriptions by D.C. Gellatly, and by Miss R. Peers (G.S.W.A. Petrological Report 155) are given in the appendix. Specimen localities are shown on the accompanying map.

HALLS CREEK GROUP (Ah)

The Halls Creek Group (so named by Dow and others, 1964) is a series of metamorphosed eugeosynclinal sediments, and is represented here by scattered remnants of sericite-muscovite-biotite schist.

Field occurrence

Near the northwestern end of the inlier two small outcrops, separated by an area of soil cover, indicate a narrow east-west belt of metamorphics extending for over half a mile.

The schists are overlain by Whitewater Volcanics (Pw) and intruded by granodiorite ($Ƀbp_2$) and adamellite ($Ƀbp_1$). The schists show no appreciable contact metamorphism. The granodiorite has pronounced variation in grain-size and mafic content near the contact with the schists, and contains xenoliths of schist in varying stages of assimilation. Xenoliths of these metamorphics are also present in the adamellites of the southeastern part of the inlier.

The schists are strongly foliated and lineated, with foliations mostly dipping steeply to southwest, parallel or nearly so to those of the overlying acid volcanics.

Petrography

The dominant rock type is a pelitic or semi-pelitic sericite-muscovite-biotite-quartz schist. Psammitic quartz-biotite-muscovite-oligoclase schist is less common.

The most noteworthy feature of these schists is the presence of 2 to 3 mm long aggregates of finely-crystalline sericite which contains rare small inclusions of corundum. Similar rocks from the Lennard River area contain well-preserved andalusite (chiastolite) pseudomorphs consisting entirely of sericite and corundum, and the schists of the Pillara Range inlier are likewise considered to be andalusite schists that have undergone retrograde metamorphism. Evidence from thin-sections, that movement probably accompanied the alteration of andalusite, suggests that the retrograde metamorphism was a phase of the regional metamorphism, rather than a localised effect resulting from the intrusion of the granodiorite.

MIDDLE LAMBOO COMPLEX

WHITEWATER VOLCANICS (Pw)

Porphyritic acid volcanics referred to the Whitewater Volcanics (Dow and others, 1964) are preserved along the south-western side of the inlier. They overlie schists of the Halls Creek Group and are intruded by granite.

Field occurrence

The Whitewater Volcanics occupy approximately 30 per cent of the inlier area. They are confined to the western side where they form a southwesterly dipping sequence. The belt underlain by the volcanics ranges from less than a half mile wide in the southern part of the area to a little over one mile wide in the northern part (near Outcamp Hill).

Figure 1a. Typical low granite tor outcrop: 3 miles south of Emanuel Bore. D.C.G.

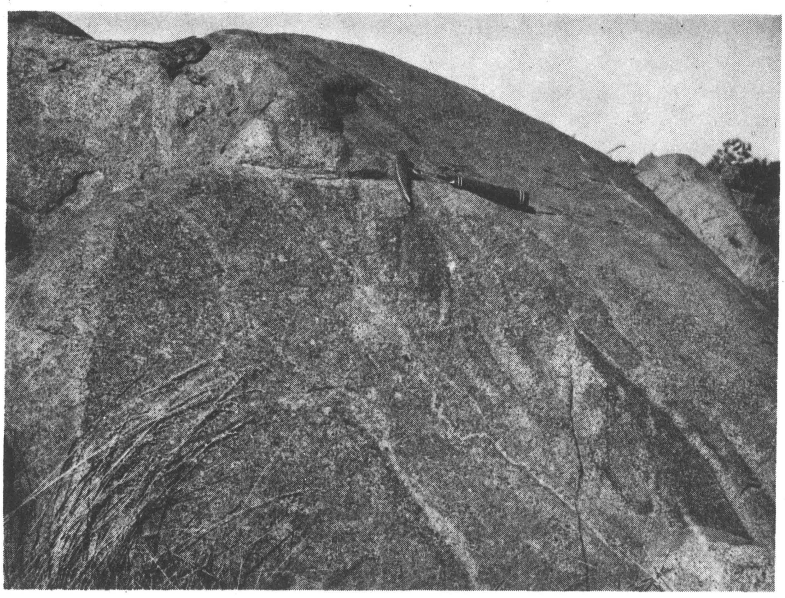


Figure 1b. Outcrop of granodiorite (Ebk_2) showing flow-orientation of partially assimilated biotite-rich xenoliths derived from adjacent Halls Creek Group schists. The orientation of xenoliths parallels the contact: one mile east of Outcamp Hill. D.C.G.

Exposures are mainly tilted sheets of tombstone slabs rising a few feet above ground level. Other exposures are elongated stony hills with relatively smooth topography.

The Whitewater Volcanics consist of a thick sequence of ash-flow tuffs similar to those described for the Lennard River Sheet area. (Gellatly and others, in preparation). The bulk of these volcanics are dark grey, brown, chocolate, pink or light green, fine-grained brittle rocks, some of which are strongly sheared. They have a foliation banding which has resulted from either flow or compaction, as well as bedding. They are commonly porphyritic, consisting of phenocrysts and fragments of quartz and feldspar up to 5 mm, set in a cryptocrystalline groundmass.

Granitic rocks intrude the Whitewater Volcanics with variously sharp or gradational contacts. These contacts generally dip steeply and appear concordant with bedding in the volcanics, but locally the granites are transgressive. In the central part of the area, numerous xenoliths and remnant strips of Whitewater Volcanics are interlayered with granite to simulate migmatitic contacts. In some localities the contact is defined by narrow (6 inch) selvage zones. Quartz and aplite veins are common in the volcanics close to the granite contacts.

Devonian rocks which unconformably overlie the Precambrian are faulted against Whitewater Volcanics by the Virgin Hills fault. The contact is commonly soil covered, but is marked locally by secondary crystalline calcite veins up to 2 feet thick. These veins intrude the limestone reef complex as well as the uppermost part of the exposed Whitewater Volcanics sequence.

Petrography

Hand specimens of the Whitewater Volcanics are commonly porphyritic, and banded or well-foliated. The banding and foliation are particularly evident on the weathered surface.

Thin-section examination of three specimens showed that phenocrysts and phenocryst fragments consist of quartz, K-feldspar, and plagioclase. Quartz phenocrysts predominate; plagioclase phenocrysts are subordinate to K-feldspar.

The quartz phenocrysts are euhedral and commonly embayed. Some have been destroyed by shearing and recrystallization, and now form polygonal aggregates. K-feldspar and plagioclase (An_{35}) phenocrysts are euhedral and tabular. Small clots of biotite and epidote with some magnetite probably pseudomorph original pyroxene phenocrysts. Minor muscovite and carbonate are developed along shear planes.

The groundmass has an a.g.d. of 2Q and is a mosaic of quartz, microcline, plagioclase, and magnetite. Most grains are elongated parallel to the foliation. Sphene and epidote are accessory minerals. Minor pyrite is visible in hard specimens, but not in thin-section. There is small-scale compositional flow-banding in the matrix, but eutaxitic structures are absent.

LATE LAMBOO COMPLEX

There are four main suites of acid intrusive in the area. They are (a) coarse-grained biotite adamellite, (b) coarse-grained biotite granodiorite, (c) biotite tonalite and microtonalite, (d) medium-grained leucocratic aplite. The first two are plutonic intrusions that occupy most of the area and the others are minor intrusions of limited extent. The first three suites are characterized by small amounts of allanite and are apparently derivatives of a single magma. The plutonic rocks are tentatively correlated with parts of the Bow River Granite of the East Kimberley (Roberts and others 1965) and the microtonalite with the Violet Valley Tonalite (Gemuts, 1965).

BIOTITE ADAMELLITE (Ꝑbp$_1$)

This suite consists of a medium- to coarse-grained biotite adamellite (grey, pink or mottled) with minor granitic and granodioritic phases. The adamellite is sparsely porphyritic and is locally foliated to give a gneissic appearance. Xenoliths of biotite-rich metasediment and of Whitewater Volcanics in various stages of assimilation are present locally (Fig.1b, 2b).

Field occurrence

The "biotite adamellite" is extensively exposed and comprises 85 per cent of the total granitic area.

Over most of the area it crops out as low tors (Figure 1a), and stony pavements interspersed with sandy pediments. More prominent exposures are found as rounded hills up to 80 feet or more in height between the Pillara and Home Ranges.

