COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS

RECORDS:

RECORD No. 1966/68

THE GEOLOGY OF THE AYR 1:250,000 SHEET AREA, QUEENSLAND

by

A.G.L. PAINE, C.M. GREGORY, and D.E. CLARKE

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ENCLOSURE

AYR : 1:250,000 Geological Sheet, Preliminary Edition

SUMMARY

The geology of the AYR 1:250,000 Sheet area was mapped on a regional scale in 1964 by the Bureau of Mineral Resources and the Geological Survey of Queensland as part of a three-year project to complete the regional mapping of the TOWNSVILLE, HUGHENDEN, CHARTERS TOWERS, AYR, BOWEN, and PROSERPINE Sheet areas.

Most of the land surface of AYR* is underlain by alluvial, deltaic, and littoral deposits of the coastal plain, of which the most important feature is the Burdekin River Delta. Bedrock, most of which consists of plutonic igneous rocks, is exposed over about 600 square miles.

The oldest rocks are roof-pendants of possible early Palaeozoic low-grade metasediments. These have been intruded and metamorphosed by locally foliated granodiorite and diorite which are correlated with the Silurian-Lower Devonian Ravenswood Granodiorite of TOWNSVILLE and CHARTERS TOWERS. About 120 square miles of the southern central part of AYR are occupied by granite and adamellite of unknown but presumed Palaeozoic age. Acid volcanics which are correlated with Upper Carboniferous volcanics on TOWNSVILLE and BOWEN crop out in the south-west; the Carboniferous to Permian intermediate volcanics of TOWNSVILLE extend into the north-western part of the Sheet area. Granite intrusion was widespread in the late Palaeozoic, and may have extended into the Mesozoic. Most of the plutonic rocks in the eastern half of AYR are part of the Upper Carboniferous to Cretaceous Urannah Complex of BOWEN and Sheet areas farther south. Dyke swarms are abundant in most of the rock units.

No metalliferous deposits have been worked on AYR. However, nickel, copper, and molybdenum have been detected by spectrographic analysis of rocks collected during the course of this survey.

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*Hereafter in this report 1:250,000 Sheet areas (Australian Geological Series) will be referred to simply by name, in capitals; e.g., "on AYR", rather than "in the Ayr 1:250,000 scale Sheet area".

FIG. 1

18°00'
144°00'
150°00'
22°00'

EINASLEIGH
INGHAM
Hinchinbrook Island
Rollingstone
Magnetic Island
Cape Cleveland
TOWNSVILLE
Cape Bowling Green
AYR
HOME HILL
Cape Upstart
Cape Edgecombe
BOWEN
Whitsunday Is
Proserpine
Collinsville
MACKAY
RIVER
CLARKE
BURDEKIN
Reid River
Mingela
CHARTERS TOWERS
Pentland
FLINDERS
Torrens Ck.
HUGHENDEN
CAPE
BOWEN
SUTTOR
Mt. Coolon
LAKE BUCHANAN
Tangorin

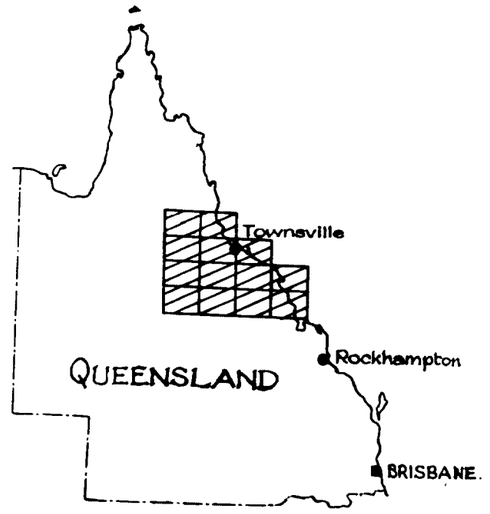
EINASLEIGH
INGHAM
CLARKE RIVER
TOWNSVILLE
AYR
CHARTERS TOWERS
HUGHENDEN
BOWEN
PROSERPINE
MACKAY
TANGORIN
BUCHANAN
MT. COOLON

REFERENCE

Area mapped to the end of 1964 by combined Geological Survey of Queensland and Bureau of Mineral Resources field parties

Area of Present Survey (1963-5)

LOCALITY MAP



SCALE OF MILES
20 10 0 10 20 30 40

INTRODUCTION

The Bureau of Mineral Resources in conjunction with the Geological Survey of Queensland carried out regional geological mapping in the Ayr 1:250,000 Sheet area from July to October, 1964. This area was mapped as part of a programme of regional mapping designed to cover the Townsville-Charters Towers-Bowen region (see Locality Map, figure 1).

As a result of field work on BOWEN and PROSERPINE in 1965, some of the rock units as erected earlier in the year were reappraised, and the report and geological map were amended accordingly; in particular most of the plutonic rocks in the eastern part of the Sheet area are now recognised as belonging to the composite Upper Carboniferous to Cretaceous batholith, the Urannah Complex, which has been mapped on BOWEN, MOUNT COOLON, PROSERPINE, MACKAY, and SAINT LAWRENCE.

AYR is situated between latitudes 19 and 20 degrees south and longitudes 147 and 148½ degrees east. The area is served by two towns, Ayr and Home Hill, on the northern and southern sides of the Burdekin River, respectively, and the smaller centres of Giru, Brandon, Clare, and Millaroo. The North Coast Railway from Brisbane to Cairns closely follows the Bruce Highway, and links Ayr and Home Hill with other large centres along the coast. The Bruce Highway is sealed over its entire length on AYR. Another sealed road follows the western side of the Burdekin River, and joins Dalbeg (on BOWEN) with Ayr. In the Ayr, Home Hill, and Giru districts there are many miles of sealed roads serving the sugar-cane growing areas. Gravel roads connect the cattle stations with the sealed roads.

Access within the area is good except for the few rugged parts, and to some of the coastal outcrops. The survey used four-wheel drive vehicles as the main form of transport, and hired a boat to visit the otherwise inaccessible coastal outcrops and islands. A light aircraft was briefly used towards the end of the survey for a final appraisal of the area, and for spotting outcrop in the Burdekin River.

The climate in the area is mild and usually dry in winter, and hot and wet in summer. The annual rainfall which is about 40 inches at Ayr, decreases away from the coast. Three quarters of the rain usually falls between November and April, and heavy falls sometimes close all roads for short periods.

Sugar production is the main industry around Ayr, Home Hill, and Giru. In the Ayr and Home Hill districts water is available for irrigation from the alluvium of the Burdekin River delta. Cane farms have also been established farther upstream where suitable land and water for irrigation are available. Around Giru the rainfall is just sufficient to grow cane without the use of irrigation. Beef cattle raising is the main industry in the rest of the area. Minor primary industries include small-scale fruit and vegetable growing, some grain and fodder production, and quarrying of "earth lime" and rock aggregate. There is no port at Ayr, and all products are transported to markets or ports by rail or road.

The Sheet area was mapped using aerial photos (1:85,000 scale, flown by Adastra in 1961) which cover the Sheet area completely, except for Holbourne Island and Nares Rock.

The only published base maps available at present are the 4 miles to 1 inch Military Sheet (Ayr, E55-15), published in 1943, and the 1:1,000,000 scale World Aeronautical Chart (ICAO Series), Sheet 3219 (Townsville). Holbourne Island and Nares Rock are shown on the ICAO map. The Military Sheet is now very largely out of date as far as roads and tracks are concerned, and, except at Mount Elliot, Saddle Mountain, and Cape Cleveland, lacks topographic contours.

At the time of writing (December, 1965) the Royal Australian Survey Corps was compiling topographic maps covering the Sheet area at 1:100,000 scale. Copies of the initial 1:75,000 scale compilations of these sheets were made available to us by the R.A.S.C. for use as a base. Planimetry and cultural detail on these sheets is comprehensive, and the topographic contour interval is 100 feet.

The 1:250,000-scale geological map which accompanies this report consists of two superimposed plates, planimetric and geological, which were compiled in the following manner:

Planimetric plate:

Simplified tracings showing essential planimetric and cultural detail, but omitting topographic contours, were made of the 1:75,000-scale, controlled, topographic compilations supplied by the Royal Australian Survey Corps. These tracings were then photo-reduced to 1:250,000-scale, and redrawn at that scale within the 1:250,000-scale grid as computed for AYR.

Geological plates:

Geological data obtained in the field and derived by photo-interpretation were plotted onto transparent overlays of the air photographs. Simplified tracings, showing essential drainage and photo-centres only, were made from the R.A.S.C. 1:75,000-scale topographic sheets. These tracings were photo-reduced to 1:85,000-scale (photo-scale), and the geology was drawn from the photo-overlays onto these tracings. The tracings, now bearing all geological information, were then further photo-reduced to 1:250,000, and re-drawn at that scale within the grid.

Though the relationships and extent of the plutonic units on AYR are broadly known, many problems remain to be solved, and the map presented with this report shows geological boundaries and subdivisions which in places are based on incomplete or indirect evidence. In 1965 A.W. Webb (an officer of the Bureau of Mineral Resources who is at present working with the Department of Geophysics and Geochemistry, Australian National University, Canberra) collected 23 samples for isotopic dating on AYR, mostly from bodies of plutonic rock. When the results of his work become available, modification of the boundaries and subdivisions may be necessary. All isotopic dates cited in this report are the result of Webb's work, unless otherwise stated.

Since the maps which accompany this report were printed the name "BURDEKIN FAULT" has been changed to "MILLAROO FAULT".

Where appropriate, individual responsibility for authorship of specific parts of this report is indicated by the author's initials.

ACKNOWLEDGMENTS

One hundred and sixty three thin sections of rocks from the Sheet area were described briefly by R. Townend and A.R. Turner of the Australian Mineral Development Laboratories, Conyngham Street, Parkside, S.A., and by W.R. Morgan, of the Bureau of Mineral Resources. These descriptions constitute Appendix 5.

We are indebted to the Queensland Irrigation and Water Supply Commission for the Burdekin Delta water-bore information contained in Appendix 4. Mr. W. Hickmott, of Guthalungra, freely shared with us his knowledge of mineral occurrences and interesting geological features in the Home Hill - Bowen district. His assistance is gratefully acknowledged. W.B. Dallwitz materially assisted in further examination of some of the thin-sections.

PREVIOUS AND CONTEMPORARY INVESTIGATIONS

In 1950 the Land Research and Regional Survey Division of the Commonwealth Scientific and Industrial Research Organisation carried out a survey of the Townsville-Bowen Region. The purposes of this survey were to describe and map the land characteristics of the region, and to report on the possibilities of land use, including those related to the irrigation proposals that had been made in connexion with the possible damming of the Burdekin River. This survey included AYR. The report on the survey (Christian et al., 1953) contained a brief account by D.M. Traves (Bureau of Mineral Resources) of the geology of the region; this was a summary of a fuller report (Traves, 1951).

Apart from the 1950 survey by C.S.I.R.O. no regional geological work had been carried out in the area before the present survey by the Bureau of Mineral Resources and the Geological Survey of Queensland. A few investigations of specific mineral occurrences have been made from time to time. These include a brief mention of graphite near Cape Upstart (Dunstan, 1906); reports on the phosphate deposit at Holbourne Island (Saint-Smith, 1919, Reid, 1944, and Young, 1944); a description of Cainozoic "earth lime" deposits near Home Hill (Connah, 1958); and a report on vermiculite and asbestos occurrences near Home Hill (Carruthers, 1954).

In recent years much attention has been devoted to studying the underground water potential of the Burdekin River Delta. Watkins and Wolff (1960) reported on the geology of the delta and the neighbouring area. More recently, at the request of the Queensland Irrigation and Water Supply Commission, the Bureau of Mineral Resources carried out extensive geophysical investigations in the delta, with the object of determining the structure and distribution of its sediments, the movement pattern of the groundwater, and the behaviour of the interface between fresh and salt water. Reports on this work (which is still continuing) have been prepared by: Andrew and Wainwright (1964), Andrew et al. (in press); Wiebenga et al. (1964); and Wiebenga et al. (in prep.).

In 1964 three geologists (Coleman, Smyth, and Gagliano) from Louisiana State University, U.S.A., carried out a survey of the Quaternary and Recent sediments of the coastal plain between Cape Cleveland and Cape Upstart. The purpose of this survey was to obtain more information on deltaic sedimentation in general, with special reference to aspects which might help petroleum exploration in similar sediments on the Gulf Coast of the United States.

FIGURE 2

147°
19°

Ayr 1:250,000 Sheet Area

Physiographic Sketch Map

Mud-flats, etc.
Coastal plain

Isolated coastal hills

Areas of low hills

~~Plateau~~ Plumtree plateau-basin

Rugged ~~upland areas~~ hills

2 0 2 4 6 8 10 12 14 16

miles

Cape Cleveland

Cape Bowling Green

Giru

Ayr

Home Hill

Burdekin River

Cape Upstart

Abbot Point

20°
148° 30'

Bureau of Mineral Resources, Geology & Geophysics. April, 1965. To accompany Record 1965/

In 1965 the Bureau of Mineral Resources carried out a regional geochemical survey of the Sheet area. Samples were collected from stream sediments (both the minus 80-mesh fraction and heavy mineral concentrates), soils, and rocks.

PHYSIOGRAPHY

The Ayr 1:250,000 Sheet area is here divided into five main physiographic units (see Fig. 2).

The coastal plain covers most of the land surface on AYR. One subunit is separated out from the coastal plain; it comprises mud-flats, salt-pans, mangrove swamps, and coastal sand dunes. The areas of sand dunes were included in this subunit because they are too small to be shown separately on the map.

The remainder of the coastal plain is flat to very gently undulating. Water courses are usually steep-sided. The Burdekin River is incised in places down to 80 feet below its levees. Most of the plain consists of alluvial and deltaic deposits.

At various places in the coastal plain there are small areas of isolated hills, most of which form prominent land marks.

Within the areas of low hills the land surface ranges from open undulating country to small areas of rough hilly terrain. Relief within this unit is not very great, but locally may be up to 500 feet. There is quite a sharp break between the areas of low hills and the coastal plain.

The Plumtree "plateau-basin" is a remnant of a south-directed, mature drainage basin (Plumtree Creek) which has been truncated around its western, northern, and eastern sides by the headwaters of more youthful streams which flow radially outwards from it. The surface of this feature is a mature, gently undulating erosion surface which slopes gently southwards. Its northern and eastern sides are irregular scarps 100 to 200 feet high; the western margin, although scarp-like locally, is poorly defined, and, like the southern margin, merges with the base level of the creeks which drain the areas of low hills. The northern part of the Plumtree 'plateau-basin" is a low plateau, but the southern half is basinal in relation to the bordering hills.

The rugged hills occur as widely separated, discrete ranges which rise steeply to between 1500 and 3000 feet above sea-level. The summit of Mount Elliot, just west of the Sheet area, is 4025 feet above sea-level. Deep, straight, fault-controlled ravines have been eroded in the Cape Cleveland, Saddle Mountain, and Cape Upstart ranges. The Cape Cleveland and Cape Upstart ranges are literally peninsulas, being connected to the mainland only by sand dunes and mud flats.

Much of the area is drained by short coastal streams that commonly merge with the tidal areas or broaden out and lose their identity in the plains immediately adjacent to the coast. The Burdekin River is by far the largest water-course in the Sheet area; however, the area it drains within the Sheet area is relatively small.

REGIONAL GEOLOGY

The stratigraphy of the area is summarised in Table 1.

EARLY PALAEOZOIC

UNNAMED METAMORPHICS (Pzu) (D.E.C., A.G.L.P.)

Introduction

Remnants of a metamorphosed arenite-siltstone sequence which is older than the Ravenswood Granodiorite occur in the south-western part of the Sheet area. The sediments have been dynamothermally metamorphosed, generally to the quartz-albite-muscovite-chlorite subfacies, and locally to the quartz-albite-epidote-biotite subfacies of the greenschist facies of regional metamorphism. However, it seems that the metamorphic regime of these rocks was not a regional one in the generally accepted sense; it is believed that the dynamic and thermal metamorphism which they have suffered was related to intrusions and fault-zones.

These rocks are probably early Palaeozoic, although a Precambrian age cannot be ruled out. They are regarded as broadly equivalent to the Cape River Beds of CHARTERS TOWERS, and to unnamed metamorphics (Pzu) in the south-eastern part of TOWNSVILLE.

Hornfelses, some of which are similar in hand specimen to the rocks mentioned above, occur near Guthalungra, where they are intruded by the Urannah Complex. The age of these is unknown, but they are unlikely to be Precambrian.

Distribution and Topography

Metamorphosed sediments occur in small areas in the south-western part of the Sheet area. The largest occurrence is an irregular area of about four square miles centred five miles south-west of Mount Woodhouse. In places it forms a range of hills about 400 feet higher than the surrounding alluvium-covered Ravenswood Granodiorite. Similar metamorphosed sediments form steep ridges a few hundred feet high two miles west of Mount Benjonney. Other outcrops occur just west of Landers Creek Homestead, and in the bed of the Burdekin River near Millaroo.

Outcrops of similar rocks occur in the hills north-west of The Cape Homestead (8 miles north of Guthalungra). The rocks here have been intruded by granite (Urannah Complex), the contact being very irregular; it has been much simplified on the map. Other similar outcrops occur just west of the Seven Sisters. A small spur of andalusite quartzite occurs just west of the Bruce Highway, half a mile south-east of Clevedon railway siding.

Lithology and Metamorphism

Five miles south-west of Mount Woodhouse the rocks are metamorphosed coarse-to medium-grained micaceous sandstone, well sorted subarkose, poorly sorted micaceous pebbly sandstone, micaceous silty arenite, and pebble conglomerate. These rocks have been dynamothermally metamorphosed to a low grade. Oligomictic cobble conglomerate, quartzite, subarkose, and thinly bedded carbonaceous siltstone crop out two miles north-west of Mount Benjonney. Cobbles in the conglomerate comprise quartz porphyry, quartz-feldspar porphyry, biotite schist, quartzite, and fine-grained amphibolite. The sediments form a roof-pendant on the Ravenswood Granodiorite, and were further metamorphosed by granodiorite (Pzg) immediately to the east.

The sediments south-west of Mount Woodhouse also form a roof pendant in the Ravenswood Granodiorite, and have been thermally and dynamically metamorphosed. Metamorphic grade is higher where the roof pendant is thinner, e.g., in the headwaters of Sandy Creek, where metamorphosed siltstone and quartz-chlorite-sericite-muscovite schist occur. The metamorphosed siltstone consists of sub-spherical aggregates of silt-size quartz, chlorite, and muscovite surrounded by an intensely foliated groundmass of muscovite, rare sericite, and quartz grains. Similar metamorphics crop out in the south-eastern part of TOWNSVILLE.

Metamorphosed sediments near the margins of the roof-pendant consist of various assemblages of the quartz-albite-muscovite-chlorite subfacies of regional metamorphism (greenschist facies). They are chiefly

chlorite-muscovite-sericite-quartz schists which have a weak schistosity. Only at the thinner south-eastern end of the roof-pendant is the schistosity sufficiently well developed to be clearly evident in hand-specimen. In general, recrystallisation has been confined to the matrix of the sediments especially towards the thicker (north-western) part of the roof-pendant, where thermal effects are weakest.

Half a mile west of Landers Creek Homestead strongly foliated quartz-chlorite-muscovite-sericite schist, quartz-chlorite-sericite-muscovite schist, and black schistose argillite form an isolated rise above the alluvium bordering Landers Creek. The metasediments appear to lie in a shatter-zone associated with strong faulting. The spotted sericite schist and metamorphosed pebbly arenites exposed in the bed of the Burdekin River a little to the east also lie in this zone.

The metamorphics north-west of The Cape Homestead have been intimately intruded and hornfelsed by granite, tonalite and gabbro (Urannah Complex). There is quite a variety of hornfelses, and some are moderately high-grade. The following rock types have been identified: biotite-alkali feldspar-quartz hornfels; epidote-hornblende-andesine-quartz hornfels; garnet-biotite-albite-potash feldspar-quartz hornfels; garnet-biotite-microcline-plagioclase-quartz hornfels; biotite-quartz-sericite hornfels; biotite-andalusite-quartz-sericite hornfels; andalusite-biotite-muscovite-oligoclase-quartz hornfels; andalusite biotite-sericite-quartz hornfels; and ferruginous biotite-cordierite-chiastolite-quartz schist.