Contact relationships

The adamellite intrudes and has sharp contacts with Whitewater Volcanics along the western side of the inlier. It is itself cut by tonalite and by aplite dykes and quartz veins. Elsewhere along the margin of the inlier the adamellite is faulted against, or is unconformably overlain by, Devonian rocks.

Where it intrudes the Whitewater Volcanics the adamellite commonly has chilled margins, also flow foliation parallel to the contact. In the central western part of the area, remnant belts and large xenoliths of Whitewater Volcanics, commonly up to 300 feet wide, are interlayered with the granite.

Petrography

Rocks of this map unit are mainly adamellite; granodiorite and probably granite, are also represented. Five specimens examined are all leucocratic, medium-grained, biotite-bearing, with an allotriomorphic granular texture. Some have a weak foliation resulting from preferential orientation of biotite flakes. They are mainly non-porphyritic but locally are sparsely porphyritic with irregular phenocrysts of pink microcline.

Quartz variously occurs as large (2 mm) anhedral strained grains commonly with smaller marginal subgrains, and as polygonal aggregates of 0.1 mm unstrained grains. K-feldspar, which tends to predominate over plagioclase, is mostly a microcline-microperthite containing up to 5 per cent of plagioclase, as small inclusions and as thin exsolution lamellae. Plagioclase of composition An_{10-15} forms subhedral grains up to 6 mm. It shows partial alteration to sericite and clinozoisite, especially in crystal cores. Biotite (both green and grey-brown varieties) forms discrete platy crystals and aggregates up to 3 mm. It is partly altered to penninite. Minor accessories, which include zircon, apatite, sphene, opaque ores, epidote, and metamict allanite, commonly occur in association with biotite or as inclusions within it.

BIOTITE GRANODIORITE ($\text{Ꝑ}bp_2$)

Field occurrence

Coarse-grained biotite granodiorite (with some biotite-hornblende granodiorite) has been noted near the northwestern part of the inlier, where it forms a discrete mass about 2 miles across. The granodiorite resembles the adamellite in hand specimen, but is distinguishable mainly by its higher biotite content.

It intrudes metasediments of the Halls Creek Group, and near the contact contains partially assimilated biotite-rich xenoliths of probable metasediment. At the contact the granodiorite has a flow foliation indicated by alignment of biotite flakes and of xenoliths, and it contains thin leucocratic granitic veins (Figure 1b). The adamellite is cut locally by small dykes of porphyritic microtonalite. Contacts with the Whitewater Volcanics are not exposed.

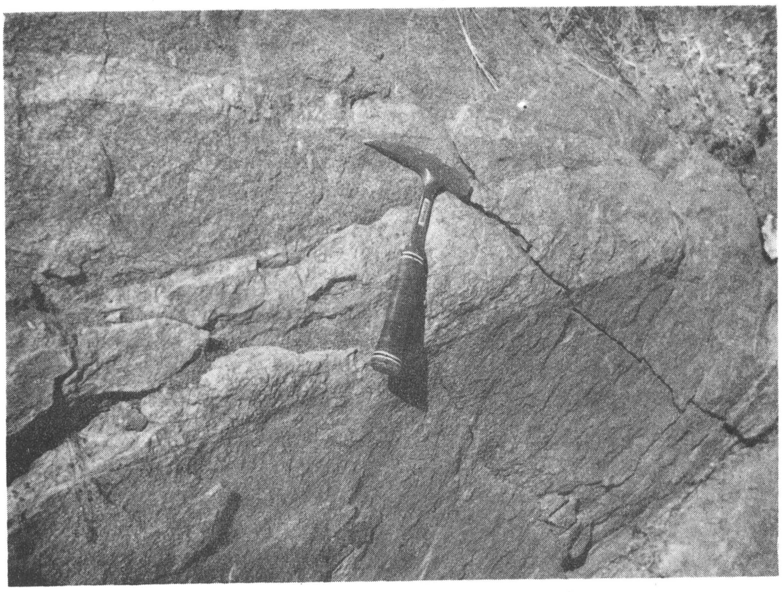


Figure 2a. Grey biotite adamellite (Bbp_1) cut by dykes of pink leucocratic aplite (ap): 3 miles NNE of No. 3 Outcamp Bore J.S. (FN 1226)

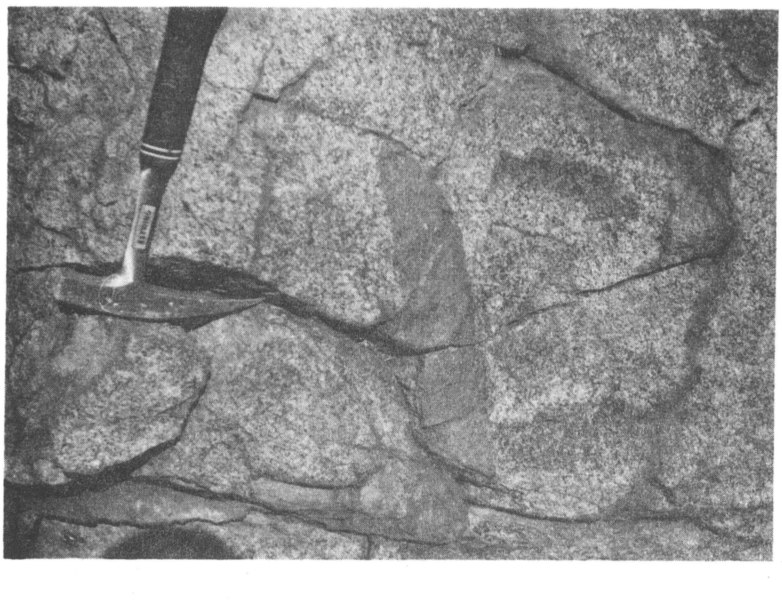


Figure 2b. Grey biotite adamellite (Bbp_1) with biotite-rich xenolith derived from Whitewater Volcanics (Bw): 3 miles WNW of Mountain Home Spring J.S. (FN 1227)

Petrography

Rocks of the granodiorite suite are mineralogically similar to those of the adamellite suite described above, but are compositionally closer to rocks of the tonalite suite (Figure 3a).

Some significant differences noted in the granodiorite suite include: a much more calcic variety of plagioclase (An_{28-38}) with more intense zoning and a slightly greater degree of alteration; K-feldspar tends to be interstitial and is partly replaced by myrmekite at interfaces with plagioclase; the presence of exsolution rods of rutile in biotite; and the presence locally of hornblende. Metamict allanite is an accessory.

BIOTITE TONALITE (Pbp_3)

Rocks of the tonalite suite are dark grey, medium-grained, biotite-rich, and are readily distinguished from the other acid intrusives of the inlier by their colour and smaller grain-size. However their topographic expression is similar to that of the other acid intrusives, and boundaries can only be delineated accurately after field observation. The tonalite may be equivalent to the Violet Valley Tonalite mapped in adjacent Sheet areas (Roberts and others 1965; Gellatly and others 1965).

Field occurrence

The tonalite is found mainly as small discrete masses intruding the biotite adamellite and Whitewater Volcanics. Thin dykes of porphyritic microtonalite cut the granodiorite. Veins of aplite which intrude the adamellite also penetrate the tonalite, particularly along shear zones.

Where the tonalite intrudes Whitewater Volcanics it has contact features similar to those described for biotite adamellite. Where in contact with the adamellite, the tonalite contains xenoliths of the adamellite, has chilled margins, and has a flow foliation parallel to the contact. Some biotite-rich xenoliths were noted.

Sheared equivalents of the tonalite, found locally in shear zones, are chloritic schist and phyllonite.

Petrography

Rocks of the tonalite suite are similar in their mineralogy to those of the adamellite and granodiorite suites. They are distinguished in the field by their smaller grain size, and in thin-section by their lower K-feldspar content, although isolated examples of rocks from the tonalite suite are sufficient K-rich, possibly through assimilation of adamellite close to the contact, to fall into the compositional field of granodiorite (Figure 3a).

Slightly zoned plagioclase, is common as phenocrysts and lies in the compositional range An_{28-35}. Microcline-microperthite, locally containing up to 20 per cent of exsolved 'veinlet' plagioclase, occurs as a late interstitial phase. Biotite is invariably a greenish variety; hornblende has been noted, but only in a specimen of porphyritic microtonalite dyke-rock. Sphene is a common accessory, locally forming grains up to 1 mm; opaque oxides are more abundant than in the other suites. The presence of allanite, although noted in only some of the specimens, suggests consanguinity with the other acid intrusives.

APLITE (ap)

The term aplite is used here to include dykes of leucocratic fine-grained adamellite (locally with pegmatitic phases), and larger masses of leucocratic muscovite-bearing adamellite. The latter is similar to the Mount Amy Granite of the Lennard River Sheet area (Gellatly and others, in preparation). Both types are probably derivatives of the biotite adamellite suite.

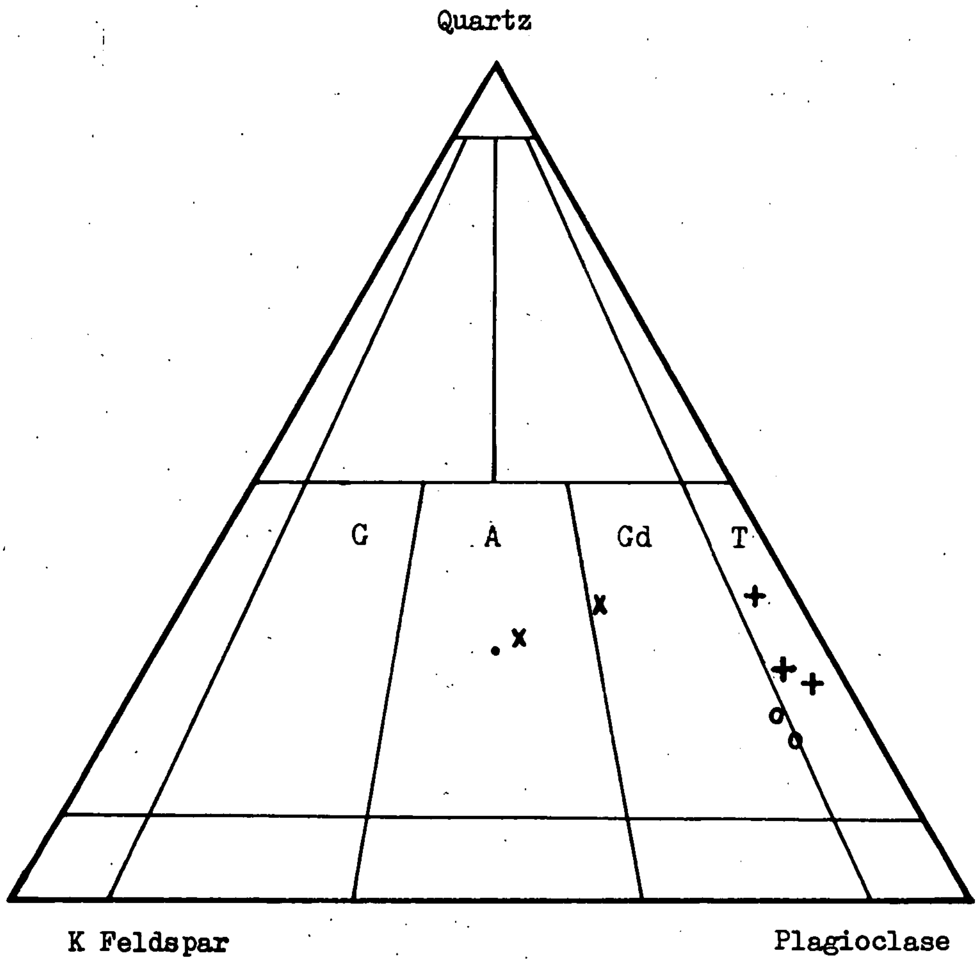


Figure 3a. Approximate modal compositions of acid intrusives of the Pillara Range Precambrian inlier. x adamellite suite; . aplite; o granodiorite; T tonalite. Compositional fields modified from Johannsen (1939).

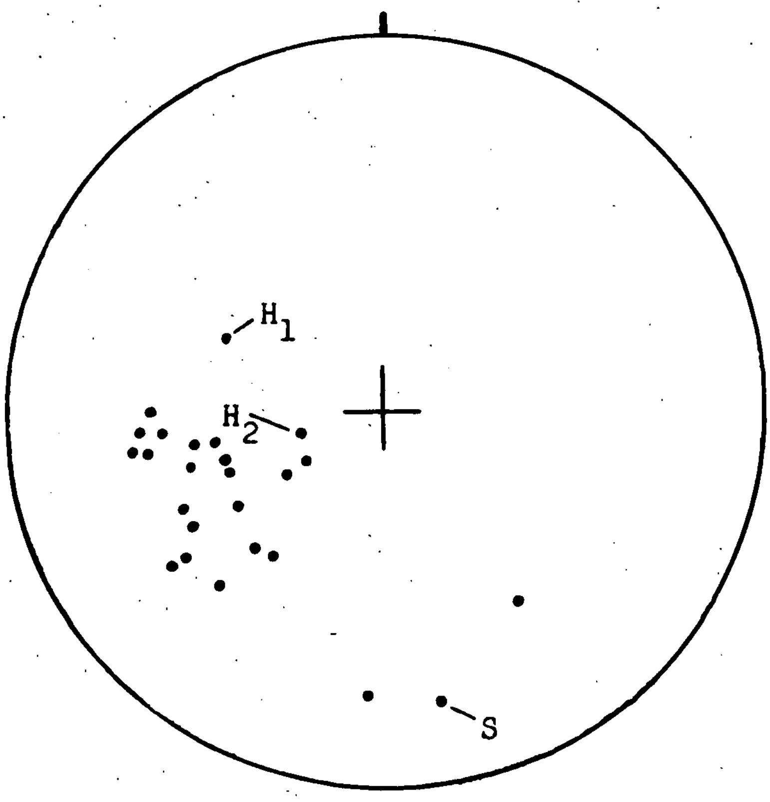


Figure 3b. Lower hemisphere projection of lineation trends, Pillara Range Precambrian inlier. H_1, H_2, lineations in Halls Creek Group. S lineation in shear.

Field occurrence

Dykes of aplite mostly only 1 to 3 feet thick but with isolated examples up to 50 feet thick, are found over most of the area of adamellite outcrop. A single intrusion of leucocratic muscovite-bearing adamellite about one mile southwest of Mountain Home Spring, is more than ½ a mile long and 1/5 of a mile wide.

Trends of the aplite dykes are variable, but two principal trends are apparent; north, and east-northeast. The muscovite-bearing adamellite trends northwest, parallel to the contact of the Whitewater Volcanics and the enclosing adamellite.

The aplite is mostly poorly exposed, forming low rubbly linear outcrops. The muscovite-bearing adamellite forms blocky and stony pavements with isolated tors up to 10 feet above the general surface level.

Dykes and veins of aplite cut the Whitewater Volcanics, and rocks of the adamellite and tonalite suites; none have been observed cutting the granodiorite. Contacts are sharp. Margins are commonly finer-grained than the cores, but a few aplite dykes have pegmatitic margins. A flow foliation parallel to the contact was noted in one place.

Most of the aplites are grey white to pale pink, and consist of fine- to medium-grained leucocratic adamellite. Coarse-grained and pegmatitic schlieren are present locally in some of the dykes. One example from a large mass of muscovite-bearing adamellite is entirely pegmatitic with large feldspar and muscovite grains up to several inches across in the central part of the dyke, decreasing to ⅛ inch at the margins. Apart from quartz and pink feldspar, the only minerals noted in these dykes in the field are muscovite, biotite, ?allanite, and pale green sericitised feldspar.

The muscovite-bearing adamellite is generally massive and unfoliated, and locally contains scattered inclusions of biotite adamellite and tonalite, as well as partly assimilated biotite-rich xenoliths probably derived from the Halls Creek Group.

Petrography

Rocks of the aplite suite are characterised by their hololeucocratic character and fine to medium grain-size. They consist almost entirely of quartz, K-feldspar, and plagioclase, minor amounts of muscovite, and traces of sphene, epidote, clinozoisite, chlorite, and goethite.

Quartz occurs as an equigranular mosaic of clear unstrained 0.1 mm grains between larger (0.5 to 1 mm) feldspar, or as larger strained grains. K-feldspar is a microcline microperthite in an aplite from near Menyous Gap, but microcline in a muscovite-bearing type from the southeast. The plagioclase is a sodic oligoclase (ca An_{15}) which is slightly turbid due to incipient alteration to sericite and clinozoisite.