The biotite-alkali feldspar-quartz hornfels, epidote-hornblende-andesine-quartz hornfels, garnet-biotite-albite-potash feldspar-quartz hornfels, and garnet-biotite-microcline-plagioclase-quartz hornfels are strongly foliated and in places quite coarse, with incipient gneissic textures. They occur on the southern slopes of a south-west-trending ridge, one mile west-south-west of The Cape Homestead. In hand-specimen they resenble granodiorite. In places the foliation is flow-folded. Rare spherical clots of epidote-quartz-hornblende (hand-specimen description) up to 3cm. in diameter occur in these foliated rocks; these evidently developed later than the foliation. The rocks are all close to a contact with garnetiferous tonalite, which is also foliated in places. Contacts are generally rather sharp, but may be gradational over a few inches. The biotite-alkali feldspar-quartz hornfels may be a metamorphosed rhyolite or microgranite; it contains what may be relict phenocrysts of quartz, sodic plagioclase, and biotite. The epidote-hornblende-andesine-quartz hornfels is possibly a metamorphosed calcareous and aluminous sandstone; some andesine and hornblende have been partly replaced by epidote. The garnet-biotite-albite-potash feldspar-quartz hornfels contains a few partly re-

crystallised megacrysts of albite, which suggest that the rock may have been an acid porphyry. Rare colourless garnet (probably almandine) has been partly replaced by biotite and chlorite; knots of biotite flakes may also represent altered garnet. The garnet-biotite-microcline-plagioclase-quartz hornfels contains garnet porphyroblasts in the coarser (0.5mm.) layers. The main metamorphism of these rocks was probably caused by the gabbro (C-Md); later, retrograde metamorphism (plagioclase and hornblende altered to epidote) was no doubt caused by the tonalite (C-Mg). About two miles west of The Cape Homestead large areas of "granite" (C-Mg) have also caused strong hornfelsing.

Biotite-quartz-sericite hornfels forms the south-western end of a spur one and a half miles west-south-west of The Cape Homestead. It was described in the field as a dark grey, fine- to medium-grained, well-sorted, impure, hematitic quartzite. Banding is visible and presumably represents bedding. In places sericitic parting planes give the rock a cleavage. The specimen sectioned consists of amoeboid quartz grains (30%), aggregates of fine sericite flakes (?pseudomorphing feldspar or andalusite), and randomly oriented chloritised biotite.

The biotite-andalusite-quartz-sericite-hornfels, andalusite-biotite-muscovite-oligoclase-quartz hornfels, and andalusite-biotite-sericite-quartz hornfels crop out as thin roof-pendants and large xenoliths in "granite" in the centre of the range which extends several miles west from The Cape Homestead. The biotite-andalusite-quartz-sericite hornfels contains tabular, slightly poikiloblastic, and somewhat sericitised andalusite porphyroblasts. It is probably a more strongly metamorphosed version of the biotite-quartz-sericite hornfels. The andalusite-biotite-muscovite-oligoclase-quartz hornfels was probably a tuff. It contains 50-60% inequigranular (0.03 to 4.0mm.), anhedral, recrystallised quartz and tabular, slightly recrystallised oligoclase (igneous twinning still preserved) in a matrix of fine biotite and muscovite, with some granoblastic quartz and feldspar; groups of partly sericitized crystals of andalusite are present in places. Both rocks are dark blue-grey, dense, and flinty.

A fragment of ferruginous biotite-cordierite-chiastolite-quartz hornfels was found in the valley between this range and the mountains to the north. The hand specimen is a dark brownish-black, fine-grained rock with a resinous fresh surface. Small, perfectly euhedral, pinkish-brown crystals of chiastolite are crowded through it. In thin section the rock is seen to contain two kinds of porphyroblasts: one is chiastolite with the long axes in the plane of the schistosity; the other forms xenoblastic crystals containing many inclusions of iron oxide. Parts of these crystals are in

optical continuity with neighbouring crystals of altered chiastolite which they appear partly to replace. The xenoblastic mineral is uniaxial or low biaxial negative, with a birefringence rather lower than that of quartz and a refractive index slightly higher than that of quartz. Except for the optic axial angle, these properties fit those of cordierite. However, cordierite with very low or zero optic axial angle has been recorded in the literature. Furthermore, cordierite is a common associate of andalusite in hornfelses. The fine-grained matrix consists of ferruginous biotite, iron oxide dust, and quartz.

A piece of blastomylonite was found on the southern slopes of the range, west of The Cape Homestead. The matrix of this rock has a grainsize of 0.01 to 0.03mm., and consists of amoeboid grains of plagioclase (probably labradorite), prismatic to granular pale brownish green amphibole, and granules of iron ore. Poikiloblastic porphyroblasts of almost colourless clinopyroxene are about 0.3mm. in diameter. There are a few residual megacrysts of clinopyroxene and orthopyroxene. This rock is evidently a gabbro which was mylonitized and later probably thermally metamorphosed; criss-crossing veinlets of clinopyroxene and porphyroblasts of this mineral were probably formed at the same time.

Biotite-quartz-sericite hornfelses very similar to some of the hornfelses west of The Cape Homestead form undulating rises immediately west of the Seven Sisters. They have been intruded by tonalite (C-Md) and by the "granite" of the Seven Sisters (C-Mg). In the field they appear to be low-grade metamorphics - fine-grained, brownish red and brownish green impure arenites. Cleavage is developed in the very fine-grained interbeds.

A small spur of andalusite quartzite (Photo Plate 1) abuts against the north-eastern foot of the Saddle Mountain granite, half a mile south-east of Clevedon railway siding. Xenoblastic grains of andalusite form up to 20% of the rock; most have an alteration rim of sericite (or pyrophyllite). In places the mica completely replaces andalusite. The quartzite is even-grained: individual quartz grains range from 0.05 to 0.1mm., and the largest andalusites measure 0.4 x 0.2mm.. The rock is rich in rutile/opaque aggregates which do not seem to be detrital.

Structure and Thickness

In the western part of the Sheet area the sediments are well-bedded, and in the outcrop area south-west of Mount Woodhouse they dip at moderate to steep angles to the north-north-east, except for reversals near the Woodhouse Fault. The thickness of the sediments here is estimated at 6000 feet. Graded bedding is apparent in thin sections, and rare cross-

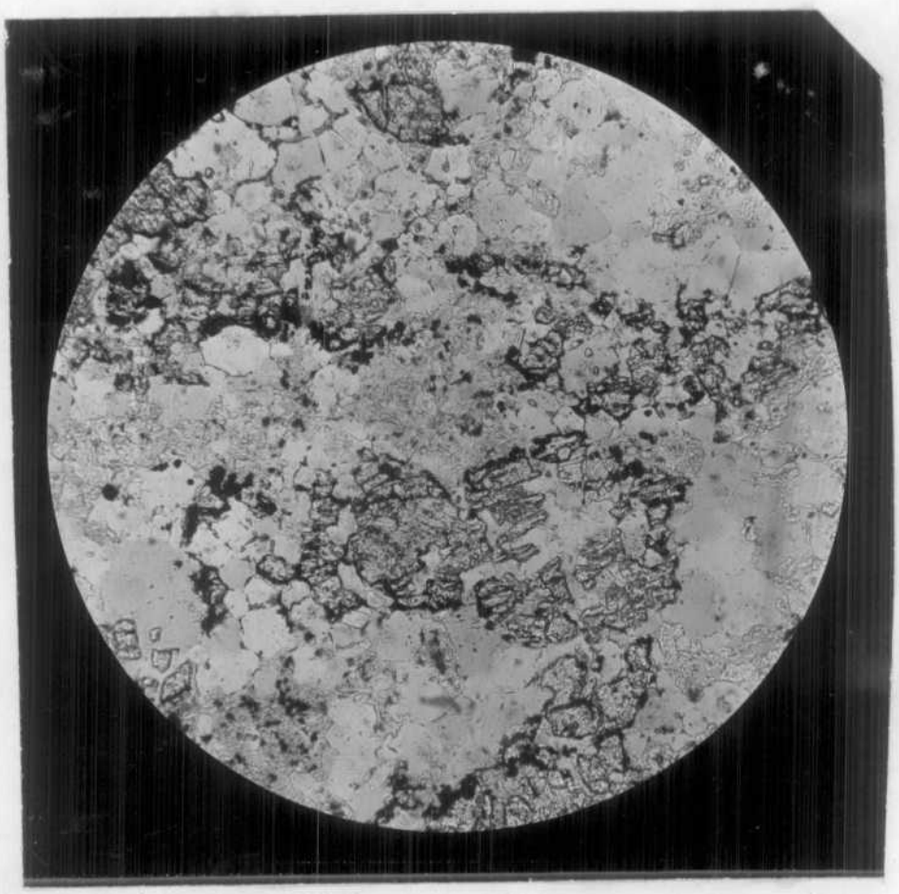


Photo Plate 1: Andalusite quartzite (Pzu), 0.5 mile south-east of Clevedon railway siding. Xenoblastic andalusite is partly rimmed by aggregates of rutile and iron ore. White mica (sericite or pyrophyllite) occurs between subhedral quartz grains.
Plane Polarised Light X45. B.M.R. T.S. No. 15715. B.M.R. Neg. No. G/6751.

bedding was observed in outcrop. The sediments of the roof-pendant south-west of Mount Woodhouse have been faulted in two principal directions. The Woodhouse Fault trends south-east, and is marked by a wide zone of silicified sandstone and breccia. This zone of silicification and brecciation has been displaced by later dextral transverse faults. Many smaller faults are indicated by areas of intense quartz-veining.

The roof-pendant north-west of Mount Benjonney is complexly faulted, and appears to be a resistant remnant preserved by the hornfelsing associated with the granodiorite (Pzg) immediately to the east.

Foliation, cleavage, and relict bedding are visible in different places in the hornfelses west of The Cape Homestead. The cleavage and bedding strike east-south-east to south-east. Near the Seven Sisters the cleavage and bedding probably coincides; they strike in roughly the same direction as do the hornfelses west of The Cape Homestead. No estimate of their thickness can be made.

Age and Relationships

The rocks south-west of Mount Woodhouse are intruded by the Ravenswood Granodiorite (Silurian-Lower Devonian); erosion and intrusion have removed all but a few remnants. Contacts are both faulted and intrusive; Ravenswood Granodiorite, masked by alluvium, crops out in gullies along the southern limit of outcrop of the metasediments. The metasediments are also intruded by rhyolite, quartz porphyry, felsite, and feldspar porphyry dykes. The metasediments are probably mostly early Palaeozoic, and they are broadly correlated with similar unnamed metamorphics in the south-eastern part of TOWNSVILLE. They are tentatively correlated with the Cape River Beds which form the bulk of the country rock of the Ravenswood Granodiorite on CHARTERS TOWERS. However, it is possible that cobbles found in the conglomerates may have been derived from the Cape River Beds or their equivalents.

The age of the hornfelses in the Guthalungra/The Cape Homestead district is not so well established. They are intruded by gabbro mapped with the older phase of the Urannah Complex; therefore they are unlikely to be younger than Carboniferous.

Mineralisation

A few small costeans have been bulldozed in the hornfelses west of the Seven Sisters. It is not known whether any mineralisation was found in the course of these excavations; none was seen during this survey.

Early this century a small shaft was sunk in graphitic hornfels 2.5 miles west of The Cape Homestead (see Economic Geology).

RAVENSWOOD GRANODIORITE (S-Dr and S-Da) (C.M.G.)

Summary

Areas of granodiorite, quartz diorite, and diorite cropping out south of Home Hill and around Mount Benjonney are mapped as Ravenswood Granodiorite (Silurian-Lower Devonian). Dyke swarms are abundant. The unit gives rise to a varied topography. It is strongly sheared in places (e.g., Inkerman Shear Zone), and foliated in many outcrops.

Introduction

The Ravenswood Granodiorite, a large batholith which crops out on CHARTERS TOWERS, TOWNSVILLE, and HUGHENDEN as two phases (an earlier granodiorite and quartz diorite phase, and a later granite and adamellite phase), is mapped on AYR, extending as far as longitude 147 degrees, 35 min. east. Apart from small areas of granite and adamellite south of Horse Camp Hill and south of Mount Benjonney, all outcrops on AYR are mapped with the earlier granodiorite phase.

Extensive areas of granite and adamellite (Pzg) which crop out between the Gregory Ranges and Beaks Mountains are of unknown age (Pzg). It is not known whether or not this granite intrudes the granodiorite (S-Dr), but this is thought likely on regional grounds. The granite may represent the late acid phase of the Ravenswood Granodiorite; on the other hand very similar granite crops out intermittently up the Burdekin valley towards the Bowen River junction (on BOWEN) where Upper Carboniferous isotopic ages have been obtained. Satisfactory demarcation of the limits of the Ravenswood Granodiorite in the Gregory Ranges-Beaks Mountains district must await further work.

Bodies of diorite and gabbro are known to occur within the Ravenswood Granodiorite on AYR. It was not possible to delineate these bodies during the course of this reconnaissance survey; their relationship to the main granodioritic phase of the Ravenswood Granodiorite is not known. There is a possibility that they are the same age as similar bodies in the Urannah Complex.

Granodiorite and Diorite Phase (S-Dr)

Topography and photo-pattern

The area of outcrop includes rough hilly country with moderately high hills with relief up to 300 feet, areas of parallel ridges, some over one hundred feet high; and gently undulating areas. The ridges which are caused by numerous parallel dykes, can be easily traced on the aerial photos. However, most of the area occupied by the coarse plutonic rocks is not amenable to mapping by photo-interpretation.

Lithology

The mapped area of the granodiorite and diorite phase includes a large number of rock types, primarily granodiorite, diorite, and adamellite and micro-varieties of these, with minor amounts of gabbro, granite and microgranite. Hornblende is a mjor constituent of the calcic rocks. The area can be subdivided into several parts for ease of description. Each part has a character sufficiently different from each of the others for it to be discussed separately.

(a) East of Charlie's Creek there is an area of gently undulating country with generally poor outcrop. This area consists mainly of diorite and granodiorite with minor areas of adamellite, gabbro, and granite. Dykes of microdiorite and microadamellite were also noted. Some granodiorite outcrops show weak foliation. Most of these rocks are fairly calcic, and weather to a dark brown to black soil containing abundant lime-rich nodules.

(b) Near the eastern margin of this phase of the unit are many parallel swarms of dykes intruded into diorite and granodiorite. These dykes are extremely abundant, and in some places they predominate quantitatively over the host rocks. As can be seen on the map, the strike of these dykes turns from approximately north-south at the southern end of the area to north-north-west at the northern limit of the area, and are there normal to the Inkerman Shear Zone.

The dykes consist of porphyritic microgranite, microadamellite, microdiorite, microgranodiorite, and dolerite. The coarse-grained leucocratic rocks are noticeably foliated parallel to the strike of the dykes. In the more melanocratic rocks this foliation is not apparent.

(c) South-east of Kelly's Mount there is a second area of dyke swarms which intrude granodiorite, diorite, and adamellite. These dyke swarms appear at first sight from the air photos to be equivalent to the swarms at the eastern margin of the unit, from which they seem to have been

displaced by the Inkerman Shear Zone; however, this is not the case, for the dykes continue into the shear-zone, and are younger than it. In general this area is similar to the last (b) and contains dykes of microdiorite, microgranite, microadamellite, and dolerite. Epidotization along joints is quite common, and may extend a few inches outwards from them.

A small deposit of asbestiform tremolite was noted by Carruthers (1954) about two miles south-east of "The Rocks". He indicates that this outcrop is very similar to the material found in Six-Mile Creek in the Inkerman Shear Zone (see sub-section (e)).

(d) "The Rocks" (Photo Plate 2) is a large area of waterworn outcrop in the bed of the Burdekin River south-east of Kelly's Mount... Exposed here, in almost continuous outcrop, is a nearly complete suite of the various rock-types found in the adjacent areas. Within this area of outcrop the sequence of events was:

(1) Emplacement of biotite-hornblende granodiorite (tonalite), which contains fairly abundant, small (one foot long), tabular xenoliths of melanocratic, foliated, hornblende-biotite microgranodiorite.

(2) Intrusion of a second phase of granodiorite as irregular masses. These are quite coarse-grained hornblendic rocks.

(3) Intrusion of porphyritic microgranodiorite, again as irregular masses. This rock also has hornblende as a major constituent, and contains xenoliths of the hornblende granodiorite (2) above. Epidotization has taken place along joints in the microgranodiorite.

(4) Intrusion of dykes of flow-banded spherulitic dacite. The rock is porphyritic in places, and coarsely flow-layered with gradations in colour from pink to pinkish grey between the layers. These dykes are up to about 40 feet thick; their strike is not consistent within the area of outcrop.

(5) Intrusion of irregular masses of porphyritic microdiorite. This rock is medium-grained, and contains phenocrysts of plagioclase; it has been extensively epidotized along joints.

Photo Plate 2. Aerial view of part of an outcrop known as "The Rocks" in the Burdekin River, 12 miles south-west of Ayr. The outcrop consists of massive granodiorite and intermediate to acid dykes (Ravenswood Granodiorite) intruded by swarms of probably Late Palaeozoic microdiorite dykes.
B.M.R. Neg. No. G/7948.

(6) Emplacement of microdiorite dykes. These rocks are fine-grained, dark-green to almost black, and commonly porphyritic in their central zones. Fine-grained chilled margins can be seen in almost all of them. These dykes are of at least three ages, and their direction of emplacement appears to be random.

Potash feldspar is present only in the spherulitic dacite and microdiorite dykes, which contain notably less quartz than the granodiorite.

(e) The Inkerman Shear Zone intersects the Ravenswood Granodiorite as a belt about two miles wide. Shearing and metasomatic alteration of the diorite and granodiorite have produced many varieties of rocks, but some of the original rocks have been preserved unaltered.

In Six-Mile Creek, near Leichhardt Downs Homestead, a section across much of the shear-zone can be seen. In this creek there are wide exposures of gneiss, which in some places contain lenses of unaltered rock. Also found in this zone of alteration are: rocks rich in vermiculite, foliated diorite, garnet rocks as dyke-like masses, epidote rocks, thin quartz veins, magnetite bodies, amphibole-epidote-garnet rocks, and amphibolite.

The grainsize of the gneiss is very variable. Some of the rock is fine-grained and uniformly banded. Cleavage is generally good owing to parallel growth of hornblende crystals. Other areas are very coarse-grained with biotite flakes up to one inch diameter, and equally large plagioclase crystals. These occur as pegmatitic pods enclosed in the finer-grained material. The gneiss in some areas is very contorted. Banding ranges from layers 1/64 inch thick to about six inches. Hornblende-rich bands are plentiful. The bands vary in thickness along their length, and are commonly lenticular.

Two metasomatic "dykes" of garnet rock were noted. The first consists of about 95 percent brown garnet with intergranular quartz and very small grains of pyroxene, probably diopside. The garnet is strongly anisotropic, and shows excellent sector-twins as well as what appear to be multiple twins with many closely-spaced lamellae. Some crystals are also zoned, and the zones show different degrees of birefringence. The second rock contains pale yellow-green isotropic garnet with an outer zone of the anisotropic brown garnet, and about five percent intergranular quartz. The quartz in both these rocks shows no strain patterns, although twin lamellae in the garnets show slight undulose extinction. The garnetiferous

rocks appear to have formed after the shearing, possibly by metasomatic alteration of dyke rocks (e.g., microdiorite). Benson (1913) and Turner (1933) have described occurrences of highly garnetiferous rocks. Turner (1933) described a suite of rocks from Westland, New Zealand, where he observed highly garnetiferous rocks developed at the expense of gabbro. In this region gabbro and peridotite intrusion was accompanied by metasomatism and strong regional metamorphism.

Benson (1913) notes numerous occurrences of garnet-bearing altered gabbroic rocks from the "Great Serpentine Belt" in northern New South Wales. The degree of alteration of the gabbro to garnet ranges from rock with a small percentage of garnet up to almost monomineralic rock containing only minor amounts of prehnite. Other samples contain garnet selectively replacing either plagioclase or pyroxene. The environment of alteration of this gabbro may be similar to that which gave rise to the highly garnetiferous rock in the Inkerman Shear Zone, although there is no clear indication of the nature of the parent rock.

White (1959) notes the co-existence of two calcium garnets in the same rock from an area in South Australia. Here the garnet-bearing rock is in a zone where calc-silicate rocks are veined by migmatite, gneiss, and granite, and are formed as a result of metasomatism and interaction between mineral phases.

The magnetite-epidote-quartz-garnet rocks contain euhedral, brown, sector-twinned garnet (about 60 percent), quartz (20 percent), epidote (10 percent), and magnetite (10 percent).

Epidote rocks (not seen in situ), consist of about 98 percent pale yellow-green, weakly pleochroic epidote. The remaining two percent of the rock is an amorphous brown material, which has possibly replaced biotite.

Amphibole-rich rocks were noted in many places in Six-Mile Creek. Two specimens of amphibolite were examined. The first consists entirely of tremolite (colourless in thin section, with good crystal form; X-ray spectrographic analysis indicates about 2 percent aluminium). The second consists of 85 percent green, pleochroic hornblende and 15 percent talc. The talc occurs as aggregates of small flakes, poikiloblastically enclosed within hornblende. Two other specimens examined contain tremolite and talc in approximately equal quantities. In one of these rocks the talc appears to be replacing tremolite. All these amphibole-rich rocks have a schistosity which reflects the orientation of the amphibole crystals; they probably formed during shearing by the combined effects of hydrothermal

Photo Plate 3. Foliated garnet-wollastonite-diopside rock in the Inkerman Shear Zone, 8 miles south-south-east of Home Hill.
B.M.R. Neg. No. M/381/7.

action and the shearing itself.