STRUCTURE

The Precambrian rocks of the inlier are part of a structurally complex zone defined by Traves (1955, p.91) as the King Leopold mobile zone. Northwest structural trends which are characteristic of this Zone, are associated locally with northeast trends that characterize the Halls Creek mobile zone to the east. Rocks of the inlier are similar in both trend and intensity of folding to the Precambrian rocks within the mobile zone, and it appears that the southern concealed boundary of the King Leopold mobile zone lies to the southwest of this inlier.

Most of the deformation of the Precambrian rocks is probably of Precambrian age. A mild post Devonian deformation may have affected the inlier, since dips in the limestones range from a few degrees up to 50^{o} or more, and are interpreted as being partly structural and partly depositional.

However no evidence of the Palaeozoic deformation was detected in the Precambrian rocks.

Bedding and foliation

Bedding planes of the Whitewater Volcanics parallel the regional northwest trend and dip southwest. Graded bedding noted in tuffaceous beds shows that they are west-facing and not overturned. Sheared Whitewater Volcanics have a foliation more or less coincident with bedding or differing from it by only a few degrees.

Foliation directions recorded in the granitic areas conform mainly with those of the Whitewater Volcanics. An igneous flow foliation with arcuate trend in the northwest suggests proximity to a contact (probably with the Halls Creek Group) that has a similar arcuate trend.

Lineations

Lineations as recorded by alignment of mineral grains (mainly biotite) are prominent in the Precambrian rocks. The lineations plunge at 50^{o} to 70^{o} in a south-westerly (220^{o} to 270^{o}) direction, their plunge locally coincides in amount and direction with bedding or foliation dip. Plunges of lineations are mostly steeper in the southeastern part of the area than in the northwestern part. Sparse lineations in the granite, are the result of inter-section of two foliations. They have plunges similar to those in the Whitewater Volcanics.

The southwesterly plunge is unusual, since the dominant plunges in the King Leopold mobile zone are to the northwest or southeast. However, southwest plunges are known also from the Surprise Creek area of the King Leopold mobile zone, and they predominate in many areas of the Halls Creek mobile zone to the east.

Folding

Folding is not well displayed in the Precambrian rocks of the inlier area and no detailed fold pattern was resolved.

The constant plunge of lineations recorded within the area suggests that the sequence of Whitewater Volcanics as exposed in this inlier would represent the western limb of an anticlinal structure plunging southwest.

Faults and shear zones

Faults and shears within the Precambrian inlier are zones of sericitic and chloritic schist and phyllonite, together with discontinuous quartz reefs and quartz breccias. These zones range from a few feet up to 50 feet or more wide and mostly dip steeply towards the southwest and conform with the bedding foliation noted in the Whitewater Volcanics. Minor flat to steeply-dipping faults and shears of random orientation are also present locally.

Shearing and faulting within the granite have also produced various porphyroclastic schists in which gradation from foliated granite to phyllonite can be traced in the field. Many of the schist zones contain lenticular quartz veins up to 5 feet or more thick which usually are more resistant than the adjacent granitic rocks and form prominent ridges.

Most of the faults and shears are regarded as Precambrian in age although it is likely that some of them were reactivated during Palaeozoic times.

The more conspicuous Palaeozoic faults are described by Playford and Lowry (1966). The Virgin Hills fault, believed to be a normal fault with a throw of at least 2,000 feet, runs along the east side of the Virgin Hills and throws the Devonian reef facies and conglomerate down against Whitewater Volcanics and granitic rocks of the inlier.

The Home Range fault, a large fault extending along the eastern side of the Home Range, faults the middle Devonian back-reef facies down against Precambrian adamellite. The throw of this fault is estimated to be greater than 1,000 feet. To the southeast, the fault branches into a number of smaller faults: in the other direction it appears to die out in Precambrian rocks.

The northwestern end of the Precambrian inlier is also marked by another normal fault and a large number of smaller faults branching off it.

ECONOMIC GEOLOGY

There are no economic mineral deposits known within the Precambrian rocks of this area. Traces of fluorite were noted in adamellite about 2 miles south of Menyous Gap and scattered grains of pyrite were recorded in the tonalite 3 miles northeast of No.3 Outcamp Bore.

Road construction materials

Devonian limestone currently provides a source for materials used in constructing, surfacing, and bitumenising the road between Derby and Fitzroy Crossing. With the extension of the bitumen towards Halls Creek, the limestone, and the volcanics and granite of this inlier area, could provide a source of material for this purpose.

Water

The only surface water noted in the Precambrian area was that from Mountain Home Spring which issues from the unconformity between the Devonian and underlying Precambrian about 5 miles northwest of Bob Bore. Melon Spring and Pillara Spring within the Pillara Range limestone belt are also permanent. No water bores have been sunk in the Precambrian rocks, since these are regarded as poor prospects for underground water.

Water supplies mainly sub-artesian, for stock in the area are provided by bores sunk directly into the limestone fronting the ranges. The water is obtained mainly from joints and solution channels in the limestone. Bore depths range from 100 feet at Emanuels Bore to 405 feet at Donald Bore (see Plate 1).

REFERENCES

Bofinger, V.M., 1967, Geochronology in the East Kimberley region, Western Australia: Australian New Zealand Assoc. Cong. 39th Abstracts I.12-13.

Dow, D.B., Gemuts, I., Plumb, K.A., and Dunnet, D., 1964, The geology of the Ord River region, Western Australia: Australia Bur. Mineral Resources Rec.1964/104 (unpublished).

Gellatly, D.C., Derrick, G.M., and Plumb, K.A., 1965, The geology of the Lansdowne 1:250,000 Sheet SE/52-5, Western Australia: Australia Bur. Mineral Resources Rec.1965/210 (unpublished).

Gellatly, D.C., Sofoulis, J., Derrick, G.M., and Morgan, C.M., in preparation, The Precambrian geology of the Lennard River 1:250,000 Sheet SE/51-8, Western Australia: Australia Bur. Mineral Resources (unpublished).

Gemuts, I., 1965, Metamorphism and igneous activity in the Lamboo Complex, East Kimberley area, Western Australia: Australia Bur. Mineral Resources Rec.1965/242 (unpublished).

Guppy, D.J., Lindner, A.W., Rattigan, J.H., and Casey, J.N., 1958, The geology of the Fitzroy Basin, Western Australia: Australia Bur. Mineral Resources Bull.36.

Johannsen, A., 1939, A descriptive petrography of the igneous rocks. Vol.1: Chicago, Univ. Chicago Press.

Matheson, R.S., and Guppy, D.J., 1949, Geological reconnaissance in the Mt. Ramsay area, Western Australia: Australia Bur. Mineral Resources Rec.1949/48 (unpublished).

Peers, R., 1968, West. Australia Geol. Survey Petrological Rept.155 (unpublished).

Playford, P.E., and Lowry, D.C., 1966, Devonian reef complexes of the Canning Basin, Western Australia: West. Australia Geol. Survey Bull.118.

Roberts, H.G., Halligan, R., and Gemuts, I., 1965, Geology of the Mount Ramsay 1:250,000 Sheet area, E/52-9, Western Australia: Australia Bur. Mineral Resources Rec.1965/156 (unpublished).

Thomas, G.A., 1958, Explanatory notes on the Noonkanbah 4-mile geological sheet: Australia Bur. Mineral Resources Explan. Notes 10.

Traves, D.M., 1955, The geology of the Ord-Victoria region, Northern Australia: Australia Bur. Mineral Resources Bull.27.

Veevers, J.J., and Wells, A.T., 1961, The geology of the Canning Basin, Western Australia: Australia Bur. Mineral Resources Bull.60.

STRATIGRAPHIC TABLE - PILLARA RANGE PRECAMBRIAN INLIER, NOONKANBAH SHEET AREA, W.A.

Age		Rock unit	Lithology	Stratigraphic relationship	Topography	Remarks	Distribution and structure
PROTEROZOIC	LATE LAMBOO COMPLEX	Aplite (ap)	Aplite with localised pegmatitic phases; felsite; muscovite-bearing granite/adamellite	Intrudes adamellite, tonalite, and Whitewater Volcanics	Aplite dykes form low linear bouldery outcrops; muscovite-bearing adamellite forms stony pavements	Probably residual phase of adamellite magma	Scattered aplite dykes over most of the area; muscovite-bearing type forms a small lenticular body one mile southwest of Mountain Home Spring
		Biotite tonalite($\mathit{P}bp_3$)	Biotite tonalite and microtonalite, locally porphyritic; minor biotite granodiorite	Intrudes adamellite	Low bouldery outcrops; small tors	Differs only slightly in composition from granodiorite	Small scattered stocks, lenses and dykes south and west of Mountain Home Spring, and in northwest near Menyous Gap
		Biotite granodiorite($\mathit{P}bp_2$)	Coarse-grained biotite and plagioclase-rich granodiorite	Intrudes Halls Creek Group; intruded by dyke of porphyritic microtonalite	Low tors and rounded bouldery hills	Distinguishable in field from adamellite only in its higher biotite content. Flow foliated.	Forms a single discrete pluton at the northwest end of the inlier

Age		Rock unit	Lithology	Stratigraphic relationship	Topography	Remarks	Distribution and structure
PROTEROZOIC	LATE LAMBOO COMPLEX	Biotite adamellite(Pbp$_1$)	Coarse-grained biotite adamellite; minor granodiorite	Intrudes Halls Creek Group and Whitewater Volcanics: intruded by tonalite, and aplite dykes	Stony pediments, low tors, and bouldery hills	Commonly xenolithic near contacts with older rocks	Forms most of the inlier except for a strip along southwest margin
	MIDDLE LAMBOO COMPLEX	Whitewater Volcanics (Pw)	Fine-grained, locally bedded, porphyritic rhyolitic ash-flow tuff	Overlies Halls Creek Group schists. Intruded by adamellite, aplite, and tonalite	Low hills and stony pediments with scattered inclined 'tombstone slabs'	Graded bedding indicates right way up, mostly fresh and unaltered, but locally sheared and sericitic	Occupies a northwest trending belt approximately one mile wide that extends along the southwestern margin of the inlier; dips consistently to southwest
UNCONFORMITY (Inferred from Lansdowne and Lennard River Sheet areas)							
?ARCHAEAN		Halls Creek Group (Ah)	Pelitic biotite muscovite schist with andalusite pseudomorphs; minor semipelitic quartz-biotite schist	Overlain concordantly by Whitewater Volcanics: intruded by adamellite and granodiorite	Low, poorly exposed debris-free outcrops	Sericite and sericite corundum pseudomorphs after andalusite are similar to those of Lennard River area	In the northwest near Outcamp Hill; also small scattered remnants in southeast

APPENDIX

PETROGRAPHIC DESCRIPTIONS

Specimens with B.M.R. numbers have been described by D.C. Gellatly; others by Miss R. Peers (1968). Igneous rocks have been named according to the classification of Johannsen (1939) except that the 5% and 95% modal limits have been replaced by 10% and 90% respectively.

HALLS CREEK GROUP

Quartz-biotite-muscovite-oligoclase schist.

R67-16-5009 (B.M.R.) NK 6-69-3a

Hand specimen: A dark grey finely banded friable psammitic biotite schist.

Thin-section: A medium-grained rock with a hypidioblastic-granular texture. Quartz (50%), biotite (20%), muscovite (15%), and oligoclase (15%) are the principal constituents. Also contains traces of apatite, sphene, and zircon. Quartz grains (0.25 to 0.5 mm) are mostly anhedral and are weakly strained. Grain boundaries are irregular but not sutured. Biotite flakes (0.5 mm) are pleochroic from very pale yellow brown to walnut brown, and show good parallel alignment. They are associated with flakes of muscovite (0.5 mm) which grade locally into patches of sericite. Oligoclase of composition ca An_{28-30} occurs as scattered anhedral 0.5 mm grains many of them showing little or no twinning.

Muscovite sericite-quartz-biotite schist

R67-16-5008 (B.M.R.) NK 6-69-3(b)

Hand specimen: A grey-brown foliated micaceous pelitic schist with elongate sericitic pseudomorphs after ?andalusite.

Thin-section: Consists principally of biotite (30%), quartz (30%), sericite (20%), and muscovite (20%) and minor

accessory goethite, zircon, corundum, and sphene.
Biotite, pleochroic in varying tones of yellow brown, occurs as well oriented flakes, 0.5 to 1 mm long, that curve round pods of sericite. Quartz occurs as small isolated grains and in aggregates (up to 7 mm) with sutured boundaries.
Sericite occurs in lenticles and lozenge-shaped monomineralic patches that grade marginally into muscovite. The sericite patches have rare small inclusions of corundum, and, by analogy with rocks from the Lennard River Sheet area, are thought to represent andalusite pseudomorphs. Muscovite occurs as discrete flakes, as intergrowths with biotite (probably pseudomorphing an early phengite), and as margins to sericite pseudomorphs after andalusite.

Muscovite-biotite-quartz-sericite schist

R67-16-5010 (B.M.R.) NK 6-69-11(b)

Hand specimen: pale grey-brown foliated, very fine-grained, pelitic mica schist.
Thin section: Consists mainly of sericite (50%), quartz (15%), biotite (20%), and muscovite (15%) and minor accessory magnetite and patches of secondary goethite.
Biotite occurs as small (0.25 to 1 mm) yellow-brown flakes showing good parallel alignment and concentration into narrow bands where it is associated with flakes of muscovite (0.5 to 1 mm). Fine-grained sericite forms discrete lenticles that probably pseudomorph original andalusite, and fine-grained quartz-sericite bands due to comminution of sericite lenticles and quartz. Quartz forms discrete grains (0.5 to 1 mm) and also small fragments associated with sericite.

LAMBOO COMPLEX

WHITEWATER VOLCANICS

Rhyodacite ash flow tuff

R67-16-5001 (B.M.R.) NK 6-69-12

Hand specimen: A dark brown, hard, fresh, quartz feldspar porphyry with phenocrysts of quartz, and clear feldspar and small glomeroporphyritic aggregates of white turbid feldspar.

Thin section: Euhedral phenocrysts, and rare phenocryst fragments, of quartz (8%), K-feldspar (5%), and plagioclase (4%) and minor biotite and epidote are set in fine-grained quartz-feldspar matrix (ca.0.03 mm).

Quartz phenocrysts (0.5 to 3 mm) are markedly euhedral and locally show resorption embayments. K-feldspar phenocrysts (0.5 to 2 mm) are euhedral and mostly tabular. They are dusty and have slightly undulose extinction suggesting possible inversion to microcline. Plagioclase phenocrysts (0.5 to 2 mm) are short prismatic and euhedral. Composition is An_{35}. Small clots of biotite and epidote, locally associated with magnetite, probably pseudomorph original pyroxene.

The matrix is fine-grained and contains flow streaks and cross cutting veinlets of biotite and epidote. No eutaxitic structures present, and only a few fragmental phenocrysts. The rock is probably an intensely welded ash-flow tuff.

R67-16-5002 (B.M.R.) NK 6-69-11(a)

Dellenite ash-flow tuff(?)

Hand specimen: A very pale grey brown foliated microporphyritic acid volcanic.

Thin-section: A fine-grained 'quartz feldspar porphyry' consisting of phenocrysts of quartz (8%), K-feldspar (4%), and plagioclase (3%) in a fine-grained carbonate-bearing quartz-feldspar matrix.

Quartz grains (0.2 to 2 mm) are mainly euhedral and embayed, but some have been destroyed by deformation and recrystallisation, and form polygonal aggregates some of them intergrown witn K-feldspar. K-feldspar grains are mostly small, euhedral and cloudy; it shows patchy extinction and is probably a low microcline. Plagioclase grains (0.2 to 2 mm) are euhedral, only slightly altered to sericite and show only very slight zoning. Composition is An_{35-40}.

The matrix consists essentially of very fine grained granular quartz, feldspars, and minor biotite and fine-grained muscovite; muscovite is developed only along shear planes which are associated with patches and lenticles of carbonate.

Specimen NK 6A-99-1

In hand specimen this rock is fine-grained, chocolate brown, compact, brittle, porphyritic and well foliated. The foliation is particularly evident on the weathered surface.

The phenocrysts are composed of microcline (10%) and quartz (4%). Microcline phenocrysts are in general larger being up to 3 mm in diameter. Some are only fragmentary. Lenses visible in the hand specimen are composed of a coarser-grained mosaic of quartz, microcline, epidote, biotite, muscovite, and rare plagioclase. There are a few small albite phenocrysts.