Near the eastern end of the shear-zone, foliated quartz garnet-pyroxene "granulite" and garnet-wollastonie-diopside "granulite" (Photo Plate 3) have been noted. The first of these consists of garnet, augite, labradorite and quartz; the quartz grains are elongated, and the garnet is largely segregated into distinct layers; plagioclase is extensively altered to clinozoisite. A thin section of the second rock shows little evidence of a foliation apart from parallelism of inclusions in the garnet. This rock consists of about 50 percent garnet, together with wollastonite, diopside, calcite, and quartz. Two types of garnet are present here also; one is colourless and isotropic; the other is brown and anisotropic, and shows sector twinning. Both these rocks appear to have been formed by metasomatic alteration of sheared rocks.

Traces of copper mineralisation (secondary copper minerals and sporadic grains of chalcopyrite) were found in parts of the shear-zone. Four rock samples from the shear-zone have been analysed spectrographically, and the results appear in Appendix 1.

Intruded into the shear-zone are two swarms of dark green, fine-grained microdiorite and porphyritic hornblende gabbro dykes, as well as small plugs of massive granite. The directions of dyke emplacement are parallel to and normal to the shear direction; there are a few dykes oblique to these directions but they are subordinate.

(f) At various places in the bed of the Burdekin River there are large areas of water-worn outcrop. Between "The Rocks" and the southern edge of the Sheet area, especially, there are a number of notable areas of outcrop, all similar, and consisting of foliated and in places sheared granite, granodiorite, and diorite. The rocks have been mylonitized in places. The foliation and shear directions are not regionally consistent (except locally), and do not conform with the Inkerman Shear Zone. The sheared rocks are intruded by dykes of microadamellite, porphyritic microdiorite, micromonzonite, and dark green, fine-grained microdiorite. Quartz veining and epidotization, especially along joints, is common in places.

(g) West of the Burdekin River hornblende-biotite granodiorite is the main rock type, although adamellite, quartz diorite, diorite, and minor alkali granite have also been noted. The unit is deeply eroded and weathered, and is largely covered by soil.

Structure

The granodiorite-diorite phase of the Ravenswood Granodiorite may be foliated, in places quite strongly. The foliation was probably impressed after emplacement; its direction and intensity are not constant throughout the area, but in places it is obviously associated with shear-zones and faults.

Joint patterns are apparently random in most outcrops. Some areas are very highly jointed, but in most jointing is moderate. Polygonal joint patterns are common, but the angles between joints vary in different, though adjacent, rock-types. At "The Rocks" joint directions were measured in granodiorite, microgranodiorite, and microdiorite.

Lithology	Strike directions of major joint sets
Microgranodiorite	030° and 085°
Microdiorite	030° and 095°
Granodiorite	020° and 095°

These joints are vertical or nearly so. Joints in the adamellite strike at 135°, and epidotization has commonly taken place along them. In the microdiorite, joints striking 095° carried the epidotising solutions, and in the granodiorite joints striking 035° are most commonly epidotized. In the granodiorite there is another near-vertical joint striking 155°, and the sequence of jointing in this rock-type appears to have been 095°, 020°, and 155°. Flat-lying to shallowly-dipping joints also occur in all three rock-types.

A number of faults, in addition to the Inkerman Shear Zone, are shown on the map. All have caused strong foliation locally. The Inkerman Shear Zone dips vertically, and is at least two miles wide; it is the largest single structural feature in the Ravenswood Granodiorite.

Later Granite and Adamellite Phase (S-Da)

The small areas mapped as the later granite and adamellite phase of the Ravenswood Granodiorite in the south-western corner of AYR are photo-interpreted extensions of outcrops on TOWNSVILLE and BOWEN. The outcrop south of Horse Camp Hill forms a steep, east-north-east-trending ridge; that south of Mount Benjonney forms low hills and rises.

Age and Relationships

Isotopic dating of hornblende and biotite from samples of granodiorite collected from the Ravenswood Granodiorite on TOWNSVILLE has given an age of 420 million years ± 30%. Although the unit has been

sampled in several places on AYR, only two results are available so far, both from the Inkerman Shear Zone. The results are: 265-275 million years (Lower Permian) from hornblende in a hornblende-plagioclase-quartz gneiss; and 245 million years ± 3% (Upper Permian) from a green hornblende rock (99% hornblende - probably largely metasomatic/hydrothermal). Both of these specimens occurred as loose blocks in Six Mile Creek, nine miles south-south-west of Home Hill. All three dates were obtained by the K/Ar method.

The young ages obtained from the Inkerman Shear Zone are not in accordance with the (albeit scanty) field relationships of the Ravenswood Granodiorite on AYR. The best field evidence known is provided by the Charlie's Hill beds (probably Upper Devonian), which contain cobbles of sheared granodiorite identical with much of the Ravenswood Granodiorite in the Inkerman Shear Zone. The Permian ages are thought to date the last major shearing and also metasomatic/hydrothermal activity within the Shear Zone.

The Ravenswood Granodiorite is thought to have been intruded by "Undivided Palaeozoic Granitic Rocks" (Pzg) east of Mount Louisa and north of Rangemore Homestead. The adamellite and granite of the "Undivided Palaeozoic Granitic Rocks" resemble small bodies of adamellite which crop out within the area which is mapped as the granodiorite and diorite phase of the Ravenswood Granodiorite; similar adamellite at "The Rocks" intrudes the granodiorite and diorite.

On CHARTERS TOWERS and TOWNSVILLE both phases of the Ravenswood Granodiorite intrude the Cape River beds (early Palaeozoic?), and are intruded by the Lolworth Igneous Complex (also Silurian-Lower Devonian); they are overlain unconformably by the Fanning River Group (Middle Devonian). No isotopic ages are available yet from the late acid phase (S-Da). At present the Ravenswood Granodiorite is regarded as Silurian-Lower Devonian.

UPPER DEVONIAN(?)

UNNAMED CALCAREOUS HORNFELS (Pzj) (A.G.L.P.)

Calcareous hornfelses which are believed to be Upper Devonian form Charlie's Hill, about four miles south-east of Home Hill.

Charlie's Hill is a small steep hill elongated north-east; it is about 400 yards long by 100 yards wide and rises about 70 feet above the surrounding alluvium of the Burdekin Delta. The hill consists of dark grey, strongly hornfelsed, calcareous cobble and pebble conglomerate with some interbeds of grey, cross-bedded calcareous quartzite. Such

calcareous sediments are unknown elsewhere on AYR.

The rocks dip at about 20° to the south-east, and cross-bedding in the quartzite indicates that they are overturned. The conglomerate contains phenoclasts of white quartz, marble, and foliated to gneissic, dioritic to granodioritic rocks identical with much of the Ravenswood Granodiorite in the Inkerman Shear Zone. Garnet, tremolite, and diopside occur in the conglomerate, in places disposed in zones concordant with the margins of the phenoclasts. All phenoclasts in the conglomerate are ellipsoidal; the long axes lie in the plane of the bedding, indicating that the rocks were compressed, and perhaps also sheared, during folding. In places the conglomerate has been intruded by post-tectonic veins of medium-grained, leucocratic diorite up to six inches wide.

The age of these rocks is unknown. However the conglomerate very closely resembles the distinctive "Deadman's Gully Conglomerate" at the base of the Upper Middle Devonian Dotswood Formation of the Reid River district (TOWNSVILLE). Charlie's Hill may in fact be an outlier of the calcareous sediments which are typical of the Middle to Upper Devonian succession on TOWNSVILLE.

UNDIVIDED PALAEOZOIC

UNNAMED GRANITIC ROCKS (Pzg)

Areas of granitic rocks, whose age is unknown but probably Palaeozoic, occur in the western part of the Sheet area. These rocks occur chiefly in a belt near the southern boundary of AYR, between the Gregory Ranges and Beaks Mountains; elsewhere they occur as isolated masses, many of which lack contacts with units of other than Cainozoic age.

Gregory Ranges - Beaks Mountains (C.M.G.)

Correlated with the Gregory Ranges - Beaks Mountains outcrop area, and described here, are: (1) a smaller outcrop of microadamellite in the Burdekin River near Mount Dalrymple, and (2) dykes and small masses of adamellite and rhyodacite which intrude the Ravenswood Granodiorite at "The Rocks" (these are not mapped separately from the Ravenswood Granodiorite).

Topography and Photo Pattern

Topography ranges from very rough, steep hills to plains. Near the eastern limit of outcrop there are many dyke swarms which stand up as ridges. South-east of Mount Louisa the country changes abruptly from high, steep hills to plains. In the plains outcrop is generally poor, and weathering very deep.

Photo pattern is variable and unreliable.

Lithology and Structure.

The oldest rocks are leucocratic pink adamellite and biotite granite. They have been sheared to varying degrees, in some places strongly. Jointing is generally well developed. Many of the rocks are deeply weathered and iron-stained, making precise identification impossible.

There are very abundant dykes of microdiorite, microadamellite, microgranite, rhyolite, rhyodacite, dacite, and related porphyries. These dykes, which commonly occur in swarms, in some areas occupy so much space that outcrop of the host rock is rare, e.g., near Beaks Mountains. Their strike mostly ranges between 315° and 045°, though some lie oblique to these directions.

Microdiorite dykes are most common. Microgranite, microadamellite, and rhyodacite, together with their porphyritic varieties, are next in abundance. Dacite is comparatively rare. Rhyolite (or microgranite) dykes were found near Beaks Mountains and near Mount Louisa. At Beaks Mountains they appear to be related to Edinburgh Castle, an intrusive centre 4 miles south of the margin of the Sheet area. One of these rhyolite (or microgranite) dykes (see Appendix 5, specimen 64155093), contains many elongate, concentric, ovoid structures. The structures have the shape of spheroids or truncated cones, compressed in the plane of the dyke, that is, each structure has its long and median axes parallel to the sides of the dyke. The maximum observed length of the short axes is about 15 inches, and [illegible] did not appear to vary with depth. The median axis of one structure ranged between one and two feet in outcrop, but widened downwards. The plunge of the long axes is about 70 degrees. The dyke containing these structures is about two feet wide.

The width of dykes ranges between one foot and 10 feet generally, although some are much wider. [illegible] In the Burdekin River, near its junction with Landers Creek, a microadamellite dyke is up to 300 feet wide. This mass has a weak east-west foliation, and is very highly jointed. Jointing here is probably due to the Millaroo Fault, mapped just west of here, although no actual brecciation is found in this outcrop.

Shearing is strongly developed in some areas, especially just east of the Burdekin River, but it cannot be related to any known major shear direction. The strike of the shearing ranges between about 060° and 160°. Dip of the shearing is steep, and generally vertical.

Age and Relationships

Evidence obtained from the outcrop at The Rocks suggests that the adamellite and rhyodacite are intrusive into the Ravenswood Granodiorite. Mount Louisa, an acid plug, possibly of Carboniferous age, intrudes the adamellite. The overall evidence suggests a Middle Palaeozoic age for this mass of granitic rocks.

South-eastern part of the Mount Dalrymple Range (D.E.C.)

A body of granite with vaguely defined boundaries forms the south-eastern extremity of the range of which Mount Dalrymple is the highest peak.

Pink, medium- to coarse-grained, leucocratic, slightly porphyritic, granophyric alkali granite is the chief rock-type exposed in a quarry north of Landers Creek Homestead. South-west of here the granite is porphyritic, and contains rounded quartz phenocrysts averaging 2mm. in diameter. A pink granophyric microgranite phase with rare pink feldspar phenocrysts is intimately associated with the granite in this vicinity. In the quarry the granite is strongly shattered by a north-west-trending fault-zone into which many greenish grey, porphyritic microdiorite dykes have been intruded.

One mile north-west of the quarry grey to pink, medium-grained granophyre is intruded by dark greenish-blue microdiorite dykes.

The contact between the granophyre and the (?)Upper Carboniferous Volcanics (Cuv) was examined in this area, but it was not possible to establish the relationship; absence of metamorphism in the volcanics next to the contact suggests an unconformity.

Half a mile west-south-west of Mount Woodhouse (D.E.C.)

A 300-foot thick sheet-like intrusion which ranges from medium-grained biotite granite to granophyric alkali microgranite, and dips at a moderate angle to the east-north-east, forms a low hill half a mile west-south-west of Mount Woodhouse. Slight foliation is generally evident in hand specimen, and granophyric microgranite at the southern end of the body is the most strongly foliated. A number of slightly different microgranite phases are present, but their inter-relationships and areal extent are unknown. In some places the microgranite is contaminated by assimilation of country rock. The microgranite intrudes deeply eroded blue-grey hornblende-biotite granodiorite of the Ravenswood Granodiorite. The origin of the foliation is uncertain; it may be an original flow feature of the sheet-like body, or it may indicate a later shearing stress, especially as the intrusion lies on a possible westerly extension of the Inkerman Shear Zone.

Two miles north-north-west of Mount Woodhouse (D.E.C.)

Two small bodies of white granodiorite and microgranodiorite intrude the Ravenswood Granodiorite two miles north-north-west of Mount Woodhouse. They appear to have been contaminated by assimilation of country rock. The granodiorite is white and fine-grained; it consists almost entirely of equigranular calcic oligoclase, with minor quartz, hornblende, biotite, iron oxides, and epidote. Both bodies are strongly fractured in a north-south direction.

Two miles west of Mount Benjonney (D.E.C.)

An irregular mass of medium-grained, blue-grey granodiorite intrudes quartzites (Pzu) two miles west of Mount Benjonney. It may also intrude the hornblende granodiorite (Ravenswood Granodiorite) which partly surrounds it, but this was not proven. The granodiorite which is leucocratic, contains abundant large plagioclase phenocrysts which in places are surrounded by micropegmatite. Some hornblende was noted in hand specimen. The granodiorite is intruded by glomeroporphyritic plagioclase-hornblende porphyry dykes. The presence of dykes in this mass, and the general absence of dykes in the late Palaeozoic intrusives in this area, suggest that the granodiorite may be an older mass.

Six miles north-north-east of Mount Dalrymple (D.E.C.)

Pink, fine-grained leucogranite, intruded by numerous rhyodacite and rhyolite dykes, forms a broad, almost imperceptible rise surrounded by alluvium, between Gladys Lagoon and the Burdekin River.

Kelly's Mount (A.G.L.P.)

Kelly's Mount, , eight miles south-west of Ayr, is an uneven granite hill rising to 600 feet above sea-level, and surrounded by a broad apron of outwash sand. A specimen collected from the northern spur is a coarse, massive, leucocratic biotite granite consisting of microcline-perthite, quartz, albite-oligoclase, and biotite. The accessories are chlorite and rutile (after biotite), and zircon associated with opaques and muscovite. The plagioclase shows incipient sericitisation, and the potash feldspar is commonly cloudy. There is a quite extensive development of greisen on the north-eastern slopes of the hill (see map). Several costeans and benches have been bulldozed in it. No mineralisation was seen in the field. However, a specimen analysed by optical spectrograph contained 300 ppm. molybdenum (see Appendix 1). Thin basic to intermediate dykes intrude the granite on the southern slopes.

The range of hills two and a half miles south-west of Kelly's Mount also consists of granitic rocks which are similarly encircled by a broad apron of outwash sand. The rocks are well exposed in a road-metal quarry at the south-eastern end of the range. The rock here is a massive, medium-grained, pink biotite adamellite composed of oligoclase, perthite, quartz, and biotite (now mostly altered to chlorite and epidote). Potash feldspar and quartz are commonly intergrown semi-graphically. The biotite appears in places to have been replaced by potash feldspar. The quartz crystals are strained and slightly biaxial. Opaques, apatite, and zircon are the accessories. The adamellite is typically somewhat epidotised. Stronger epidotisation has taken place along small faults. Aggregates of pyrite occur in association with quartz and small rosettes of muscovite in rare pegmatitic segregations. There are some coarse aggregates of quartz-calcite-epidote-pyrite which occur as lenses and as the linings of small vugs. A swarm of thin amygdaloidal, pyritiferous augite dolerite dykes intrudes the adamellite.

Mount Inkerman (C.M.G.)

Mount Inkerman is an inselberg which rises steeply to 700 feet above sea-level, and is elongated in a north-easterly direction. The hill is composed of a strongly sheared, jointed and foliated granite. The foliation direction is north-east by east and it is clear that Mount Inkerman lies within the major shear-zone (named the "Inkerman Shear Zone" in this report) which has affected the Ravenswood Granodiorite in the hills to the south-west. The granite of Mount Inkerman contains xenoliths of biotite schist and dykes of microdiorite (post-shearing). Mount Alma is geologically similar to Mount Inkerman.

Four miles south-west of Mount Inkerman (C.M.G.)

A small hill near Stud Lagoon, four miles south-west of Mount Inkerman consists of sheared, recrystallised, and hydrothermally altered granitic rock. This rock is composed of equigranular quartz and feldspar with cubes of magnetite and small crystals of red garnet as accessories. This hill also lies within the Inkerman Shear Zone.

Three miles south of White Rock Bay (Cape Cleveland) (A.G.L.P.)

Two small hills three miles south of White Rock Bay (Cape Cleveland peninsula) consist of fine-grained, foliated biotite adamellite. These hills are much lower than the main part of the Cape Cleveland range which is composed of massive coarse biotite adamellite (P-Mg).

The foliated adamellite appears to have been intruded by the massive adamellite. The foliated adamellite, which is gneissic in places,

consists of xenomorphic quartz, perthite, and albitic plagioclase traversed by thin trails of very fine-grained biotite. The foliation dips at 45° to the south-east.

Five miles south-west of Guthalungra

An area believed to be underlain by granitic rocks, next to the southern boundary of AYR five miles south-west of Guthalungra, has been included with this unit. The area appears on the air photographs to consist almost entirely of low rises, from which emerge rare core-stones. Biotite adamellite of unknown age crops out two miles to the south, on BOWEN.

UNNAMED BASIC PLUTONIC ROCKS (Pzt) (D.E.C.)

An area occupied by basic plutonic rocks has been mapped in the south-western corner of AYR, one mile south-west of Sandalwood Waterhole. These rocks form an easterly-trending ridge, fifteen feet high and entirely surrounded by alluvium. The rocks are crudely banded in places. The only specimen sectioned is an olivine microgabbro.

This outcrop strongly resembles similar layered gabbroic phases of the Urannah Complex (see below).

UPPER CARBONIFEROUS

ELLENVALE BEDS (Ce) (D.E.C.)

Horse Camp Hill, which is bisected by the AYR/TOWNSVILLE boundary, consists of grey, flow-banded rhyolite, rhyolitic breccia, andesite, and porphyritic rhyolite with either feldspar or abundant rounded quartz phenocrysts.

These volcanics were included in the Ellenvale Beds on TOWNSVILLE by Wyatt who assigns a late Middle to Upper Carboniferous age to them in their type area in the valley of the Reid River, upstream from Ellenvale Homestead (Wyatt et al., 1965). The evidence for this age is: (1) fragments of cf. Rhacopteris sp. and indeterminate equisetalean stems (McKellar, 1963) in interbedded sediments, (2) the position of the Ellenvale Beds higher in the stratigraphic column than known Tournaisian strata, and (3) the absence in them of any trace of a Glossopteris flora.

UNNAMED ACID VOLCANICS (Cuv) (D.E.C.)

Summary

Acid and minor intermediate volcanics form Mount Dalrymple (1900 feet) and a number of smaller hills and rises in the south-western part of the Sheet area. Rhyolite and rhyolitic pyroclastics (commonly welded) are the chief rock-types, and andesite occurs in minor quantities. These volcanics are believed to be of similar age to the Ellenvale Beds (TOWNSVILLE) and Bulgonunna Volcanics (BOWEN).

Introduction

Acid volcanics similar to the Ellenvale Beds were mapped on the southern half of BOWEN (Malone et al., 1962). Malone regarded these volcanics (Bulgonunna Volcanics) as probably Upper Carboniferous because, (1) they unconformably overlie the Lower Carboniferous Drummond Group, and (2) they are unconformably overlain by the Lower Permian "Lower Bowen Volcanics" (now Lizzie Creek Volcanics).

Isolated blocks of volcanics similar to both the Ellenvale Beds and the Bulgonunna Volcanics, and commonly having faulted contacts, crop out in the intervening country in south-western AYR and north-western BOWEN. While it seems logical at present to regard these volcanics as the same age as the Ellenvale Beds and the Bulgonunna Volcanics, no sedimentary interbeds have been found in them, nor is their age so well established stratigraphically. At present they are mapped as unnamed "Upper Carboniferous Volcanics" (Cuv).

Distribution and Topography

These volcanics form most of the steep, rugged range of which Mount Dalrymple (1900 feet above sea level) is the highest peak. They also form Mount Woodhouse, which rises only a few hundred feet above the general level of the alluvial plain. The minor occurrences of these volcanics in the south-western part of the Sheet area have insignificant topographic expression.

Lithology

Rhyolite and welded tuffs which form the south-western flank of Mount Dalrymple are very fine-grained and highly brecciated by a strong south-east trending fault. The welded tuffs consist of feldspar and quartz phenocrysts, and rock fragments in a devitrified matrix. The matrix is a crypto-felsitic mass of feldspar and quartz which has been strongly altered to sericite and saussurite. Rock fragments are of three main types: altered glassy ejectamenta (now devitrified glass, partly or wholly converted to sericite and quartz), quartz-rich fragments, and welded(?) tuff. These

volcanics differ from others of presumed similar age on northern BOWEN mainly in the degree of the alteration: devitrification is much further advanced. The highly shattered volcanics of Mount Dalrymple are intruded by red-brown, feldspar-hornblende porphyry dykes.