The groundmass (86%) has an average grain diameter of 20 and is composed of a mosaic of quartz, microcline, magnetite, and plagioclase. Most grains are elongate parallel to the foliation. Sphene and epidote are accessory minerals

Name - magnetite-bearing porphyritic acid volcanic rock.

ADAMELLITE SUITE (Ebp$_1$)

Biotite granodiorite

R67-16-5004 (B.M.R.) NK 6-67-5

Hand specimen: A pale grey medium-grained biotite granodiorite with pale pink K-feldspars. (Specimen for age determination.)

Thin-section: Consist principally of quartz (35%), K-feldspar

(20%), and plagioclase (40%) along with minor biotite (5%) and traces of allanite(?), epidote, and zircon(?).
Quartz occurs as 2 mm patches of small (0.15 mm) unstrained polygonal grains and rare strained grains about 2 mm across. The polygonal aggregates have possibly been derived through recrystallisation, of the larger grains. K-feldspar is a microcline-microperthite containing about 5% of exsolved sodic plagioclase mostly as thin sub-parallel lamellae. The grains are subhedral to anhedral, have a.g.d. of 1.5 mm, and show relict Carlsbad and rare Baveno twinning. Parts of grains show finely developed cross hatching; other parts show streakiness characteristic of low to intermediate microcline. Plagioclase grains (1 to 2 mm) are mostly subhedral to euhedral and show finely developed albite twinning, and Carlsbad twinning. Composition is An_{10-12}. It shows partial alteration to sericite and clinozoisite, particularly in crystal cores. Brown to grey-brown biotite is the main accessory. It has strong pleochroic haloes round inclusions of clinozoisite, metamict allanite (rimmed by clinozoisite) and rare zoned zircon or monazite. Biotite shows localised alteration to penninite.

Biotite adamellite

R67-16-5003 (B.M.R.) NK 6-67-11

Hand specimen: A coarse-grained pale grey brown biotite bearing granitic rock.
Thin-section: consists essentially of quartz (30%), K-feldspar (30%) plagioclase (35%), and biotite (5%) and minor sphene, apatite, metamict, allanite, opaque ores, and (?)zircon.
Quartz forms large anhedral slightly strained grains up to 5 mm. K-feldspar is a microcline-microperthite. It forms anhedral grains up to 4 mm many of them with small inclusions of plagioclase. Plagioclase grains (up to 6 mm) are tabular, subhedral, and show slight zoning. Late interstitial plagioclase is unzoned: alteration is slight. Composition is

around An_{10}. Biotite is olive green, forms discrete crystals and aggregates up to 3 mm, and is commonly associated with minor amounts of apatite (as inclusions), opaque ores, and epidote. Sphene forms unusually large lozenge-shaped grains - up to 2 mm.

Specimen 6A-00-8

The hand specimen is of a medium-grained pink and grey granitic rock which is sparsely porphyritic with anhedral phenocrysts of pink microcline.

The phenocrysts are sufficiently large and rare that only one was included in the thin-section. It is a very irregular grain of microcline over 5 mm across and quite unaltered. It has abundant inclusions of biotite, plagioclase, and quartz, but these have no preferred orientation. 50% of the rock is composed of microcline.

Plagioclase and quartz comprise the bulk of the groundmass. The plagioclase (30%), is oligoclase and forms irregular grains which are extensively saussuritized to epidote, sericite, and biotite. The quartz (15%) is quite unaltered. Biotite (5%) forms scattered flakes which are pleochroic with X = pale yellow, Y = brownish-green, and Z = greenish-brown. Inclusions in the biotite are epidote, zircon, and acicular rutile(?). Chlorite flakes are clearly the product of biotite breakdown as they retain the zircon inclusions and pleochroic haloes common in biotite. The only other minerals are scattered apatite crystals, and a single euhedral grain, which was once probably allanite and is now rimmed by euhedral epidote crystals and filled by amorphous yellow material.

Name - medium-grained adamellite.

Specimen NK 6A-98-14

This is a medium-grained grey granitic rock which is a little coarser-grained than 6A-00-8, but is not porphyritic.

The texture is allotriomorphic granular. The main minerals are quartz (35%), plagioclase (40%), microcline (20%), and biotite (5%). The microcline is fresh and completely unaltered, while the plagioclase (oligoclase) is extensively altered to sericite and epidote. The quartz grains are strained and fractured, and commonly have recrystallized to small quartz grains around the margins. Biotite is abundant, and is pleochroic with X = pale yellow, Y = brownish-green, and Z = greenish-brown. Inclusions of apatite, zoisite, zircon, and acicular rutile are common. One grain of an altered opaque mineral was noted.

Name - medium-grained adamellite.

Specimen NK 6A-00-4

This is a leucocratic, medium-grained granitic rock with a weak foliation due to the preferential orientation of biotite flakes.

Quartz (25%), plagioclase (30%), microcline (40%), and biotite (5%), are the main constituents. Plagioclase forms irregular grains up to 2.5 mm across. They are composed of oligoclase and are altered to a mixture of zoisite and sericite. The microcline grains are quite unaltered but include irregular fragments of plagioclase thus forming a microcline-perthite. Quartz forms irregular grains of variable grain size, all with a marked strain extinction. The biotite is pleochroic with X = pale yellow, Y = olive green, and Z = dark olive green. It is altered in part to chlorite. Inclusions are zoisite, sphene, zircons surrounded by pleochroic haloes, and the acicular crystals (rutile?) found in the biotite of 6A-00-11. The texture is allotriomorphic granular.

Name - medium-grained adamellite.

GRANODIORITE SUITE (Pbp_2)

Biotite granodiorite

R 67-16-5005 (B.M.R.) NK 6-69-10

Hand specimen: A coarse-grained grey biotite granodiorite.

Thin-section: A coarse-grained rock with a hypidiomorphic granular texture consisting essentially of quartz (20%), plagioclase (65%), K-feldspar (10%), and biotite (5%) and minor accessory epidote, apatite, sphene, hornblende, zircon, and metamict allanite.

Quartz forms large strained grains up to 3 mm and aggregates of polygonal 0.1 mm grains. K-feldspar is a late interstitial microcline microperthite containing up to 5% of exsolved plagioclase. Small blebs of myrmekite commonly replace K-feldspar at interfaces with plagioclase. Plagioclase forms large (1 to 5 mm) euhedral to subhedral, strongly zoned, short prismatic grains. Zoning is oscillatory. Composition ranges from about An_{18} to An_8. Crystal cores are more calcic, and large strongly zoned crystals are more calcic than smaller weakly zoned ones. Sericite and epidote group minerals partly replace plagioclase cores. Umber brown biotite, with pronounced dark haloes round small inclusions of ?zircon, contains inclusions of apatite, sphene, and exsolved needles of rutile; and is associated with minor epidote.

Biotite-hornblende granodiorite

R 67-16-5011 (B.M.R.) 6-69-8

Hand specimen: A coarse-grained grey biotite-hornblende granodiorite with rare grains of pink K-feldspar.

Thin-section: consists mainly quartz (16%), plagioclase (60%), K-feldspar (7%), biotite (10%), and hornblende (5%) and minor amounts of sphene, apatite, opaque oxides, zircon, and metamict allanite.

Quartz forms large (3 mm) strained grains and small interstitial granules. K-feldspar is a streaky microcline containing very thin partings of exsolved plagioclase. Myrmekite replaces it locally near plagioclase interfaces.

Plagioclase (1 to 4 mm) forms euhedral to subhedral equant grains. Composition ranges from An_{28} to An_{38}. It shows well developed albite twinning and strong zoning which locally forms a barrier to the twinning. Sericite and clinozoisite partially replace most grains. Biotite is green-brown and commonly encloses hornblende. It includes, or is associated, with minor amounts of apatite, opaque oxides, sphene, and rutile rods. Hornblende, pleochroic from pale straw to pale blue-green, has Z c = 16° and shows anomalous purple birefringence instead of extinction.

TONALITE SUITE (Pbp_3)

Biotite granodiorite

R 67-16-5007 (B.M.R.) NK 6-67-10(b)

Hand specimen: A medium-grained grey massive biotite tonalite.

Thin-section: Consists essentially of quartz (25%), plagioclase (60%), K-feldspar (7%), and biotite (7%), and minor accessory sphene, zircon, and apatite, and rare altered allanite.

Quartz occurs as large (3 mm) strained grains and as small (0.2 mm) unstrained interstitial ones. Plagioclase forms euhedral and subhedral grains showing a range in grain size from 0.2 mm to 5 mm. Composition is around An_{28-30} passing to more sodic margins. Plagioclase is partly altered to sericite and clinozoisite. K-feldspar forms interstitial grains (0.5 to 1 mm) showing both microcline cross hatching and streaky twinning. It contains thin sub-parallel veinlets of exsolved plagioclase. Biotite is green brown and occurs as scattered flakes (0.5 to 1 mm) and aggregates. It has intense dark haloes round radioactive inclusions and is commonly associated with grains of sphene up to 0.5 mm.

Microtonalite

R 67-16-5006 (B.M.R.) NK 6-67-10(a)

Hand specimen: A fine-to medium-grained dark grey biotite-rich intermediate rock with scattered 5 mm plagioclase phenocrysts. Chilled marginal phase of 5007 above.

Thin section: A medium-grained rock with an average grain diameter of around 0.4 mm consisting of quartz (30%), plagioclase (50%), and biotite (10%), and minor accessory K-feldspar (4%), opaque ores, sphene, allanite, apatite, and zircon; and secondary epidote, clinozoisite, and sericite.

Quartz occurs as subhedral grains (0.25 to 0.5 mm) showing pronounced strain. Plagioclase grains (0.3 mm to 2 mm) are euhedral to subhedral, equant, and unaltered. The larger grains show reversed zoning with cores An_{30} and margins An_{35}. Biotite is olive green and occurs as scattered flakes locally associated with abundant small granules of epidote, and with orange brown altered allanites mantled by epidote. K-feldspar is a plagioclase-rich microperthite that forms a late interstitial phase. Grains of sphene reach 1 mm in length.

Porphyritic biotite hornblende microtonalite

R 67-16-5012 (B.M.R.) NK 6-69-7a

Hand specimen: A dark grey-medium-grained biotite-rich porphyritic dyke rock with prominent white 1 cm phenocrysts of plagioclase.

Thin section: Quartz (20%), plagioclase (55%), biotite (10%), and hornblende (5%) are the principal minerals and are accompanied by minor amounts of K-feldspar (3%), sphene, opaque ores, apatite, metamict allanite, and secondary epidote.

Quartz occurs as anhedral grains from 0.2 mm to 3 mm. Plagioclase forms subhedral grains about 1 mm across and scattered phenocrysts ca. 5 mm long. Composition is around An_{35}. Zoning is slight, and grains are fresh. Biotite is olive green and commonly surrounds hornblende. Hornblende forms poorly cleaved grains with pleochroism: X = pale yellow brown, Y = olive green, Z = pale blue-green, $Z\ c = 16^{o}$. K-feldspar is a microcline microperthite that occurs interstitially.

Specimen NK 6A-98-18

This is a medium-grained, mesocratic granitic rock in which the predominant minerals are quartz (40%), plagioclase (45%), and biotite (15%). The texture is allotriomorphic granular. Plagioclase forms irregular grains up to 2 mm across. These are weakly zoned oligoclase and are mildly saussuritized to a mixture of sericite, epidote, and green biotite. Minor potassium feldspar is included in the plagioclase grains thus forming antiperthite. Quartz grains vary in size up to 5 mm in diameter but are in general smaller. They show marked strain extinction and are commonly rimmed by a quartz mosaic of average grain diameter = 0.1 mm. Biotite is abundant and forms aggregates of flakes which are strongly pleochroic with X = pale green, Y = olive green, and Z = dark green. Associated minerals include epidote, magnetite, and zircons (surrounded by pleochroic haloes). There were a few irregular sphene grains up to 0.5 mm long.

Name - medium-grained tonalite.

Specimen 6A-00-11

This rock is a medium-grained mesocratic granitic rock which is weakly porphyritic with scattered phenocrysts of pale green plagioclase. Apart from the phenocrysts, it appears to be a little finer-grained than 6A-98-18.

The phenocrysts are composed of oligoclase, but some grains are so extensively saussuritized as to be almost obscured. The alteration products include sericite and epidote. The remainuer of the rock is composed of plagioclase (50%), quartz (35%), biotite (15%), and minor minerals. The plagioclase forms laths which although altered could be identified as oligoclase, Quartz forms irregular grains which have a strain extinction and are fractured. The biotite is pleochroic with X = pale yellow, Y = greenish brown, and Z = golden brown.

Zircon inclusions are surrounded by pleochroic haloes. Other inclusions are zoisite, sphene, and numerous acicular crystals oriented in three directions and which may be rutile. K-feldspar occurs as minor interstitial grains. The only other minerals are apatite and a few scattered grains of pyrite.

Name - medium-grained tonalite.

Specimen 6A-98-19

This is a medium-grained granitic rock which is darker in colour than 6A-98-14 owing to an abundance of biotite. Alignment of the biotite flakes has produced a rough foliation.

The texture is allotriomorphic granular and the predominant minerals are quartz (40%), plagioclase (45%), biotite (10%), and minor microcline (5%). The plagioclase is oligoclase which forms irregular grains which are extensively altered to sericite, epidote, and biotite. Some grains are virtually obscured by alteration products. The quartz grains are all fractured and strained, and much forms a mosaic of average grain diameter = 0.1 mm. The biotite flakes are pleochroic with X = pale yellow, Y = green, and Z = olive green. Inclusions of epidote, apatite, and zircons are abundant. Accessory minerals include euhedral and subhedral crystals of sphene and epidote. Microcline forms irregular grains with patchy inclusions of plagioclase and a little calcite.

Name - medium-grained tonalite.

APLITE SUITE (ap)

Specimen NK 6A-98-2A

This specimen is a fine-grained, leucocratic, pink granitic rock.

It is composed of microcline (40%), quartz (25%), plagioclase (30%), and a little muscovite (5%).

The plagioclase was identified as oligoclase and is unaltered except for light sericitization. Microcline forms irregular grains which are quite unaltered, and the quartz grains have strain extinction. The only other minerals in this rock are flakes of pale green muscovite and a little epidote. The average grain diameter of this rock is 1.00 mm and the texture is allotriomorphic.

Name - fine-grained adamellite aplite.