At the eastern end of the Mount Dalrymple range, near the headwaters of Deep Creek, dense, very fine-grained, light grey rhyolite and rhyolite-breccia predominate. Blue-black dacitic, welded tuff also occurs. The volcanics are strongly jointed, and locally appear thermally metamorphosed.

Two miles west of the junction of Deep Creek and the Burdekin River are white, siliceous, strongly sheared vitric tuff(?) and spherulitic rhyolite which are strongly pyritic, and locally resemble pyritic quartzite. The strong shearing is related to the south-east trending fault, and the pyrite may have been introduced by metasomatism associated with the mass of microgranite (Pzug) just north of Deep Creek. White, pyritic hornfelsed rhyolite also occurs adjacent to the smaller mass of microgranite (Pzug) which intrudes the volcanics along Deep Creek.

Minor occurrences of brecciated intermediate volcanics in the Burdekin River, and brecciated volcanic breccia in Landers Creek, are small blocks caught up in the very strong shear-zone along the south-western side of Mount Dalrymple.

East of the Burdekin on the southern edge of the Sheet area are low hills sparsely covered with rubble of acid volcanics and siliceous rocks resembling quartzite. The acid volcanics are very poorly exposed on AYR, but just to the south, on BOWEN, exposures are much better; the rocks here are pale green, pink, and white, and some contain small phenocrysts of quartz and feldspar in either a flow-banded or massive groundmass. Flow-banding is steep and generally contorted. No vitric rocks were noted. The "quartzite", which consists of angular quartz grains with strongly oriented threads of sericitic material, may be older than the volcanics. It was not possible to map "quartzite" separately from volcanics in this area.

Andesitic breccia and tuff, rhyolitic tuff, minor rhyolite and andesite are the chief rock-types at Mount Woodhouse; some of the tuff is partly welded. Strongly flow-banded rhyolite crops out adjacent to the Woodhouse Fault, five miles south-west of Mount Woodhouse.

Structure and Relationships

The volcanics at Mount Dalrymple occur as a block down-faulted into the Ravenswood Granodiorite. Internal structure of the block is not well known, but it probably is a complex of extrusive and minor intrusive phases. Along the Woodhouse Fault the acid volcanics are very strongly sheared, brecciated, and recrystallized and in places they are also strongly pyritic.

The granite-aplite and alkali-microgranite mass (Pzug) north of Deep Creek intrudes the volcanics, but the granophyric alkali-granite (Pzg) just north of Landers Creek Homestead may be unconformably overlain by the volcanics. Near this contact the volcanics are not noticeably metamorphosed, but contact relations are complicated by poor exposure and strong faulting.

The tuffaceous volcanics at Mount Woodhouse unconformably overlie the Ravenswood Granodiorite. The minor outcrop area south-south-west of Mount Woodhouse is strongly brecciated along the Woodhouse Fault.

The three small areas of volcanics near the southern edge of the Sheet area occur in an intense shear-zone which trends east-south-east along the south-western side of Mount Dalrymple. They are strongly brecciated.

Age

No critical relationships which would establish a definite age for these volcanics have been found. The volcanics are younger than the Ravenswood Granodiorite, and are intruded (more abundantly in the Leichhardt Range on BOWEN) by granitic bodies (Pzug) which are believed to be late Palaeozoic.

CARBONIFEROUS TO PERMIAN

UNNAMED VOLCANICS (C-Pv) (A.G.L.P.)

Summary

Intermediate and acid volcanics, correlated with Carboniferous to Permian volcanics near Townsville, form the foothills of Saddle Mountain and Mount Elliot, and the northern mile or so of the Cape Cleveland peninsula. A maximum thickness of 4000 feet is possible at Cape Cleveland.

Distribution and Topography

Rocks included in this unit crop out in the north-western corner of the Sheet area. At Cape Cleveland they form a narrow, steep, irregular headland whose summits rise in places to 300 feet above sea level. Across the granite contact to the south this headland becomes higher, and broadens to form the main mass of the Cape Cleveland peninsula. West of Giru these rocks form an uneven fringing zone of foothills east and south-east of Saddle Mountain and Mount Elliot . Uneven hills of volcanics, rising in places to 800 feet above sea level, extend for several miles to the south-east of Mount Elliot .

Lithology

Rather well bedded, dark to pale brownish grey acidic, welded crystal tuff occurs at Cape Cleveland. One specimen has a dacitic composition. Some thin flows of acid lava were also noted.

In the south-eastern foothills of Saddle Mountain, the chief rock-types are massive, dark greenish grey, andesitic agglomerate and lapilli tuff. Cubes of pyrite are commonly disseminated through these rocks. Pale pinkish brown rhyolitic feldspar porphyry crops out on the western side of the road due east of the summit of Saddle Mountain.

Massive, porphyritic, greenish grey andesite or dacite and some dark blue, finely porphyritic andesite occur three quarters of a mile south-west of where the Bruce Highway crosses Palm Creek.

South-east of Mount Elliot , in the Walkers Creek/Black Gully district the rocks are purple and greenish purple porphyritic and aphanitic (?)andesites. They are commonly amygdaloidal, and are almost everywhere strongly epidotised. Abundant boulders of fine-grained basic rocks are believed to have come from dykes.

Structure and Thickness

At Cape Cleveland the rocks appear well bedded, and the dip is fairly constant to the south-east. North-west trending lineaments, probably faults, appear in places on the air photos. Dip measurements of 50° were recorded at two points about one mile apart. If there has been no repetition of the sequence by faulting, the maximum thickness possible here is about 4000 feet.

Elsewhere the thickness and overall structure of the volcanics were not determined. In a road cutting in the main road just west of Black Gully, (?)andesite appears to dip north-west at 5°. (?)Andesite half a mile south-west of where the Bruce Highway crosses Palm Creek seems to dip west at a moderate angle. All other outcrops seemed to be structurally featureless.

Age and Relationships

The volcanic rocks around Mount Elliot and Saddle Mountain are continuous with volcanics of similar lithology near Townsville which have been dated as late Carboniferous to Permian because they contain sedimentary interbeds in which Glossopteris sp. has been recorded (Wyatt et al., in prep.(a)).

The volcanics at Cape Cleveland are not especially similar lithologically to the volcanics near Townsville; they are mapped at present in this category owing to absence of evidence that they are of any other age. They are intruded by the Cape Cleveland adamellite, whose age is unknown.

LATE PALAEOZOIC

UNNAMED INTRUSIVE RHYOLITIC ROCKS (Pzh) (C.M.G.)

Introduction

A plug-like mass of probably late Palaeozoic rhyolitic rocks has been mapped at Mount Louisa. It is correlated with similar occurrences on CHARTERS TOWERS (Wyatt et al., in prep. (b)).

Distribution, Topography and Photo Pattern

The only known area of outcrop of these intrusive rhyolitic rocks is at Mount Louisa. Mount Louisa, twenty miles south-south-west of Home Hill, is a high, very steep hill, with cliffs developed in places near its summit.

Photo-pattern is not especially different from that in adjacent granitic areas except where cliffs are developed. These are clearly distinct from the surrounding plutonic rocks. Ground observations are necessary to map the boundaries of the unit.

Lithology

Rock-types observed in the Mount Louisa area are strongly flow banded rhyolite, felsite, trachyte, and trachyandesite. These rocks are generally weakly porphyritic, green to white, and highly jointed, and some of

them are vitric. Flow banding is usually steep and commonly very contorted. The cliff-faces exhibit strong vertical joints. The rocks are intruded by dykes of microdiorite and microadamellite, similar to those seen to the east intruding the Ravenswood Granodiorite. Dykes of felsite and trachyandesite, similar to lavas in the Mount Louisa body, intrude the adamellite (Pzg) to the east.

The main rock-type consists of microlites of feldspar, iron stained clay, and quartz. Quartz is not obvious, although it probably forms quite a high percentage of the groundmass. Small patches of penninite and of epidote are scattered through the rock. Granular quartz occurs in irregular accumulations, and feldspar phenocrysts are completely altered to clay and epidote.

Structure and Relationships

The rocks at Mount Louisa seem to intrude the "Undivided Palaeozoic Granitic Rocks" (Pzg). They appear to consist of a plug and minor extrusive phases.

Microdiorite dykes similar to those which intrude the "Undivided Palaeozoic Granitic Rocks" and the Ravenswood Granodiorite also intersect the rhyolitic rocks of Mount Louisa.

UNNAMED GRANITIC BODIES (Pzug)

Several granitic bodies which, by comparison with similar stocks on TOWNSVILLE, CHARTERS TOWERS, and BOWEN, are believed to be late Palaeozoic, are mapped in the western part of the Sheet area. They are mainly granite, microgranite, and adamellite bodies which post-date the Ravenswood Granodiorite and, in places, the numerous dykes which intrude it. Stratigraphic control is not good enough to allow determination of an age more precise than late Palaeozoic. These intrusives probably range from Carboniferous to Permian in age. Some are probably the same age as those mapped as Permian to Mesozoic (P-Mg) and bodies in the eastern half of the Sheet area which are mapped with the later phase of the Urannah Complex.

Mount Benjonney (D.E.C.)

Mount Benjonney, a roughly oval stock [illegible] of alkali-granite, is sparsely vegetated and strongly jointed. The alkali-granite is grey, even textured, fine- to medium-grained, and leucocratic, and contains numerous small hornblendic xenoliths. It intrudes the Ravenswood Granodiorite. Biotite is the chief mafic constituent. No dykes were seen to intrude the alkali-granite, which post-dates the numerous and varied dykes

intruding the Ravenswood Granodiorite nearby.

Three miles west of Mount Benjonney (D.E.C.)

Red alkali microgranite forms a 250-foot high arcuate ridge three miles west of Mount Benjonney; two smaller areas to the east and west of the ridge have been photo-interpreted as microgranite. The alkali microgranite, in places with graphic texture, contains scattered small basic and intermediate xenoliths; advanced assimilation of these has produced mafic clots throughout the microgranite. Biotite, amphibole((?)ferro-actinolite) and minor clinopyroxene together constitute less than 5 percent of the rock. Chlorite and epidote are products of strong deuteric alteration.

Fragments of hornblende granodiorite distributed throughout the microgranite are derived from the Ravenswood Granodiorite. Other fragments, chiefly feldspar-hornblende porphyry, resemble dykes in the swarm which intrudes the Ravenswood Granodiorite on the eastern side of the microgranite. The microgranite is not intruded by dykes, and closely resembles parts of a late Palaeozoic granite which crops out six miles to the north-west, in the Leichhardt Range on TOWNSVILLE.

Upper Barratta Creek (D.E.C.)

An oval stock of pink, medium-grained, biotite adamellite crops out in the headwaters of Barratta Creek; the eastern half of this stock occurs on AYR. The adamellite intrudes the Ravenswood Granodiorite, and closely resembles the biotite adamellite stock of the Molybdenite Creek body in the north-eastern corner of CHARTERS TOWERS (Wyatt et al., in prep.). It is not intruded by dykes.

North-east Mount Dalrymple (D.E.C.)

A spur of the Mount Dalrymple range extending west-north-west from the junction of Deep Creek and the Burdekin River consists of granite aplite and alkali microgranite. Intensely fractured, pinkish brown granite aplite exposed in the west bank of the Burdekin River is locally extremely fine-grained, and is commonly flow-banded. Here it is intruded by a porphyritic microdiorite dyke. A thin, fine-grained biotite adamellite dyke also intrudes the granite aplite.

Fine-grained, brownish grey alkali-microgranite in the main spur also shows this irregular banding in which the rare micaceous minerals are strung out in fine, irregular layers. One and a half miles up Deep Creek a small body of similar brownish grey microgranite intrudes and hornfelses Upper Carboniferous volcanics (Cuv). Adjacent to its contact the microgranite

contains blocks of hornfelsed, vesicular, porphyritic volcanics.

The alkali-microgranite is strongly fractured by the Woodhouse Fault. It intrudes the Ravenswood Granodiorite which is covered by scree, outwash, and alluvium at the eastern end of Mount Dalrymple. A late Palaeozoic age is suggested by the intrusive relationship with the Upper Carboniferous Volcanics (Cuv).

The Gap (C.M.G.)

Just north of The Gap (five miles east-north-east of Mount Louisa) is a small area of very rough, boulder-covered hills of adamellite. These rocks have been mapped as late Palaeozoic; their boundaries can be seen readily on aerial photos.

The rock type is a massive, medium-grained biotite adamellite, the only variation being a few, thin, wispy dykes of finer-grained material of similar composition. No dykes of extraneous material were seen.

Artillery Hill - Major Creek Mountain (A.G.L.P.)

Pink, coarsely porphyritic microgranite forms two north-north-west trending irregular ranges of hills up to 900 feet high north-west of the Haughton River, near the western boundary of the Sheet area. The western range is known as Artillery Hill; the eastern range trends north-west from Major Creek Mountain.

In the northern bank and bed of Major Creek, south of Artillery Hill, are large outcrops of brecciated pink and red porphyritic microgranite.

The coarsely porphyritic microgranite which forms the eastern range contains round phenocrysts of quartz and mainly white, euhedral feldspar averaging 5 to 6 mm., but ranging up to 3 cm., in a very fine pink groundmass. The microgranite is aphyric in places. Rare chloritized biotite is the chief mafic mineral. Microdiorite dykes are abundant in both ranges of hills.

The contact between the microgranite and the Carboniferous to Permian volcanics (C-Pv) to the north-west was not seen, and their age-relations are not known.

The microgranite, close to a microdiorite dyke which intrudes it near a gravel pit at the northern part of the steep hill immediately south-east of Mount Ironbark, has been altered to a white siliceous rock containing

disseminated pyrite.

CARBONIFEROUS TO MESOZOIC

URANNAH COMPLEX (C-Md and C-Mg) (A.G.L.P.)

Summary

Basic, intermediate, and acid plutonic rocks mapped with the Urannah Complex form hills of varying height and also low-lying country east of Bobawaba Siding. Two phases have been identified: an earlier dioritic suite (C-Md) which includes diorite, gabbro, and dolerite, with minor tonalite and norite; and a later granitic suite (C-Mg) which consists mainly of adamellite and granite, with some granodiorite. The boundaries of the Complex on AYR are mapped on the basis of indirect evidence only, and are largely the result of lithological, geographical, and to some extent, structural extrapolation northwards from BOWEN, where the boundaries of the Complex are better known. On AYR neither critical field relationships with rock units of known age nor isotopic dates are at present available; present evidence from BOWEN indicates that the Urannah Complex is chiefly Upper Carboniferous to Upper Permian, but also contains some Lower Cretaceous phases.

Introduction

Much of the bedrock exposed east of Bobawaba Siding is mapped as part of the Urannah Complex (Malone et al., 1962), a composite batholith which covers 3000 square miles on AYR, BOWEN, PROSERPINE, MOUNT COOLON, MACKAY, and SAINT LAWRENCE.

The name "Urannah Complex" was first proposed by Malone et al. (1962) as a result of mapping of the eastern parts of MOUNT COOLON in 1960 and BOWEN in 1961. In 1962 other field parties of the Bureau of Mineral Resources and the Geological Survey of Queensland mapped the batholith without interruption as far south as the headwaters of the Connors River on MACKAY (Jensen et al., 1963) and SAINT LAWRENCE (Malone et al., 1963). In 1964 a wide variety of plutonic rocks was mapped in eastern AYR during the course of the present survey, but, although local relationships could be established in places between the different rock-types, the regional relationships, structural environment, and age of these plutonic rocks were unknown. In 1965 the Urannah Complex was found to continue northwards in a belt 30 miles wide across north BOWEN, and its extension onto AYR is now recognised.

Two major phases of the Urannah Complex, an earlier dioritic phase and a later granitic phase, have been mapped on north BOWEN, and this twofold scheme has now been extended north onto AYR (C-Md and C-Mg). Several isotopic

ages have been obtained so far from the Complex on BOWEN. They indicate that emplacement began in the Late Carboniferous to early Permian, and extended into the Middle Permian; some Lower Cretaceous dates have also been obtained, but we do not yet know the extent or significance of this intrusive epoch.

Dioritic Phase (C-Md)

Distribution and Topography

South and south-west of the Seven Sisters, gabbro/diorite forms low, undulating rises barely higher than the adjacent soil-covered plains. Elsewhere, apart from a few smaller outcrops, these rocks form isolated, steep hills which rise from the coastal plain. The hills vary in size and height - for example, Bald Hill (250 feet), and Mount Luce (900 feet). Dioritic roof-pendants occur near the summit of Mount Roundback (2400 feet). Camp Island consists of rocks mapped with this phase.

Slopes devoid of vegetation, and covered with large rounded boulders of gabbro, occur in places on the hills, for example, the northern face of Mount Luce. These slopes appear quite black when seen from a distance, and are diagnostic of the basic to intermediate plutonic rocks.

Intermediate to basic plutonic rocks also crop out intermittently around the margins of the leucogranite stocks (P-Mg) of Gloucester Island and the Cape Upstart peninsula, and on Holbourne Island. However, there is evidence to suggest that these occurrences are closely related to the granitic bodies with which they occur; they are therefore mapped separately and described elsewhere (P-Md).

Lithology

Rocks mapped with this phase include diorites, dolerites, gabbros, and norites. Some outcrops are apparently massive and structureless; others are banded in layers of different composition, texture, and grainsize.

Occurrences are described below:

Mount Little

A specimen taken from the eastern foothills of Mount Little is a coarse, massive diorite. The diorite has been slightly recrystallised by granite (P-Mg) which crops out in the saddle between Sprole Castle and Mount Little.

Sprole Castle

The rock at the summit of Sprole Castle is a similar massive diorite. Blocks of augite diorite and banded microdiorite occur on the southern slopes (just within the Bowen Sheet area).

Alligator Swamp

Olivine gabbro, olivine microgabbro, and leucocratic olivine norite form a low rise immediately east of Alligator Swamp (north of the railway line, five miles west-north-west of Bowen). In places these rocks have an indistinctly banded appearance, the bands striking east-west and dipping sub-vertically. Some segregations of gabbro-pegmatite occur in places, and some of the rocks are intruded by biotite pegmatite and aplite dykes.

Corona structures were observed in thin sections of some of these rocks (see Appendix 5).

Abbot Point (Bald Hill)

Banding is well displayed in waterworn boulders and to a lesser extent in outcrops of basic rocks at Abbot Point. The rocks are generally coarse, but the grainsize, texture, and composition of individual bands and boulders vary widely. In places banded (?)gabbro has been intruded, and the bands sharply truncated by, similarly banded rock (Photo Plate 5). In places the banding is sharp, in places vague. Small-scale folds and contortions are common; they are frequently disharmonic, and are contained within bands which are essentially parallel (Photo Plate 6).

Some coarsely porphyritic rocks contain squat, euhedral plagioclase crystals two or three centimetres in diameter (Photo Plate 8); some of these have crystallised around a small mafic nucleus; these crystals may contain one or more thin concentric bands of similar fine-grained mafic material centred on such nuclei. Segregations of gabbro pegmatite commonly permeate the rocks. These show a tendency to form in the cores of folds in the banding (Photo Plate 7). Rare, thin veins and lenticles of fine-grained ultramafic rock transgress most of the other structures. A final thin network of late-stage pegmatitic feldspar-quartz-mafic veins cuts the rocks in places.

Mount Luce

Coarse but inequigranular, massive, uralitised gabbro occurs in the south-western foothills of Mount Luce. Banded, uralitised, anorthite gabbro, containing large poikilitic crystals of hornblende, forms the small hill on the coast north-east of Mount Luce. The banding here dips at 60° to the south (Photo Plate 4). It is very regular, and further differs from the

Photo Plate 4. Planar banding in anorthite gabbro (Urannah Complex, C-Md), on the coast half a mile north-east of Mount Luce.
B.M.R. Neg. No. G/7917.

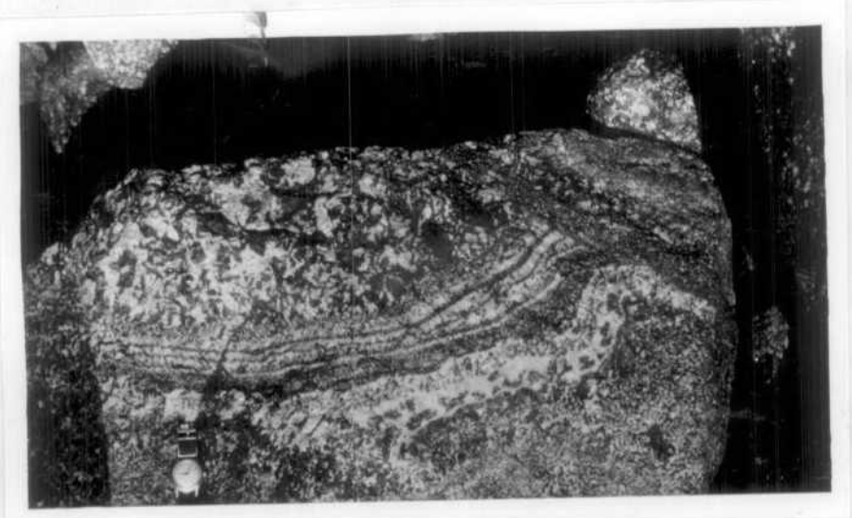


Photo Plate 5. Irregularly banded, uneven-grained gabbro (Urannah Complex, C-Md), truncated by other bands of similar rock. Waterworn boulder at Abbot Point.
B.M.R. Neg. No. G/7914.