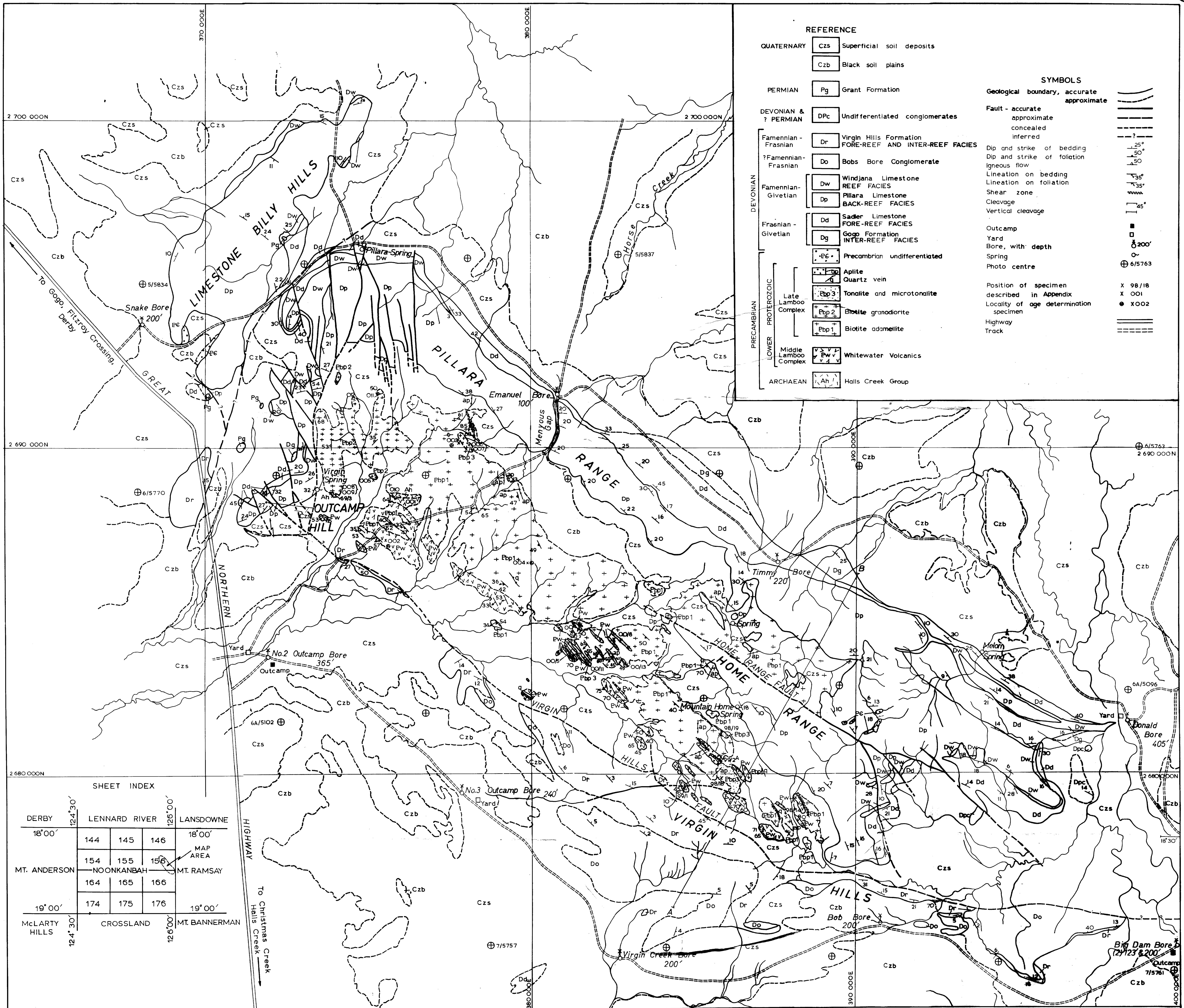
Leuco-microadamellite

R 67-16-5013 (B.M.R.) NK 6-67-9a

Hand specimen: A pink-brown medium-grained aplite. Occurs as a dyke cutting biotite adamellite.

Thin-section: A hololeucocratic rock consisting almost entirely of K-feldspar (35%), plagioclase (35%), and quartz (30%), and minor amounts (less than 1%) of chlorite, clinozoisite(?), goethite, and sphene.

Quartz (0.1 mm) forms an equigranular mosaic of clear, unstrained grains between larger (0.5 to 1 mm) anhedral feldspars. K-feldspar is partly a microcline-microperthite and partly a streaky flow microcline showing sparse exsolution lamellae of plagioclase. Plagioclase is a sodic oligoclase (ca An_{15}) showing both Carlsbad and albite twinning. It is slightly turbid due to the presence of minute specks of limonite and contains small scattered flakes of sericite, and rare clinozoisite granules. Secondary deep grey-green chlorite, small granules of clinozoisite (and rare epidote), small turbid brown granules of sphene, and specks of goethite occur associated in patches that probably pseudomorph an early biotite.



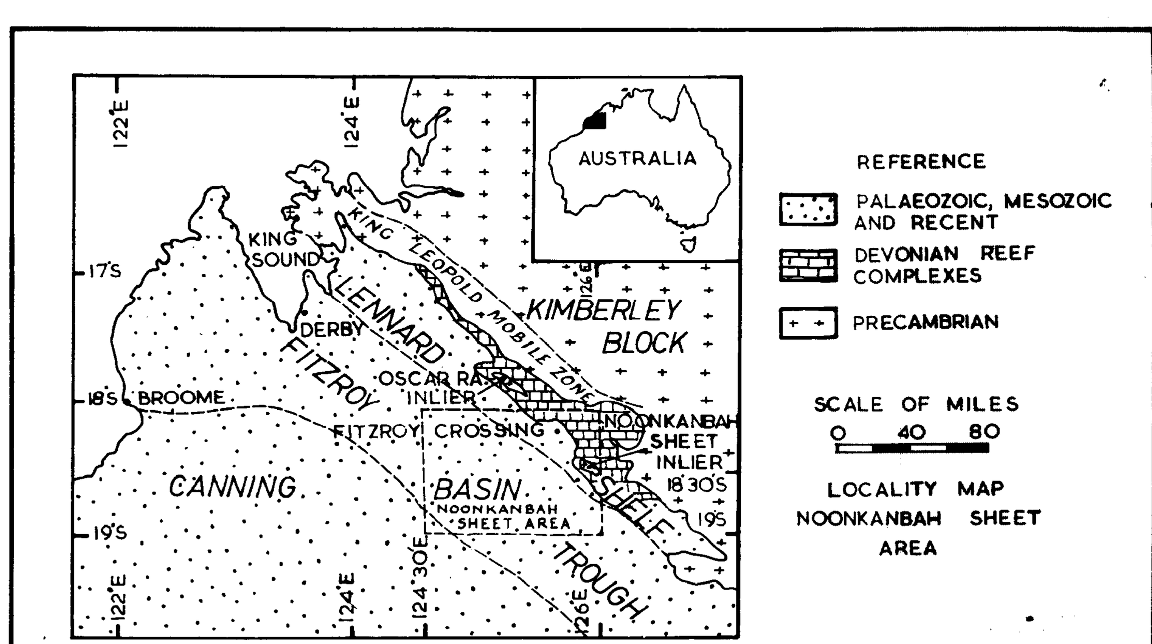
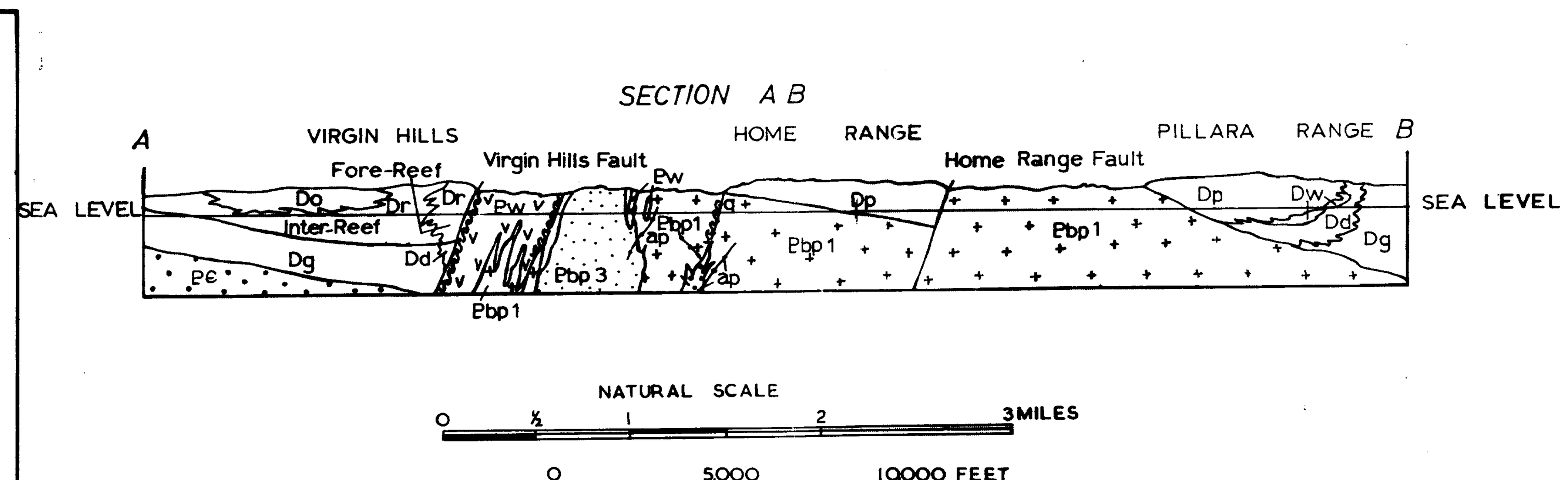


FIGURE 1



To accompany Record 1968/144

GEOLOGICAL MAP OF
PRECAMBRIAN INLIER
NOONKANBAH SHEET SE 51-12
KIMBERLEY DIVISION , WESTERN AUSTRALIA

SCALE

0 1 2 3 4 MILES

0 2000 5000 10000 15000 20000 FEET

Precambrian and Quaternary geology by J. Sofoulis & D.C. Gellatly, June 1967.
Geology of Devonian reef complexes after Playford & Lowry (1966).

E51/A12/2