Photo Plate 6. Waterworn boulder of banded gabbro (Urannah Complex, C-Md), Abbot Point. Truncation, disruption, and wedging of bands (perhaps due to contemporaneous erosion during gravitational deposition) are visible in the lower part of the boulder. Small disharmonic folds (e.g., right centre and extreme left) were probably caused by slumping during deposition. The scale is six inches long. B.M.R. Neg. No. G/7912.

Photo Plate 7. Waterworn boulder of gabbro (Urannah Complex, C-Md), Abbot Point. Gabbro-pegmatite segregation occupying the core of a "rootless" fold in the banding. A finer-grained, vein-like extension of the pegmatite has intruded the fold along its axial plane. The largest feldspar and ferromagnesian crystals are two inches long. B.M.R. Neg. No. G/7913.

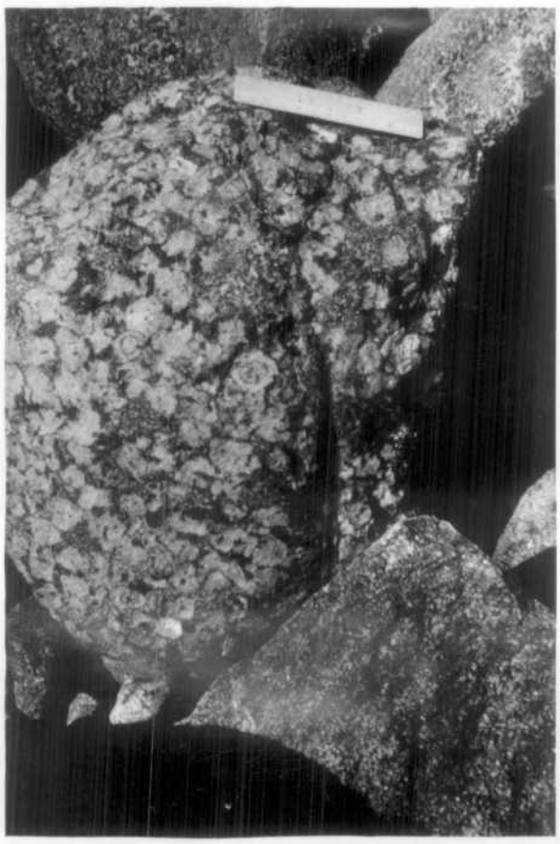


Photo Plate 8. Waterworn boulder of gabbro (Urannah Complex, C-Md) at Abbot Point. Squat, euhedral plagioclase crystals 2 to 3 cm. in diameter, containing small ferromagnesian nuclei, and in places concentric bands of ferromagnesian minerals. The groundmass consists of roughly equal amounts of plagioclase and ferromagnesian minerals. The scale is six inches long.
B.M.R. Neg. No. G/7911.

banding at Abbot Point in that it does not appear to represent such striking compositional, textural, and grain-size variations. Beach sands containing high concentrations of heavy minerals derived from basic rocks occur intermittently along the shore near Mount Luce and Abbot Point. The mineralogy of a sample of beach sand was compared with that of a specimen of gabbro from the small hill north-east of Mount Luce (see Appendix 2). This rock is a more normal augite-hornblende gabbro with labradorite.

Mount Roundback

The basic plutonic rocks which occur near the summit and on the shoulders of Mount Roundback are discontinuous roof-pendants in granite (C-Mg). They were only briefly examined; they are very similar to the outcrops so far described. Massive, melanocratic (?)dolerite, permeated by veins and stringers of gabbro-pegmatite, occurs in the western foothills.

South and west of the Seven Sisters

Numerous rounded boulders of gabbroic rocks emerge from the black soil in the low-lying country south and west of the Seven Sisters. Diorite and tonalite also occur; it is not possible to distinguish these two rock-types by photo-interpretation. Both diorite and tonalite contain melanocratic xenoliths. A melanocratic xenolith in massive hornblende-biotite tonalite in the bed of the Elliot River at Guthalungra is now a biotite-hornblende-andesine hornfels; it looks very like the gabbroic rocks which crop out nearby.

Moosie Hill

A specimen from Moosie Hill is a medium-grained hornblende-augite norite, apparently massive. Coarse, massive hornblende-hypersthene gabbro is intruded by or interlayered with thin bands of hypersthene-hornblende microgabbro in the small hill immediately north-east of Moosie Hill.

Camp Island

Coarse, medium - and fine-grained basic or intermediate plutonic rocks occur on the north-east side of Camp Island. The rocks are commonly dyke-like, one rock-type cutting another. Layering is present, but not as striking as at Abbot Point. A thin dyke of spinel-bearing "uralitised" diallagite intrudes gabbro or diorite. Ninety percent of this rock consists of fibrous to prismatic ?richterite and subordinate diallage. The richterite has been formed by replacement of diallage. The rock also contains numerous fractured crystals of green spinel and a few anhedral grains of bytownite.

Road cutting 8 miles north-west of Guthalungra (Red Hill): (C.M.G.)

Eight miles north-west of Guthalungra the Bruce Highway crosses low hills of olivine microgabbro and gabbro (Red Hill). These rocks are similar in composition to those which form low rises near Alligator Swamp.

Outcrops near Green Hill: (C.M.G.)

Two small hills near Green Hill, on the coast north of Gumlu, consist of coarse to fine-grained melanocratic gabbro with random patches of leucocratic gabbro. A local, weak foliation in these rocks strikes at 110°. Large xenoliths of sheared granite, exposed in a wave-cut platform, occur in these melanocratic rocks on the seaward side of the more northerly of the two hills.

Granitic Phase (C-Mg)

Distribution and Topography

Scattered outcrops of rocks mapped with the granitic phase of the Urannah Complex occur along the coast between Beach Hill and Bowen. These rocks give rise to varied topography, as with the dioritic phase. However, inselbergs are rather characteristic.

Beach Hill is a steep, rounded inselberg rising abruptly from sea-level to more than 400 feet; Sugar Loaf is a similar inselberg, rising to about 100 feet above sea-level. Other inselbergs are: Nobbie's Lookout, the hill north of Nobbie's Inlet, and the Maiden Mountain, each of which rise to about 400 feet above sea-level; the Seven Sisters (about 600 feet); Mount Curlewis (700 feet); and Mount Carew (100 feet).

The outcrops extending west from The Cape Homestead occur as low rises, gentle slopes, and steep hills and spurs which culminate in a steep, irregular, west-north-westerly-trending range, rising to 600 feet above sea-level four miles west-north-west of The Cape Homestead. This range is separated from the main Cape Upstart peninsula range (2400 feet) by an east-west valley with a low central saddle.

Green Hill, north of Gumlu, is little more than a low, soil-covered rise. Between Kalli Valley Homestead and the Bruce Highway are mainly low, undulating rises with scattered small outcrops and in places large, fairly level, bare expanses of granite up to 100 yards across. South of the Bruce Highway the granitic rocks form most of Mount Roundback, where, however, they are masked in places by scree derived from dioritic roof-pendants.

Granitic rocks mapped with this phase underlie most of the town of Bowen, and extend just onto the AYR Sheet area.

Lithology

Beach Hill: (C.M.G.)

Beach hill consists of granulated and in part brecciated granite, now recrystallized. Jointing is very strongly developed throughout most of the hill; the most prominent joint direction strikes 090° and dips north at between 50° and vertical. In a few areas the granite is weakly foliated (foliation striking 090°), but generally the granite appears to be granular and massive.

Microdiorite dykes in the granite are in some places foliated and in others quite massive. It appears as if microdiorite intrusion took place during and after the brecciation and shearing in the granite.

It seems likely that there was more than one period of faulting affecting this area. The prominent 090° joint direction is hard to reconcile with the north-east strike of the Inkerman Shear Zone (which, unless it has died out, should pass very close) and with the north-north-west to north-west strike of the Sugar Loaf Fault. The hill culminates in a central spine aligned on strike with the Sugar Loaf Fault.

Sugar Loaf: (C.M.G.)

Sugar Loaf consists of sheared granite. The shear-direction is south-east, parallel to the beach. The shear zone (here named the Sugar Loaf Fault) terminates in a cliff of mylonite on the ocean side of the hill. About 30 feet inland from the cliff the rock is less sheared, and grades to a gneiss which contains augen of feldspar and quartz. Another 60 feet inland the rock becomes recognisable as granite. All of these rocks are very highly jointed and weathered.

Green Hill: (C.M.G.)

A few low outcrops of deeply weathered and sheared granite occur near mud flats on the north-western side of Green Hill. Green Hill is terminated at its north-eastern edge by a wide quartz blow which has probably filled a continuation of the Sugar Loaf Fault.

Nobbie's Lookout: (C.M.G.)

Nobbie's Lookout, five miles north-west of Guthalungra, is composed of weathered, massive, fine-grained granodiorite.

Range west of The Cape Homestead:

The range trending west from The Cape Homestead consists of a variety of granitic rocks. Medium-grained, garnetiferous biotite tonalite (locally foliated) has intruded and hornfelsed sediments (Pzu) one mile west-south-west of this homestead. It consists of oligoclase-andesine (50%); anhedral, strained and granulated quartz (30%), in places re-crystallised; biotite in clots of fine grains (15%) (perhaps recrystallised); and interstitial to poikilitic microcline (5%). Rare red-brown garnets are visible in hand specimen, but were missed by the slide.

The rock immediately north of the homestead is a massive, coarse but inequigranular, biotite adamellite consisting of 35% recrystallised quartz, 30% oligoclase-andesine, 30% perthite, and 5% biotite in fine-grained aggregates. The rock contains some fine-grained dioritic xenoliths.

A thick east-west-striking, dyke-like body of biotite leuco-adamellite trends along the northern slopes of the range. It consists of oligoclase (40%), poikilitic quartz (35%), perthite (25%), and minor biotite.

An isolated hill on the coast north of Nobbie's Inlet consists of massive, brown, medium-grained biotite leucoadamellite. It contains strained quartz (35%), poikilitic microcline-perthite (35%), andesine (30%), and a few flakes of biotite.

The Maiden Mountain:

The Maiden Mountain, a hill immediately north of the Bruce Highway two miles east of Guthalungra, consists of fine-grained, biotite-hornblende alkali-granite aplite. The rock consists mainly of albite, potash feldspar, and quartz, and has an inequigranular xenomorphic texture. Small amounts of green hornblende (forming rather unusual, very poikilitic crystals) and chloritised biotite are also present. Accessories are iron oxide and sphene. A grainsize-banding is visible in places in the field, some bands being noticeably more aplitic. Rubble of strongly epidotised basic to intermediate dykes is abundant.

The Seven Sisters:

The Seven Sisters is a steep-sided, linear inselberg of slightly to moderately foliated leucocratic granite south of the Bruce Highway, three miles east-south-east of Guthalungra. The inselberg, which rises gradually to 500 feet above sea-level at its eastern end, has a very pronounced east-west trend. The foliation is only slight at the western end, but is better developed in the east, the mafic aggregates being drawn out into lenses. A specimen from the western end of the range has been described as an aplitic,

leucocratic hornblende-biotite granite consisting of quartz, oligoclase poikilitic microcline, and small amounts of biotite, hornblende, pyrrhotite, and epidote. A few phenocrysts of plagioclase and quartz are also present. Rubble of probable epidotised dolerite-microdiorite dykes is abundant among outcrops of granite at the western end of the ridge.

Mount Curlewis:

The south-eastern slopes of Mount Curlewis (on the coast seven miles east of Guthalungra) consist of weakly foliated inequigranular, leucocratic aplitic biotite granite. In the thin-section quartz forms xenoblastic grains 0.3mm. across in aggregates 1mm. across. Sodic plagioclase and microcline are roughly tabular, but much of the feldspar is recrystallised, or partly so, as aggregates of fine grains. Biotite is also recrystallised as strings of small flakes.

Mount Carew:

Medium-grained biotite leucogranite is well-exposed in a railway ballast quarry on the western side of Mount Carew, a small inselberg one and a half miles west by south of Wilmington railway siding. The leucogranite is intruded by pyritiferous basic to intermediate dykes. A quarry worker reported that he had found masses of pyrite several inches across in the leucogranite.

Mount Roundback and Environs:

A specimen from beside a railway level-crossing, two miles east of Wilmington siding is a massive, coarse, white, hornblende-biotite adamellite consisting of zoned oligoclase, perthite, quartz, fresh biotite, and chloritised green amphibole; the mafic clusters comprise sphene, apatite, zircon, opaques, and allanite.

Massive coarse white granite boulders occur beside the track near Kalli Valley Homestead. Some intrusive quartz-hornblende latite porphyry crops out near here, but its relationship to the granite is unknown.

A specimen from the north-eastern foothills of Mount Roundback is a hornblende-biotite adamellite.

Coast north of Mount Luce:

A narrow belt of granite or granodiorite intrudes gabbro on the ocean side of Mount Luce, on the shore. The size of this outcrop, which is about 50 feet wide and at least 100 yards long (the western limits were not examined), has been exaggerated on the map. The contact between granite and gabbro dips at about 50° to the south. The granite has been contaminated by

incorporation of gabbro, and contains abundant xenoliths and schlieren of gabbroic rock elongated parallel to the contact. Flow-foliated microgranite intrudes both rock-types along the contact. Both granite and gabbro have been intruded by two swarms of microdiorite/dolerite dykes, the earlier striking 290°, the later 015°. Both dykes and country rocks have been severely epidotised in zones up to six inches wide along the contacts. Abundant pegmatite veins intrude both granite and gabbro.

Town of Bowen:

Massive, white to grey, chloritised granite crops out at several places at Bowen, and is believed to underlie much of the town. A specimen collected from the eastern side of a low hill in the northern outskirts of Bowen (half a mile north of the Bowen Shire Council Rugby Football ground, just within the BOWEN Sheet area) is a massive leucoadamellite, containing phenocrysts of heavily zoned oligoclase surrounded by coarse microcline-antiperthite which is semi-graphically intergrown with quartz in places. At this locality the granite can be seen to intrude intermediate volcanics, which are probably Lower Permian. As with the outcrops at Mount Luce described above, the granite is intruded by two sets of intermediate to basic dykes, the earlier striking north-west, the later north.

Structure

Local structures in these rocks have been described above. No layering structures of regional extent have materialised from the isolated measurements made on the basic rocks during this reconnaissance survey. The contortions seen in banding at Abbot Point suggest that structures in the layering are of local significance only.

The Sugar Loaf Fault is postulated from evidence of shearing at Sugar Loaf, a quartz blow at Green Hill, and the prominent summit ridge of Beach Hill.

The pronounced west-north-west alignment of the Seven Sisters and the parallel foliation were probably caused by shearing; shear-zones with similar trends occur in the Urannah Complex on north BOWEN. There is good evidence that some of the shearing took place during the emplacement of the later granitic phases, and in some places may have localised some of the leucocratic bodies.

The present distribution in plan of the two phases is not controlled by topography; at the present level of erosion, the granitic phase occurs for the most part as separate, small bodies. In places (e.g., The Seven

Sisters, Green Hill, and Beach Hill) these may have been emplaced along faults and shears.

The contact between granite and gabbro at Mount Roundback apparently ranges in elevation from near sea-level to over 2000 feet; however, it is not known how much this is due to faulting.

Relationships and Age

On AYR relationships between the Urannah Complex and units of known age (apart from the superficial Cainozoic deposits) are not known, nor are any results of isotopic dating at present available. Recourse must therefore be had to isotopic ages and relationships in other Sheet areas.

Several such ages have been obtained from the Complex on BOWEN. The results indicate that the "diorites" range from 280 to 270 million years, straddling the Carboniferous-Permian boundary. Lower Permian (265 to 260 million years), Upper Permian (240 to 230 million years), and Cretaceous (125 to 110 million years) ages have been obtained from the "granites" (e.g., Webb and McDougall, 1964). We do not know how widespread or significant the Cretaceous dates will prove to be, but we believe at present that the Urannah Complex, at least when considered in a regional context, is a geological and structural entity. We believe it to be a mesozonal batholith, emplaced mainly during the late Carboniferous and Permian. It appears to occupy a well-defined north-westerly-trending structural belt.

On BOWEN the western contact of the Urannah Complex is regionally rather straight, and it is therefore almost certainly steep. Along its western contact on the southern half of BOWEN the Urannah Complex is partly faulted against, partly unconformable beneath, and partly intrusive into the Lower Permian Lizzie Creek Volcanics. On north BOWEN the contact is not so well defined. Diorites of the Complex are in contact with, and are presumed to intrude, deeply weathered and poorly outcropping "granite" (Pzg) of unknown age; for twenty miles north of Collinsville, faults (here striking north-north-west) have been significant factors in localising the contact.

On AYR the western limit of the Urannah Complex has not been satisfactorily established. It is not based on observable field relationships, because the area in which it is believed to lie is largely obscured by Cainozoic deposits. Furthermore, reconnaissance mapping of the area did not disclose any outcrops suitable for isotopic dating. The western limit has been set at the Sugar Loaf Fault partly as a result of north-westward

extrapolation of the position of the western boundary on BOWEN; partly because the granite of Beach Hill is not obviously affected by the Inkerman Shear Zone (although it lies very close to the extrapolated eastward extension of the Zone), and therefore may be younger than the Shear Zone (main movement believed to be late Silurian to early Devonian); and partly because the Sugar Loaf Fault and the concealed fault in the Burdekin Delta (postulated by Polak as a result of gravity work - see chapter on Structure and Figure 3 (Structural sketch map)), have a similar trend and lie roughly on strike with the western contact of the Complex on south BOWEN. To sum up, the mapped position of the western boundary on AYR is based on currently available circumstantial evidence.

Regarding the eastern boundary of the Urannah Complex, the Proserpine Graben (BOWEN and PROSERPINE; see B.M.R. Records in preparation by Paine et al./and Clarke et al. on the geology of the northern halves of BOWEN and PROSERPINE) seems a logical feature to use as a regional boundary. It is a major feature, aligned parallel to the Urannah Complex; ten miles south-east of Proserpine it contains at least 4500 feet of late Cretaceous or Cainozoic sediments. It is not known whether the Proserpine Graben extends as far north-west as the southern margin of AYR. The extrapolated extension of it would probably pass just east of Bowen.

Several bodies of granitic rocks (P-Mg - Cape Upstart, Sprole Castle, and Cape Edgecumbe) occur within, and intrude, the Urannah Complex; they have been mapped separately from the Complex because they appear to be epizonal stocks emplaced by a mechanism different from that by which the largely mesozonal Urannah Complex was emplaced.

Where internal relationships between the two main phases of the Complex are exposed, the more acid rocks are the younger; for instance, gabbroic rocks occur as roof pendants on the granite of Mount Roundback, and granite can be seen to have intruded gabbro on the beach to the north of Mount Luce.

PERMIAN TO MESOZOIC (A.G.L.P.)

UNNAMED VOLCANICS (P-Mv) (Nares Rock)

Nares Rock, an islet about 200 feet square which rises about 15 to 20 feet out of the sea three miles south of Holbourne Island, consists of strongly jointed, dark-grey, hornfelsed siliceous rocks which are probably tuffs or tuffaceous sediments. The rocks are mainly uniformly dark grey, but in places they are finely banded dark and light grey, the bands dipping vertically and striking north-west. These bands probably represent bedding; they are slumped in places. Generally the rocks are massive, and even where

banded they do not part along the bands.

In thin section the rocks are somewhat puzzling. They contain 10 to 20 percent angular to subangular grains of quartz and somewhat poikiloblastic albite which give an impression that the rocks are metamorphosed sediments. These grains are enclosed in a matrix consisting of curious poikiloblastic to granophyric intergrowths of quartz and alkali feldspar. If originally sediments, they have been strongly recrystallised.

Extensive areas of volcanics occur on both sides of the Proserpine Graben (BOWEN and PROSERPINE). The age (or ages) of these volcanics is imprecisely known. Present evidence suggests that those west of the graben are largely Lower Permian whereas those east of the graben may range into the Mesozoic, or even into the Tertiary. Geological features in the Bowen-Proserpine region show a preferred north-west orientation, and the Proserpine Graben, if projected to the north-west, would lie to the west of Nares Rock. For this reason only, Nares Rock is correlated with the volcanics east of the graben.

UNNAMED INTRUSIVE BODIES (P-Mg and P-Md)

Summary (A.G.L.P.)

Some granitic plutons on AYR/are mapped collectively as Permian to Mesozoic. These bodies occur typically as sub-circular stocks which have withstood erosion, and consequently now rise abruptly from the coastal plain as high, rugged ranges. The rocks are predominantly leucocratic and acidic (P-Mg); adamellites preponderate over true granites. Rare intermediate to basic rocks (P-Md) occur in places. Apart from superficial Cainozoic sediments, the only rocks so far known to be younger than these granites are rare acidic and microdioritic dykes whose ages are unknown.

Distribution and Topography

Granitic bodies which crop out along the north-western margin and in the eastern part of the Sheet area are believed to be the youngest in the Sheet area, and form by far the highest and most rugged country. Mount Elliot, Saddle Mountain, Gloucester Island, and the Cape Cleveland and Cape Upstart peninsulas are all rugged and deeply dissected granite ranges which in places are mantled by dense scrub. Mount Elliot rises abruptly to about 4000 feet above sea level; it dominates the scenery of the western part of the Sheet area. Saddle Mountain and the Cape Upstart peninsula rise to about 2500 feet; Gloucester Island and the Cape Cleveland peninsula reach just under 2000 feet above sea-level. Granite at Cape Edgecumbe, as well as

that forming the saddle between Mount Little and Sprole Castle, are also mapped with this unit. Cape Edgecumbe is the northern tip of a rocky headland of uneven height, consisting largely of bare outcrops and tors of granite.

Rare outcrops of diorite and dolerite (P-Md) occur around the margins of these acid stocks; other outcrops occur on Holbourne Island. Intrusion breccias and net-veining in places suggest that the more basic rocks may be genetically related to the acid stocks with which they occur. In most places the size of these outcrops has been exaggerated on the map.

Lithology

Cape Cleveland Peninsula

A specimen taken from the southern margin of this mass (P-Mg) is a coarse, massive, white and pink, porphyritic biotite adamellite with minor hornblende. The alkali feldspar is mostly perthitic, and the plagioclase shows diffuse zoning from andesine in the cores to albite along the rims. Accessories are sphene, magnetite, and apatite.

One and a half miles south-east of Cape Cleveland thick granophyre dykes, which are probably off-shoots of the granite, intrudes volcanics (C-Pv).

Saddle Mountain

Two specimens were collected from the south-western margin of this body (P-Mg) just within TOWNSVILLE. One is a massive, red, medium-grained leucogranite, containing no plagioclase. The groundmass is locally granophyric; some muscovite occurs in places. The rare mafics have been entirely epidotised and chloritised. The other specimen, taken from one and a half miles to the south-east, differs in that it contains enough plagioclase to make it an adamellite.

Some cobbles of fine-grained quartz-hornblende gabbro (Photo Plate 9), which were found in a creek near the southern margin of Saddle Mountain, indicate that this body may contain some basic components, as with the Cape Upstart granite.

Feltham Cone and its immediate neighbours, although not visited, have a photo pattern identical with that of Saddle Mountain; they are accordingly mapped in the same category.

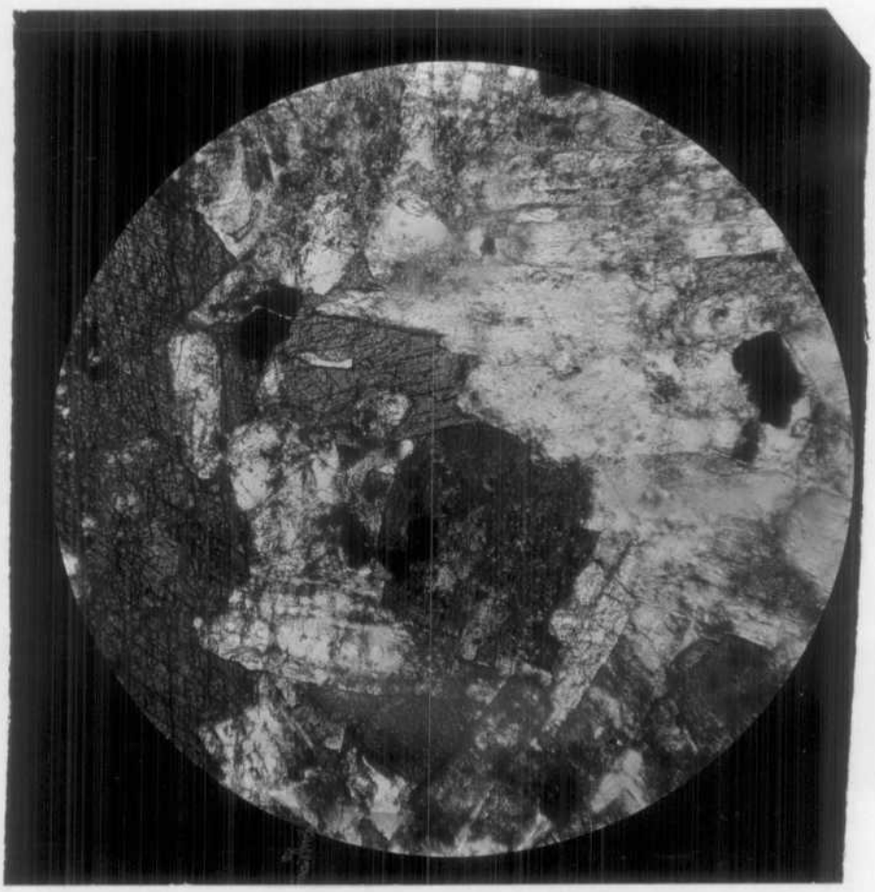


Photo Plate 9. Quartz-hornblende gabbro (mapped with P-Mg), Saddle Mountain. Brown hornblende is sub-poikilitic towards plagioclase. Magnetite and ilmenite occur both in hornblende and plagioclase. A crystal of apatite, oriented north-east, occurs in the south-east part of the photograph. Plane polarised light. X45.

B.M.R. T.S. No. 15669 B.M.R Neg. No. G/6752

Mount Elliot

A specimen from the Mount Elliot granite on TOWNSVILLE is a massive pink-brown, coarse, porphyritic biotite-hornblende granite (P-Mg). Plagioclase is zoned from andesine to albite. Mafics and accessories are green hornblende, brown biotite, magnetite, apatite, zircon, epidote, and allanite. Specimens taken from around the margins of this granite are remarkably uniform. Dr. P.J. Stephenson, of Townsville University College, has reported occurrences of diorite near the centre of the Mount Elliot stock (pers.comm.).

Cape Upstart peninsula

Except for some low hills at its southern end, most of the Cape Upstart peninsula consists of a sub-circular granite stock (P-Mg). A specimen from the south-eastern margin of this stock is a massive leucocratic pinkish-brown, porphyritic, medium-grained hornblende-biotite adamellite; this rock contains 40 percent oligoclase-andesine, 30 percent potash feldspar, 30 percent quartz, minor biotite, some hornblende, and iron oxide. A specimen from the northern coast is a massive coarse, leucocratic, chloritised biotite adamellite. This rock, however, contains recrystallised quartz, flexed biotite, and microfractured oligoclase; it may therefore be a remnant of the country rock of the main stock.

Small outcrops of diorite, microdiorite, and quartz diorite (P-Md) occur in places around the eastern and northern margins of the Cape Upstart stock.

Two miles north-north-east of The Cape Homestead is an excellent exposure of an intrusion breccia/net veined complex consisting of basic to intermediate intrusive rocks (P-Mi) in intimate association with granite (P-Mg). The more melanocratic rocks occur as a sliver, several hundred yards long and 30 to 50 feet wide, marginal to the granite. Much of the melanocratic rock is now xenolithic in the granite. The xenoliths in places show orbicular structures (P.J. Stephenson, verbal communication). Two specimens of the melanocratic rocks were sectioned: one is a leucocratic augite-biotite diorite; the other a porphyritic biotite microdiorite. In some hand specimens the mafic minerals appear acicular.

A similar marginal outcrop occurs in a bay on the north-eastern coast of the Cape Upstart peninsula. Quartz-diorite, biotite-quartz diorite, and biotite diorite have been described from this outcrop. The granite here veins the diorites. However, in places the diorite becomes finer-grained near the contact, and shows a crude foliation which may be flow-banding. Dioritic xenoliths with crenulate margins occur in places

in the granite. Thin, horizontal, granitic veins permeate the diorite; meandering, anastomosing apophyses, whose texture tends towards pegmatitic, commonly extend upwards from these veins. The features described above are known to occur in igneous complexes where basic and acid magma have been intruded essentially simultaneously, or where basic magma has intruded acid rock (Blake et al., 1965). In the first case the basic magma chills against the acid magma in which it is trapped, and may crystallise as xenoliths with crenulate margins; in the second case basic magma intrudes and remelts granitic rock, which may later "back-vein" the basic rock. Field observations of this particular outcrop were not sufficiently detailed to test this hypothesis. Nevertheless, there remains a strong possibility that here acid and basic magma were mobile side by side.

Sprole Castle - Mount Little Saddle

Granite (P-Mg) forming the saddle between Sprole Castle and Mount Little is a northward continuation of the mass which forms Mount Pring (just within the Bowen 1:250,000 Sheet area). A specimen from the Mount Pring mass is a coarse but inequingranular massive, white, biotite adamellite consisting of perthite, zoned oligoclase, quartz, and fresh biotite with associated zircon, apatite, and sphene; minor euhedral allanite is present.

Cape Edgecumbe

The granite (P-Mg) which forms Cape Edgecumbe promontory is a massive, pink, medium-grained, drusy biotite leucogranite, containing 40 percent perthite, 40 percent quartz, 15-20 percent fresh albite, and some biotite and zircon. Euhedral quartz crystals occur in rare druses.

Holbourne Island

The south-eastern tip of Holbourne Island consists of coarse, medium- and fine-grained intermediate and basic plutonic rocks (P-Md). Thick melanocratic and paler layers dip shallowly to the north-north-west. Leucocratic hornblende gabbro, augite diorite and diorite were described from this locality. A more leucocratic rock (locally pegmatitic) occurs in horizontal veins from which meandering, anastomosing apophyses extend upwards, as at Cape Upstart. The constituents of some of these veins were identified in the field as feldspar, hornblende, quartz, and epidote.

Specimens of granophyre and hornblende-quartz alkali-syenite (P-Mg) were collected from the north-east coast of Holbourne Island. These rocks are faulted against the dioritic rocks (P-Md). The granophyre was collected close to the fault; it is strongly sheared and is intruded by abundant basic to intermediate dykes. The hornblende-quartz alkali-syenite was collected 200 yards farther north-west. The north-western tip of the island appears to consist of leucogranite intruded by a swarm of dark dykes.

Island appears to consist of [illegible]

Middle Island

Middle Island also consists of leucocratic granitic rocks which are mapped with this unit (P-Mg). A specimen collected from the north-west coast of the island is a coarse, biotite alkali-rhyolite porphyry. The porphyry is intruded by numerous dykes of similar porphyry up to 20 feet thick, and by thinner dykes of dolerite or microdiorite.

Gloucester Island

Gloucester Island appears to consist mainly of granite (P-Mg); however, dioritic slivers (P-Md) occur at sea-level in places.

No thin-sections are as yet available from Gloucester Island; in the field the granite appears to be a fairly uniform, medium- to fine-grained, leucocratic, biotite granite.

At the extreme northern tip of the island an intrusion-breccia similar to that on the Cape Upstart peninsula is well exposed at sea-level. The earliest rocks in the breccia are hard, siliceous, mottled pale grey, pink, and green volcanic hornfelses which occur as xenoliths, up to about six feet across, within dioritic and granodioritic rocks. These rocks are commonly banded, and in places are amygdaloidal. Dioritic rocks occur as xenoliths and blocks (which themselves contain volcanic xenoliths) in a granodioritic rock which veins them in an irregular, permeating network. The leucocratic granite, which is believed to form most of the island, intrudes this assemblage with a clear-cut, rectilinear contact, in places modified by apophyses. Basic to intermediate dykes intrude all other rock types.

Structure

The Mount Elliot, Saddle Mountain, and Cape Upstart bodies are well-defined sub-circular stocks whose contacts can be readily photo-interpreted. The Cape Cleveland mass has an irregular, but roughly equidimensional outline; it almost certainly represents the major part of an independent stock. The granite outcrops between Sprole Castle and Mount Little represent the partly unroofed northern extension of an approximately circular stock which forms Mount Pring (BOWEN).

These granitic bodies are believed to be of the high-level, epizonal type.

Deep, V-shaped valleys, generally very straight, are characteristic of most of these granite bodies; these valleys are believed to be localised along small-displacement normal faults. The faults show no strong preferred regional trend, but a north-west direction perhaps slightly preponderates. They may be the result of quite local stresses which developed during cooling and settling.

Age and Relationships

For reasons of physiography and age-relations these granitic bodies are collectively regarded as the youngest in the Sheet area. The Cape Cleveland peninsula body intrudes volcanics which are probably equivalent to the Upper Carboniferous to Permian volcanics near Townsville. It is intruded by rare microdiorite dykes. The Saddle Mountain and Mount Elliot stocks both intrude volcanics which, although unfossiliferous, are continuous with the Upper Carboniferous to Permian volcanics near Townsville. The granite at Cape Edgecumbe is lithologically identical, and probably continuous at depth, with granite at North Head (just within BOWEN) which intrudes abundant microdiorite-dolerite dykes. Such dykes are very abundant in the earlier phase of the Urannah Complex, and are believed to be essentially Permian. Only rare acidic dykes are known in the Granite at Cape Edgecumbe. The Cape Upstart granite is included with this group because it seems to be of a similar epizonal type, and also is only rarely intruded by dykes.

The age of the rather uncommon dykes which intrude these granites is unknown, and therefore no minimum age can be established for the granites. On TOWNSVILLE the Cape Cleveland, Saddle Mountain, and Mount Elliot granites have been mapped tentatively as Permian on the basis that they intrude the Upper Carboniferous to Permian volcanics. Granites in the Whitsunday, Cumberland, and Northumberland Islands have been mapped as Tertiary (again albeit tentatively by White and Brown (1963). Five Cretaceous isotopic ages have been obtained so far from granites (four in the Urannah Complex, the fifth at Cape Hillsborough)on BOWEN and PROSERPINE (e.g., Webb and McDougall, 1964). In view of these examples there is a strong possibility that some of the youngest granites on AYR (especially in the east) may be post-Palaeozoic.

DYKES (PALAEOZOIC TO MESOZOIC)

Dykes of widely varying composition are abundant in all rock units except the younger granites. Basic to intermediate dykes (microdiorites and dolerites) are the most widespread. They are commonly between two and five feet thick, but some are up to twenty feet thick. The overwhelming majority are late Palaeozoic or younger. Epidotisation is so widespread that it is virtually typical of these dark dykes. Acid dykes (felsites, microgranites, granophyres, and porphyries) can in places be related to the Permian

to Mesozoic igneous centres (P-Mg), near some of which they are very abundant. They are usually thicker than the basic to intermediate dykes. In the central and north-western parts of the Sheet area the strike of most dykes lies within the north-north-west/west-north-west octant, except for some east-north-east trending dykes within the Inkerman Shear Zone. Dykes in the south-western and eastern parts of the Sheet area lack this preferred orientation.

South-eastern part of Sheet area

Both intermediate to basic and acid dykes are well exposed in and around the town of Bowen. Bowen is just south of the Sheet area, but is endowed with easily accessible outcrops in which the age-relations of the various late Palaeozoic to Mesozoic intrusive rocks can be seen. These outcrops are on North Head, in an old quarry west of Magazine Creek, and on the eastern slopes of a low hill just west of the turn-off to Flagstaff Hill. A composite picture built up from a study of these outcrops reveals the following chronological sequence of events: (1) Acid and intermediate volcanics (probably Lower Permian), (2) adamellite (C-Mg), (3) north-west-striking swarm of basic to intermediate dykes, (4) north-striking swarm of basic to intermediate dykes, (5) leucogranite (P-Mg), and (6) north-striking microgranite dykes.

Some of the basic to intermediate dykes at Bowen contain albite to the exclusion of other plagioclase, owing either to external metasomatism or to autometasomatism. The mafic minerals are almost invariably uralitised, epidotised, or chloritised. The rocks are mostly fine-grained and equigranular, but some contain plagioclase phenocrysts. In the non-albitised dykes the plagioclase ranges from labradorite to andesine. Some contain primary hornblende (with or without quartz), and no pyroxene. Besides normal dolerites and microdiorites there are some augite microdiorites and hornblende dolerites, some of which contain quartz. There is no significant difference in composition between the two swarms.

The basic to intermediate dykes near Bowen are intersected by thicker microgranite dykes, some of which are probably off-shoots from, and some of which intrude, the leucogranite (P-Mg) of Cape Edgecumbe.

An albitised dolerite dyke intrudes diorite at the eastern end of Holbourne Island. A swarm of albitised microdiorite dykes intrudes granite (C-Mg) at Mount Carew, west of Salisbury Plains Homestead.

A vaguely flow-banded microtonalite dyke intrudes granite (C-Mg) one mile east of Salisbury Plains Homestead. It contains phenocrysts of andesine. Besides hornblende and plagioclase the groundmass contains significant quantities of interstitial quartz and alkali feldspar. Another microtonalite dyke (very different in hand specimen from the dyke just described) intrudes granite (C-Mg) four miles west-north-west of "The Cape" Homestead. It is very strongly porphyritic (60%) in plagioclase which is zoned from An_{80} to An_{55}. The groundmass contains 15 percent quartz, with hornblende and biotite each 10 percent.

Granite (P-Mg) one and a half miles east of Cape Upstart is intruded by a multiple dyke of microdiorite and felsite. The margins of this dyke are of albitised hornblende microdiorite; the centre is a thin lenticular intrusion of porphyritic felsite. A rhyolite dyke (seriate porphyritic with phenocrysts of oligoclase-andesine, potash feldspar, embayed quartz, and epidotised hornblende in a groundmass of alkali feldspar laths, interstitial quartz, some plagioclase, epidote, and acicular apatite) intrudes granite (P-Mg) on the north-eastern coast of the Cape Upstart peninsula (Photo Plate 10).

Central part of Sheet area

Partly amphibolitised dolerite dykes (basic labradorite and augite) intrude granite (Pzg) south-west of Kelly's Mountain.

Dyke swarms intrude the Ravenswood Granodiorite, especially in the north-eastern part of its outcrop area. They occur in two major north-north-west-trending swarms and in an east-north-east-trending swarm which has been emplaced in the Inkerman Shear Zone. They include rhyolite, rhyodacite, microgranite, microadamellite, microgranodiorite, various acid porphyries, and microdiorite. The microgranodiorite dykes were evidently intruded soon after the emplacement of the granodiorite phase (Sg); they are intruded by other dykes (microgranite, microadamellite, and rhyodacite) which may possibly be related to, or represent, the later adamellite phase (Sa), or perhaps to the Undivided Palaeozoic Granitic Rocks (Pzg) which crop out farther south. Fine-grained, dark-green microdiorite dykes, believed to be no older than late Palaeozoic, are abundant in the central part of the Sheet area; at least three intrusive episodes have been recognised at "The Rocks" in the Burdekin River. Rhyolite dykes which intrude adamellite (Pzg) just west of Double Mountain appear to be off-shoots of a rhyolite plug (Edinburgh Castle) on BOWEN; this plug is of unknown age, but is probably related to the late acid phase of the Lower Permian Lizzie Creek Volcanics. Other rhyolite dykes intrude adamellite (Pzg) east of the rhyolite plug of Mount Louisa (Pzh); they are obviously associated with the plug.

Photo Plate 10. Five-foot porphyritic rhyolite dyke intruding adamellite (P-Mg) on the north-eastern coast of the Cape Upstart peninsula.
B.M.R. Neg. No. G/7916.

Western part of Sheet area

Dykes are abundant in the older rock units in the south-western part of the Sheet area, but are apparently absent from the late Palaeozoic igneous bodies. Felsite, quartz porphyry, and feldspar porphyry dykes intrude the low-grade metamorphics (Pzu) south-west of Mount Woodhouse. Leucocratic microgranite dykes intrude sheared volcanics (Cuv) at the north-eastern end of the Mount Dalrymple range. Four miles west of Mount Benjonney a complex swarm of blue-grey feldspar-hornblende porphyry, feldspar-hornblende-quartz porphyry, andesite, and aplitic quartz porphyry dykes intrudes the Ravenswood Granodiorite, and is truncated by an arcuate body of late Palaeozoic microgranite (Pzug). Some of the feldspar-hornblende porphyry dykes intrude dark-blue andesite dykes; both types are cut by flow-banded microdiorite dykes.

A swarm of flow-banded felsite, andesite, and microdiorite dykes intrudes the Ravenswood Granodiorite in the Burdekin River just east of Clare. The dykes are parallel, and their relative ages are unknown. This swarm is parallel to the north-north-west-trending swarm in the Stokes Range, six miles to the east.

Two miles south-east of the junction of Deep Creek and the Burdekin River west-trending microdiorite dykes intrude the Ravenswood Granodiorite. They are cut by thin tourmaline pegmatites whose affinities are not known. Dykes of red granite and biotite adamellite also intrude the Ravenswood Granodiorite here but their relationship to the microdiorite dykes and pegmatites is unknown.

North-striking pyroxene microdiorite dykes containing oligoclase-andesine intrude porphyritic microgranite (Pzug) in the north-eastern foothills of Major Creek Mountain; they are severely epidotised. Similar epidotised dykes (including some dolerites) are abundant in the Upper Carboniferous to Permian Volcanics (C-Pv). They appear to be largely absent from the young granites (P-Mg). However, strongly altered (?)microdiorite dykes intrude the granite (P-Mg) near Cape Ferguson.

CAINOZOIC

"EARTH LIME" (Czc)

There are two small occurrences known on AYR of superficial deposits of unconsolidated, white, earthy material rich in calcium carbonate; this material is known locally as "earth lime".

The occurrences are: (1) ten miles south-west of Inkerman Homestead, and (2) eight miles south of Inkerman Homestead.

The "earth lime" deposits are covered by several feet of soil. They have evidently been derived by leaching and preferential concentration of calcium carbonate within dioritic rocks mapped with the Ravenswood Granodiorite. In places colluvium overlying the diorite has also been calcified. Connah (1958) regarded the deposits as the products of Quaternary mound springs.

These "earth lime" deposits are described in more detail under the heading "Economic Geology".

RESIDUAL AND COLLUVIAL SOIL (Czs)

On AYR residual and colluvial soils form a discontinuous broad zone separating the hills from the coastal plains. These soil-covered areas are higher than the coastal plain; they undulate gently, and are interrupted by a few low, rounded hills. Scattered cobbles and angular blocks of weathered rock are found in a few areas, and patches of gravel are not uncommon at shallow depth (as seen in creek sections). These soils range from sandy to black, depending on the parent rocks. Depth of soil in these areas is largely unknown, but up to ten feet has been seen in places.

The soils are probably largely residual, but colluvial material has been contributed in places.

ALLUVIAL AND DELTAIC DEPOSITS (Cza)

Most of the land surface of the Sheet area is underlain by superficial Cainozoic alluvial and deltaic sediments. These are believed to be mainly Quaternary, but it is possible that Tertiary deposits exist in places.

Near the mouth of the Burdekin River these sediments are of major importance; the entire sugar crop grown on the Burdekin River Delta (present annual value about twelve million dollars) depends on underground water pumped from Quaternary aquifers. The Cainozoic deposits were not studied closely during the course of this survey, whose major object was bedrock mapping. However a group of geologists from Louisiana State University, U.S.A., made a detailed study of the coastal Quaternary deposits between Cape Cleveland and Cape Upstart in 1964 (Coleman, Smyth, and Gagliano, in prep.). Detailed geophysical surveys were commenced by the Bureau of Mineral Resources in 1962, and are continuing from time to time (see Previous and Current Investigations).

Photo Plate 11. Quaternary deltaic sediments of the Burdekin River Delta at Lynch's Beach (Alva), 10 miles north-east of Ayr. These sediments, which consist of fine sand with interbedded lenses of silty mud, are now being eroded, owing to a recent slight fall in sea-level. Thin trails of dark minerals (quite common in these coastal deposits) can be seen on the "talus slope" of sand below the ball-point pen.

B.M.R. Neg. No. G/7915.

Many water bores have been drilled in the delta. Those that reached bedrock are plotted on the map which accompanies Appendix 4. The maximum thickness of superficial sediment recorded in a bore which reached bedrock is 271 feet near Plantation Creek, five miles north-east of the centre of Ayr.

Some colluvial and outwash deposits which underlie gently sloping country close to the hills and ranges have been mapped in places with this unit. These deposits merge imperceptibly with alluvium which was laid down in the flat-lying country by overflow from the larger streams during floods. Both colluvium and alluvium merge and interfinger with the deltaic deposits. Periodic rises in sea-level during the Pleistocene no doubt caused some marine sediments to be deposited many miles inland from the present shore line.

The sediments of the Burdekin Delta consist of interbedded lenses of sand, silt, and gravel, and mud lenses near the coast. Contemporary erosion of Quaternary deposits, no doubt due to slight recent emergence, can be seen at Lynch's Beach (Alva), where a ten-foot cliff has been cut in interbedded deltaic sand and mud (Photo Plate 11). A C_{14} age of 3,870 $\pm$ 50 years b.p. was obtained from carbonised wood embedded in the sand near the top of this cliff (determination by Institute of Nuclear Sciences, D.S.I.R., New Zealand). This date sets a maximum age-limit on both the uppermost sediments and the emergence.

QUATERNARY

OUTWASH AND TALUS (Qu)

Wedge-like deposits of angular rubble and sand form an outwash apron around the foot of the Mount Dalrymple range. At the foot of the range the rubble is consolidated talus, but the finer-grained material farther away from the range is not appreciably consolidated. The apron is up to two and a half miles wide; it thins gradually outwards from the range, and merges with the alluvium. The maximum thickness of the rubble is estimated at about 50 feet. A crudely radial system of small streams dissects the outwash apron. The rubble is an accumulation of angular fragments of fine-grained acid volcanics, which range from 3 mm. to 2 feet in diameter.

Kelly's Mount[illegible] and the two hills three miles to the south-west are surrounded by a similar outwash apron.

Thick talus tongues, which coalesce to form outwash fans, occur around the slopes of Mount Roundback and Mount Little in the south-eastern

part of the Sheet area.

These talus and outwash deposits are now being dissected. They are evidently the products of a former period of active denudation, probably a pluvial period during the Pleistocene.

COASTAL SAND DUNES (Qr)

Sand dunes, some of them several miles inland, occur along much of the coastal strip. They are thought to consist of material deposited by wave action, and later distributed and built up by winds. Most of these dunes are fixed by vegetation, but present-day active beach dunes and off-shore sand bars are in places mapped with this unit. The maximum height of these dunes (for example, the dune extending south-east from "The Cape" Homestead) is about twenty five feet above sea-level. In general their crests are less than fifteen feet above sea-level.

The dunes indicate former beach-lines. Their distribution and trends are controlled by predominantly north-westerly long-shore currents. In places they have advanced out to sea by growth at their distal ends, and have bridged gaps between former islands (Cape Cleveland and Cape Upstart peninsulas) and the mainland, allowing extensive mud flats to develop in their lee. Cape Bowling Green is a complex of dunes which is growing to the north-west by addition of material derived from the Burdekin River.

Thin remnants of pale-brown, hard calcareous, cemented beach detritus ("beach rock") occur in places between tide-marks along the beaches, for example, at Dingo Beach. These deposits are too small to map. The rock consists of fragments of locally-derived rock and shelly debris embedded in a fine-grained calcareous matrix. In places the conglomerate is noticeably bedded, the beds having a mutually imbricate relationship and dipping seawards at a slightly steeper angle than the present beach surface, from which they appear to emerge. A C_{14} age of 1660 $\pm$ 300 years b.p. was obtained from a sample of this rock (Institute of Nuclear Sciences, D.S.I.R., New Zealand). This very young age suggests that such calcareous cementation of beach sands is continuing at present.

Some beach sands along the coast between Bowen and Cape Bowling Green contain high proportions of heavy minerals. Samples from three of these sands have been analysed; the results are tabulated in Appendices 2 and 3. The heavy mineral sand at Dingo Beach is spectacular, and attracts immediate attention. It occurs as a thin, deep blue-black, superficial blanket about 3000 feet long, 30 feet wide, and with a maximum thickness of about 18 inches in the centre. The analysed sample contains 87 percent iron

Figure 3

Ayr 1:250,000 Sheet Area

STRUCTURAL SKETCH MAP

Late Palaeozoic to Mesozoic Granite

Late Palaeozoic Volcanics

Palaeozoic Gabbro & Diorite

Palaeozoic Granite

Ravenswood Granodiorite, (Silurian).

Palaeozoic Metamorphics & Sediments

30 Dip and strike of strata

30 Metamorphic foliation, inclined

" " , vertical

Fault, observed

" , inferred

Major dyke direction

Boundary of major shear zone

2 0 2 4 6 8 10 12 14 16

miles

19°

147°

Cape Cleveland

Cape Bowling Green

Giru

Possible basement fault, (east block down)

Ayr

Burdekin River

Home Hill

Cape Upstart

Sugar Loaf Fault

Inkerman Shear Zone

Burdekin Fault ?

Woodhouse Fault

Abbot Point

20°

148° 30'

Bureau of Mineral Resources, Geology & Geophysics. May, 1965. To accompany Record 1965/

and titanium oxides (see section on "Economic Geology"). The heavy minerals have been derived from the gabbro at Abbot Point.

COASTAL MUD FLATS (Qm)

Much of the low-lying country fringing the coast consists of mud flats which are periodically inundated by high tides and floods. In places the mud flats are covered by a thin layer of salt. The flats are most extensively developed in the lee of the large, ancient, coastal dunes, for example at Abbot Point, Cape Upstart, and Cape Bowling Green.

STRUCTURE

The major structural units are outlined on Figure 3 (Structural Sketch Map).

The Inkerman Shear Zone is at least two miles wide in its widest part where it cuts through the Ravenswood Granodiorite. Rocks within this zone have been intensely metamorphosed by shearing and recrystallisation, and in places by metasomatic activity (producing also some traces of copper mineralisation). On TOWNSVILLE just west of Horse Camp Hill, at the western margin of the Sheet area, phyllonite, mylonite, and gneiss have developed from acid granite, and schist and gneiss from granodiorite within a similar shear-zone which lies on strike with a westerly projection of the Inkerman Shear Zone. Outcrops are not abundant in the intervening area, but those that do exist show no evidence of having been affected by major east-south-east shearing. The foliation within the shear-zone is vertical, but the sense of movement is unknown.

The Deadman Fault Zone on CHARTERS TOWERS also strikes east-north-east. The Ravenswood Granodiorite has been strongly foliated in the Deadman Fault Zone, whereas the slightly younger Lolworth Igneous Complex has not. This is taken to indicate that the major movement took place some time in the late Silurian or early Devonian. Perhaps shearing movements on the Inkerman Shear Zone took place then also. Some evidence for this is provided by the cobbles of sheared diorite in the probably Upper Devonian Charlie's Hill Beds. Nevertheless, the Permian isotopic ages obtained on gneisses from the Inkerman Shear Zone indicate considerable reactivation in the late Palaeozoic.

The Woodhouse Fault, in the south-western part of the area, can be proved for a distance of 16 miles on AYR. It extends north-west onto TOWNSVILLE where it becomes a fault system extending west-north-west up the valley of the Reid River. The total length of the fault is about 65 miles. On AYR, dip reversals, fault-breccia, and zones of silicification and shearing mark the fault in the metamorphics. The present distribution of

the Upper Carboniferous Volcanics (Cuv) suggests that the Woodhouse Fault may have somewhat localised their extrusion, in which case it existed in late Carboniferous times. The major component of movement is apparently vertical. On TOWNSVILLE the sense of movement is north-block down. Pyritic [illegible] silicified rhyolite occurs along the fault near Mount Dalrymple, but no other indications of mineralisation were observed.

A major north-west-striking fault, here named the Millaroo Fault, is believed to extend from BOWEN onto AYR. On BOWEN this fault has down-thrown Lower Permian Volcanics in the east against older granite in the west. Granite near the confluence of the Bogie and Burdekin Rivers, just south of the AYR-BOWEN boundary, is strongly brecciated on the projection of the Millaroo Fault; the fault is believed to have controlled the direction of the Burdekin River near here. The Millaroo Fault may extend much farther to the north-west beneath the alluvium: brecciated microgranite at the junction of Seven Mile Creek and Major Creek, near the western boundary of AYR, may possibly be a further indication of it. On BOWEN the latest sense of movement is east-block down. The Millaroo Fault has down-thrown the Lower Permian Volcanics on BOWEN, indicating it is younger than Lower Permian. Apart from this the age of the fault is not known with any certainty. However, if the volcanics at Drawl Creek are in fact Tertiary then the fault was active in the Tertiary or later.

Parallel to the coast between Beach Hill and Green Hill there is evidence of strong faulting (Sugar Loaf Fault), locally producing mylonite. The shearing is stronger at Sugar Loaf in the north-west than at Green Hill in the south-east. The Sugar Loaf Fault is normal to the Inkerman Shear Zone, and approximately parallel to the Millaroo Fault.

Numerous dyke swarms intrude the Ravenswood Granodiorite and Undivided Palaeozoic Granitic Rocks parallel to the Sugar Loaf and Millaroo Faults. East of Stockyard Creek the dykes strike north-south, possibly owing to rotation by the two north-east trending faults. The north-westerly dykes persist through the Inkerman Shear Zone, and therefore are younger than it; they may be genetically related to the Lower Permian volcanics (Lizzie Creek Volcanics (BOWEN) and Upper Carboniferous to Permian Volcanics (C-Pv). (P-Cv).

Numerous other faults have been mapped in the south-western part of the Sheet area. Most of these faults appear to be of local significance only. Bordering the Upper Carboniferous volcanics of Mount Dalrymple are several strong faults which may have developed as a result of subsidence of the massive pile of volcanics, together with vertical movement along the

Woodhouse Fault. The fault along the south-western side of Mount Dalrymple may be a branch fault of the Woodhouse Fault.

Detailed gravity surveys in the Burdekin River Delta have revealed a sharp north-north-west-trending gravity gradient a few miles east of Ayr. This gradient is interpreted as a possible normal fault (east-block down) in the pre-Cainozoic basement (E.J. Polak, pers. comm.).

Permian to Mesozoic granitic stocks are criss-crossed by straight, steep-sided valleys which are interpreted as faults associated with cooling and settling within the stocks.

GEOLOGICAL HISTORY

The oldest rocks known on AYR are isolated remnants of metamorphics (Pzu) which crop out in the south-western part of the Sheet area. These rocks were intruded by the Ravenswood Granodiorite; they were originally impure arenites and siltstones which are believed to have been deposited in the early Palaeozoic. Similar rocks occur in the southern part of the Upstart peninsula and near Guthalungra, but whether they are the same age or not is unknown. They are older than the Urannah Complex.

Two isotopic dates of 420 million years have been obtained from the earlier (granodioritic) phase of the Ravenswood Granodiorite on TOWNSVILLE. Only this phase is known with any certainty to crop out extensively on AYR; however, it is thought likely that some of the Undivided Palaeozoic Granitic Rocks may represent the later granitic phase of the Ravenswood Granodiorite. No isotopic dates are available from this phase.

The main movement on the Inkerman Shear Zone is thought to have taken place in the late Silurian to early Devonian. The small inlier of probable Upper Devonian calcareous sediments at Charlie's Hill contains debris of sheared granodiorite almost certainly derived from the Inkerman Shear Zone. The Charlie's Hill beds, which are the only known record of rock-forming processes during activity between Silurian and Carboniferous times, indicate a shallow-water, near shore, reef environment, with basement rocks cropping out nearby.

The late Palaeozoic was a time of widespread igneous activity. The acid volcanics in the south-west were probably extruded in the Upper Carboniferous. The rhyolitic plug of Mount Louisa was probably emplaced at the same time. Movement on the Woodhouse Fault may have localised to some extent the extrusion of the volcanics. Some of the late Palaeozoic granitic bodies (Pzug) were probably emplaced in the Upper Carboniferous.

Further intrusive and extrusive activity followed in the late Carboniferous and Lower Permian (Urannah Complex and Upper Carboniferous to Permian Volcanics). Most of the basic to intermediate dykes are also believed to have been emplaced during this very active period. The ages of the high-level granites mapped as Permian to Mesozoic are not precisely known.

The results of the current programme of isotopic dating will make a major contribution to our knowledge of the geological history of the area.

There is no record of any deposition during the Mesozoic, although there are remnants of possible Mesozoic sediments in the south-eastern part of TOWNSVILLE (Wyatt et al., 1965). During this era the environment was chiefly erosional.

Formation and subsidence of the coastal plain during the Cainozoic led to the deposition of superficial alluvial, deltaic, and littoral deposits. On AYR it is not known to what extent the formation of the coastal plain was due to faulting; however, the development of a Tertiary graben on PROSERPINE (White and Brown, 1963) indicates that faults may also have been active on AYR at the same time.

ECONOMIC GEOLOGY

Remarkably little mineralisation has been discovered so far on AYR. No metalliferous deposits are known. Minor occurrences of phosphate rock (Holbourne Island), vermiculite (Stokes Range area), and graphite (Cape Upstart peninsula) are recorded in the literature. By far the most important economic resource is the underground water of the Burdekin River Delta, and to a lesser extent the surface water of the Burdekin River.

Underground Water

Ground water is used extensively throughout the Burdekin Delta for irrigation, and in recent years has been the subject of intensive hydrological and geophysical investigations. Most of this work is summarised in an unpublished Progress Report on the Water Resources of the Burdekin Delta submitted to the Queensland Irrigation and Water Supply Commission in June, 1964. More recent geophysical work was carried out by the Bureau of Mineral Resources to help in defining the structure of the delta (Andrew and Wainwright, 1964; Andrew et al., in press; Wiebenga et al., 1964; Wiebenga et al., in prep.).

Metals

There is no recorded production of metals from AYR. Workings found

ADDENDUM

MINERALIZATION AT KELLY'S MOUNT

Since this Record was printed a report by C.C. Morton on minor silver, lead, bismuth, and gold mineralization at Kelly's Mount has been discovered on the files of the Geological Survey of Queensland.

Morton (G.S.Q. file 30/609M, 7th October, 1930), reported on an inspection of an area held by a group known as the Ayr Exploration Syndicate. He described the location as follows; "Prospecting area No.10 of 160 acres held by this syndicate is situated within a group of three hills rising prominently from the coastal plain of the Burdekin River delta, about seven miles in an air line and thirteen miles by road south-westerly from Ayr..... The major workings on the prospecting area are confined to two points about half a mile apart". The costeaned area mentioned on page 61 of this Record is believed to represent at least part of the more south-easterly of the two workings (No.1 workings), in which a shaft was sunk to six feet. No.2 workings comprised a shaft thirty-six feet deep on the steep eastern face of the centre hill.

Morton reports that "greisenisation of the granite on a grand scale, and to every degree of intensity, is in evidence /in the vicinity of the hills among which the workings are situated /..... The numerous veins and veinlets of barren quartz in evidence within the altered zone were apparently introduced during the process of greisenisation, as they do not occur in the surrounding unaltered granite".

Pyrite, or its oxidation products, was reported to be of widespread occurrence. Traces of gold and silver were reported at No.1 workings. Occasional vughs carrying lead carbonates with appreciable silver content were reported from No.2 workings. Traces of bismuthinite were seen to accompany pyrite near the No.2 workings. A sample from the lowest six feet of the shaft assayed 1 dwt.14 grs. of gold and 2 ozs. 12 dwt. of silver.

Morton concluded that the low values encountered did not justify further prospecting. However, he stressed the large extent of the greisen, and it is felt that the existence of economic mineralisation at depth can not be entirely discounted.

at the eastern end of the Mount Dalrymple Range in pyritiferous meta-rhyolite may be old gold prospects. So also may some shallow costeans and pits which have been dug in hornfelsed sediments just west of the Seven Sisters.

Minor occurrences of copper minerals (malachite, azurite, chalcopyrite) were found during the regional mapping in altered rocks of the Ravenswood Granodiorite in the Inkerman Shear Zone (four miles south-west of Mount Inkerman) and in volcanics (Cuv) exposed in the Burdekin River near Millaroo.

Three of the five samples submitted for spectrochemical analysis (see Appendix 1) show interesting metal values. A sample of greisen taken from a costeaned area on the north-eastern slope of Kelly's Mount contains 300 ppm. molybdenum. A sample of epidote rock from the Inkerman Shear Zone (Ar 9/7/37 (K)) contains 1000 ppm. nickel and 50 ppm. cobalt. A sample of magnetite rock, also from the Inkerman Shear Zone, contains 200 ppm. copper and 40 ppm. cobalt.

Some samples of beach sand collected during the regional mapping have been mineralogically examined (see Appendices 2 and 3). The most interesting mineral sand occurs at Dingo Beach, just west of Abbot Point, where a thin blanket of dark blue-black ilmenite-magnetite sand has been concentrated from gabbro which crops out nearby. The analysed sample of this sand contains 87 percent iron and titanium oxides. One of us (A.G.L.P.) has made a rough estimate of the quantity of ilmenite in this deposit: about 3000 tons of ilmenite are present in 10,000 tons of sand, based on a length of 3000 feet, an average width of 30 feet, a maximum thickness of about 18 inches in the centre, and a grade of 30 percent ilmenite; this estimate of the grade is very crude owing to the difficulty of assessing the proportion of ilmenite in the complex oxides (see Appendices 2 and 3). The old beach dune just inland from the present beach contains a considerable proportion of dark minerals; its grade is much lower than that of the narrow, high-grade blanket of sand on the recent beach, but its size is very much greater. There are certain to be problems in evaluating the potential of these deposits owing to the complex relationship of the oxides. In general, however, they are probably too small for economic treatment. In September 1965 the Bowen Mineral Company was preparing to recover and sell magnetite from the smaller beach just west of Dingo Beach.

Rock Phosphate

A small low grade deposit of phosphatised coralline beach conglomerate occurs at Holbourne Island. Total production from the island is listed below -

1918	450 tons	
1919	650 tons	
1920	850 tons	
1921	450 tons	
	2400 tons	Average grade about 18% P_2O_5

Saint-Smith (1919), Reid (1944), and Young (1944) reported on the deposit. The coralline material has been phosphatised by leaching from guano, and is not suitable for the production of superphosphate because of the widely varying grade and high iron and calcite content.

"Earth Lime"

Two small deposits of "earth lime" (described briefly in the stratigraphical part of this report) are being worked for local use.

(a) Eight miles south of Inkerman Homestead

It is claimed that sixteen acres of workable lime have been proved in this deposit. One drill hole (location unknown) is reported to have penetrated fifty feet of "earth lime" without reaching the bottom of the deposit. From the surface the section is: black soil (2 feet); grey soil (3-4 feet); white "earth lime". The deposit consists of zones of uniform "earth lime" (probably derived from diorite), and zones of partly calcified colluvium where the "earth lime" contains up to 50% of cobbles and pebbles of microdioritic and microgranitic rocks which have not

is associated with it, but some zones are probably quite low-grade; these zones are not being worked and are therefore not accessible for inspection. In its natural state the deposit is very poorly exposed owing to an extensive blanket of black soil.

Connah (1958) suggested that mound springs may have been responsible for the formation of these deposits. It seems likely that both deposits were formed by a similar mechanism and from similar parent material.

Graphite

Graphite near Cape Upstart has been recorded several times in the literature. The earliest known reference was made by R.L. Jack (1888), who recorded its location only. B. Dunstan (1921) wrote as follows: "At Cape Upstart, a seam of graphite 4 to 8 feet thick occurs in coal measure strata, the alteration of coal to graphite being caused by a massive igneous intrusion. No particulars are available, however, concerning the character or quality of the graphite".

The occurrence, which is situated 2.5 miles W.N.W. of "The Cape" Homestead low on the eastern slope of a granite spur, was visited during this survey. The lip of a collapsed shaft is surrounded by mined material which consists chiefly of a soft, friable, sooty, black chiastolite hornfels, mixed with a similar but less sooty and more dense type of rock identical with a specimen described from 0.5 miles to the north-east. Some micronodular, vermiform aggregates of calcite occur among the mullock. The hornfels crops out sporadically around the foot of the spur.

Material from this shaft is reported to have been shipped to Germany for treatment in the early part of this century (W. Hickmott, pers. comm.). The graphite content of the material which is now accessible does not seem to be high. The graphite content of a specimen collected from the lip of the old shaft was estimated petrographically at 30 to 40% (I. R. Pontifex, pers. comm.).

Vermiculite, asbestos, and garnet

Low-grade vermiculite and asbestiform tremolite occur in the Inkerman Shear Zone and in the Stokes Range (Carruthers, 1954). The vermiculite is closely associated with, and no doubt derived from, weathered biotite in altered granodiorite-gneiss. Some virtually monomineralic garnet rocks also occur in the Inkerman Shear Zone. No production of any of these minerals is recorded in the literature, although a local resident reported that they had been worked.

Road metal and railway ballast

Granite is being quarried for road metal in a hill just north of The Rocks, ten miles south-west of Ayr, and for railway ballast at Mount Carew.

Future Prospects

Areas which reveal most promise of mineralisation are (a) Inkerman Shear Zone, and (b) immediately east of Mount Dalrymple, and (c) the Mount Roundback/Sprole Castle district.

(a) The Inkerman Shear Zone is a fundamental structure which has been the focus of major metasomatic activity (monomineralic and skarn-type rocks; anomalous nickel, copper, and cobalt values). It warrants detailed attention: in the first place, detailed geological mapping combined with a detailed geochemical survey; subsequent geophysical work may be justified.

(b) The area east of Mount Dalrymple is intersected by at least two major faults, the Woodhouse Fault, and the Millaroo Fault. Pyritic rocks and old workings have been noted in the area.

(c) The granite of Mount Roundback is correlated with the later granitic phase of the Urannah Complex on BOWEN, which has caused widespread gold and minor copper mineralisation.

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APPENDIX 1

SPECTROCHEMICAL ANALYSIS OF ROCK SAMPLES FROM THE AYR SHEET AREA.

by

A.D. Haldane

Following are the results of semiquantitative spectrochemical analysis of five rock samples from the Ayr Sheet area, Queensland. All values are expressed in parts per million.

Field Sample Number	Ar 3/5/51(P)	Ar 9/7/37(K)	Ar 9/7/37(M)	Ar 10/7/37	Ar 6/7/37
Ni	a	1000	5-	10	10
Co	a	50	7	40	12
Cu	10	2-	2-	200	2
V	15	15	30	5-	60
Mo	300	a	a	10	a
Military Grid Ref.	551537	558521	558521	558521	564520
Remarks	Greisen	Epidote rock	Epidote-garnet rock	Magnetite rock with no visible copper	Unmineralised portion of sample of epidote-garnet-magnetite rock.

In addition P, W, Zn, Sn, Be, Ag, and Bi were sought, but not detected in any sample.

a = sought but not detected

5- = less than 5 parts per million

2- = less than 2 parts per million

Serial Nos. 1929 - 1933, Plate No. 872.

APPENDIX 2

B.M.R. Laboratory Report 1964, No.43

MINERALOGICAL EXAMINATION OF HEAVY MINERAL SANDS FROM BEACHES NEAR BOWEN.

by

I.R. Pontifex

The samples were submitted by A.G.L. Paine for quantitative analysis.

Field No. 14.8.61 Ar. (P)

Locality: Air photo: Ayr, run 8, No.5061, point 14. Dingo Beach, 15 miles north-west of Bowen.

Mineralogy: A polished section and a thin section of a random sample of this sand (and each of the other sands) were examined. The percentages of the minerals present were calculated from a grain count of each section.

The sand consists of the following minerals:

Opaque minerals:

Ilmenite with exsolution intergrowths of hematite, rutile, and magnetite	26%
Titaniferous magnetite	23%
Hematite containing exsolution intergrowths of ilmenite	10%
Ilmonite	11%
Ilmenite-magnetite (grains having the properties of both minerals)	9%
Magnetite partly oxidised to hematite ..	8%

Non-opaque minerals:

Zircon	6%
Amphibole	3%
Augite	2%
Epidote	2%
Rutile	1%
Quartz	1%
Plagioclase	1%

The average grain size is 0.15 mm. Generally the grains are angular and sub-angular; some of the opaque grains are well-rounded.

The proportions of iron and titanium oxides are variable from grain to grain, and it is difficult to determine the abundance of grains containing specific mixtures of these oxides. The percentages of opaque minerals given above are, therefore accurate to within about 10 percent. It is apparent that all these grains have a common source. The opaque minerals commonly form

composite grains with amphibole. Zircon occurs as stumpy euhedral crystals. The most common amphibole is hornblende. Two types of epidote are present; one is pale green-yellow, the other deep sea-green.

Field No. 1.3.37 Ar. (P)

Locality: Air photo: Ayr, run 3, No. 5037, Point 1. Lynch's Beach, 10 miles north of Ayr.

Mineralogy: This sand consists of the following minerals:

Opaque minerals:

Ilmenite with exsolution intergrowths of hematite, rutile, and titaniferous magnetite	..	18%
Titaniferous magnetite	..	12%
Ilmenite	..	10%

Non-opaque minerals:

Amphibole	..	..	10%
Quartz	..	..	19%
Epidote	..	..	6%
Plagioclase	..	..	6%
Augite	..	..	4%
Zircon	..	..	3%
Rutile	..	..	2%
Orthoclase	..	..	4%
Volcanic groundmass fragments			2%
Organic fragments			2%
Biotite	..	.. (approx.)	1%
Tourmaline	..	.. "	1%
Garnet	..	.. "	1%

The average grain size is 0.15 mm.. Generally the grains are angular and sub-angular. Many have well preserved cleavage faces and crystal form.

The comments regarding the iron-titanium oxide minerals given for sample No. 14.8.61, also apply to this specimen. In this sample, however, accessory amounts of chalcopyrite and pyrite are associated with some of the Fe - Ti oxide grains. These sulphides fill fractures in the oxides, and they form masses up to 0.05 mm..

Hornblende is the dominant amphibole. Two different types of epidote are present in about equal abundance. One has a light green - yellow colour, the other has a deep sea-green colour. The composition of several plagioclase grains (as determined by extinction angle methods), proved to be in the oligoclase-andesine range. Most of the orthoclase grains are fresh; some however, are partly altered to sericite.

The grains which appear to be derived from a volcanic groundmass are microcrystalline; the dominant component is quartz; subordinate minerals are feldspar and sericite.

Field No. 4A.9.45 Ar. (P) (just south of Ayr 1:250,000 Sheet area)

Locality: Air photo: Ayr, run 9, No.5045, point 4A. Beach north of Flagstaff Hill, 1 mile north-east of Bowen.

Mineralogy: This sand consists of the following minerals:

Opaque minerals:

Ilmenite with exsolution intergrowths of hematite, rutile, and titaniferous magnetite	7%
Titaniferous magnetite	7%
Ilmenite	6%

Non-opaque minerals:

Amphibole	25%
Quartz	14%
Plagioclase	10%
Epidote	7%
Orthoclase	5%
Augite	4%
Rutile	4%
Organic fragments	4%
Calcite	4%
Zircon	2%
Biotite	2%
Chlorite	2%
Hypersthene	1%
Spinel	1%
Apatite	1%

The grain size ranges between 0.05 mm. and 0.3 mm. The grains are angular and sub-angular.

The comments regarding the opaque minerals given for sample No. 14. 8.61 Ar also apply to this sample. The dominant amphibole is hornblende, and some fragments of this mineral have small iron oxide inclusions oriented along morphological planes. The plagioclase is generally unaltered. The composition of the plagioclase (as determined by the extinction angle method) is variable. Most of the grains checked have an andesine-oligoclase composition; about 25% of them have a labradorite-andesine composition.

Two types of epidote are present. The most abundant is a light green - yellowish type, which usually occurs in anhedral grains. The other is deep green, and commonly has a broken, prismatic form.

The identification of the hypersthene is not certain.

APPENDIX 3

B.M.R. Laboratory Report 1964, No.26

MINERALOGICAL EXAMINATION OF AN ILMENITE SAND AND A GABBRO FROM FROM NEAR ABBOT POINT

by

I.R. Pontifex

Samples submitted by: Dr. N.H. Fisher

1. Ilmenite sand

Field occurrence: This is a beach sand sample from Dingo Beach, one mile west of Abbot Point. Gabbro crops out east and west of Dingo Beach.

Mineralogy: In the field, the grains which were attracted to a hand magnet were removed. These were presumably mostly magnetite. The remaining sand was separated in the laboratory into 3 fractions on the isodynamic separator, and each of these was examined microscopically. A thin and polished section of a random sample of the original material were also examined.

From these studies the following components were identified, and their approximate volume percentages were estimated:

Ilmenite containing hematite inclusions	55%
Titaniferous hematite	15%
Ilmenite	10%
Titaniferous magnetite	5%
Zircon	8%
Hornblende	2%

Minor amounts of epidote, olivine, rutile, tourmaline, leucoxene, and pyrite are also present. The average grain-size is 0.15 mm.. The opaque grains are angular and sub-angular.

The main constituent of this sand, ilmenite, almost invariably contains needle and bleb-like inclusions of titanhematite oriented along certain morphological directions. This variety of hematite by definition contains a maximum of 10 percent TiO_2. The exsolution intergrowth relationship of titanhematite and ilmenite indicates that the Fe_2O_3 content in the ilmenite exceeds 6 percent. The grains in which titanhematite is the dominant mineral commonly carry abundant inclusions of ilmenite discs. This indicates that the TiO_2 content in the hematite exceeds 10 percent.

Some homogeneous opaque grains have optical properties intermediate between magnetite and ilmenite; others consist of titaniferous magnetite which

contains exsolution blades of ilmenite 0.01 mm. wide. All these grains are derived from a solid solution of Fe and Ti oxides. Ilmenite is the dominant component, as no suggestion of the spinel structure is evident in any grains.

Zircon and hornblende generally have a euhedral form. Commonly hornblende is associated with ilmenite. Epidote, olivine, and leucoxene occur as irregular, generally angular, fractured grains; some are sub-rounded. Rutile and tourmaline grains are relatively well rounded.

2. Gabbro (B.M.R. T.S. 14349)

Field occurrence: This is a sample of a gabbro from 2 miles west of Abbot Point.

Description of thin section: This rock consists almost entirely of an ophitic aggregate of plagioclase, hornblende, and augite. The average grain-size of the plagioclase laths and ferromagnesian grains is 1 mm. and 0.6 mm., respectively.

Euhedral crystals of plagioclase consist mainly of labradorite, and these form about 55 percent of the rock. Some plagioclase is slightly altered to sericite and epidote.

Hornblende forms about 20 percent of the section; it occurs as anhedral grains and as alteration rims around augite. The hornblende generally contains fine opaque inclusions, and it is commonly intergrown with small opaque masses. Some hornblende shows minor alteration to chlorite.

About 15 percent of the rock consists of anhedral grains of augite; these generally occur as remnant cores surounded by irregular coronas of hornblende.

Description of polished section: Opaque mineral grains have an average size of 0.2 mm., and these form the following approximate proportions of the rock:

Ilmenite containing hematite inclusions	3%
Titaniferous hematite and magnetite	2%
Pyrite	2%
Chalcopyrite	$< 0.5\%$

The ilmenite containing hematite inclusions forms anhedral grains which are associated with hornblende; it has the same mineralogical composition as the ilmenite-hematite grains in the ilmenite sand previously described. The hematite is the variety titan-hematite, and is localised as blebs and needles along morphological directions of the ilmenite host. In some grains

hematite is the dominant mineral, and these generally contain ilmenite blebs.

Grains which have a composition intermediate between magnetite and ilmenite are almost as common as the ilmenite-hematite grains. Pyrite occurs as discrete anhedral grains, and is also associated with the iron and titanium oxides.

Chalcopyrite grains up to 0.01 mm. are disseminated through the rock; these are not associated with the other opaque minerals.

Conclusions

The mineralogical composition of the opaque minerals in the beach sand and in the gabbro is similar; in both the dominant heavy mineral is ilmenite which contains exsolution intergrowths of titanium-rich hematite. Grains containing various proportions of iron and titanium oxides are also characteristic of both samples; such grains are commonly associated with hornblende.

The angular nature of the grains, and the presence of unaltered hornblende and olivine in the sand, suggest that it is relatively near its source.

These relationships indicate that the gabbro is the source rock for the detrital heavy-minerals, hornblende, and epidote on the adjacent beach.

A minor contribution of detrital minerals from a second provenance is indicated by the presence of zircon and tourmaline in the sand. These minerals were no doubt derived from the acid igneous intrusives of the area.

APPENDIX 4

WATER BORES DRILLED TO BEDROCK IN THE BURDEKIN RIVER DELTA

(see accompanying map, Fig. 4)

Information supplied by Queensland Irrigation and Water Supply Commission.

Irrigation Commission Bore Number	R.L. Natural Surface (State Datum) (N/R - not recorded)	Depth to Bedrock (feet)	Driller's Description of Bedrock
B3S1	18	252	Porphyry
L3B8	25	178	Decomposed rock
L3B7	27	189	Granite
CD4	26	185	Granite
CD7A	17	204	Granite
B3S2	N/R	271	Rock
E2.5	N/R	110	Decomposed granite
E3	42	100	Decomposed granite
D2.5	N/R	158	Basalt
DE3	N/R	170	Rock
E3A	37	114	Decomposed granite
L3B5	45	128	Diorite
L3B4	N/R	101	Decomposed granite
F4A	47	98	Decomposed granite
FG4.2	N/R	103	Decomposed granite
F4.5	N/R	104	Granite
FG4.7	N/R	60	Porphyry
FG4.9	N/R	81	Granite
EF5.2	N/R	144	Granite
EF5.4	N/R	143, 151	Granite, porphyry
E5A	41	188	Weathered rock. Quartz
D6A	29	202	Weathered granite
E6B	N/R	210	Diorite
B1S3	N/R	250	Granite
FG3A	53	64	Quartz
FG4	N/R	86	Quartz
FG4.8	N/R	103	Granite
H4	61	71	Decomposed granite
GH4.2	N/R	103	Granite
GH4.6	N/R	104	Weathered granite
GH4A	60	115	Weathered granite
G4.9	N/R	85	Granite
G50	46	79	Decomposed granite
H6	39	62	Granite
GH5A	41	139	Granite
FG5.2	N/R	94	Granite
F5	N/R	120	Granite
GH7A	18	87	Decomposed granite
G8	23	112	Rock
J0.8	65	79	Granite
J1.3	70	66	Granite
HJ3A	N/R	40	Diorite
J4	N/R	34	Weathered granite
HJ4A	55	71	Fractured rock
J5	N/R	66	Decomposed granite
HJ5	N/R	74	Decomposed granite and quartz
HJ5.2	N/R	73	Decomposed granite
HJ6	N/R	119	Decomposed granite
HJ6.1	N/R	79	Decomposed granite

Irrigation Commission Bore Number	R.L. Natural Surface (State Datum) (N/R - not recorded)	Depth to Bedrock (feet)	Driller's Description of Bedrock
J6	41	62	Decomposed granite
J7	29	56	Decomposed granite
K7	27	24	Decomposed granite
HJ7A	26	68	Decomposed granite
JK8	N/R	30	Decomposed granite and quartz
B4S5	N/R	134	Decomposed granite
F10	18	30-43 (bottom)	Black sand
HJ0.2A	60	137	Basalt
HJ1A	60	90	Granite
HJ1.7A	82	83	Granite
MP49.5/99.5	81	62	Granite
J0.3	64	86	Granite
J0.8	65	78	Granite
J1.3	70	66	Granite
MP49/98	77	46	Granite
JK0.2	69	79	Granite
JK0.8	71	63	Basalt, granite
JK1.2	79	69	Limestone, basalt, granite
MP48/97	81	76	Granite
L7B4	76	92	Hard rock
L7B10	76	105	Granite
L7B11	84	84	Granite
L7B1	90	105	Stone

Note: Bore F10 did not bottom in bedrock; it has been included here because of the interesting 13-foot intersection of black sand.

TABLE 1. STRATIGRAPHIC TABLE OF ROCK UNITS

ERA	PERIOD OR EPOCH	ROCK UNIT NAME OR SYMBOL	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
CAINOZOIC	QUATERNARY	Qm	Mud, silt, minor salt.	Littoral flats and pans.	Superficial; complementary to coastal dunes.	Deposited in calm water from high tides and floods.	Intermittent deposition continuing in lee of coastal dunes.
		Qr	Sand; some interbedded silt.	Low linear dunes up to 25 feet high.	Superficial.	Ancient and present shore dunes; perhaps some submerged offshore bars.	Includes some old blow-out dunes. Local heavy mineral concentrations.
		Qu	Scree, gravel, sand; semi-consolidated in places.	Scree-slopes.	Superficial. Merges with Cza and Czs.	Outwash fans, essentially stable at present; therefore thought to have been deposited in a wetter climate.	Being dissected by the present streams. Probably Pleistocene.
	UNDIVIDED	Cza	Sand, silt, mud, gravel; semi-consolidated in places.	Flat to gently undulating.	Superficial. Merges with Czs and Qu.	Levees, flood plains, and deltas.	Up to 270 feet thick in Burdekin Delta; elsewhere much thinner. Mostly Quaternary.
		Czs	Soil, sand, and rubble; semi-consolidated in places.	Gently undulating.	Superficial. Mainly closely related to bedrock.	Mainly residual soil developed on deeply weathered granitic rocks. Some colluvium.	Generally less than 10 feet thick.
		Czc	White, powdery material rich in calcium carbonate.	Flat.	Isolated deposits interfingering with Czs.	Superficial. Derived from weathered, coarse diorite.	Two, small isolated deposits. Up to 50 feet thickness claimed by lessees. Worked for local agricultural use.
MESOZOIC TO PALAEOZOIC	PERMIAN TO MESOZOIC	P-Mg	Leucocratic adamellite and granite; minor granophyre, syenite, and rhyolite-porphyry. Rare intermediate and basic rocks.	Rugged hills and mountains up to 3000 feet above sea-level. Some small hills, Holbourne Island.	Youngest plutonic bodies. Intrude C-Pv and Urannah Complex.	Epizonal stocks.	Only rarely intruded by dykes.
		P-Md	Gabbro, diorite, dolerite.	Forms eastern part of Holbourne Island (300 feet a.s.l.). Elsewhere small outcrops exposed on rocky coasts at sea-level.	Probably older than P-Mg, but in places may be essentially contemporaneous ("net-veining" and intrusion-breccias).	Mainly small marginal slivers around P-Mg stocks. Probably early differentiates of the P-Mg magma.	Size of outcrops (except those on Holbourne Island) exaggerated on map.
		P-Mv	Hornfelsed siliceous tuff or tuffaceous sediments.	Nares Rock; 20 feet high, and 200 feet in diameter.	Unknown.	Unknown.	Tentatively equated with volcanics of the Whitsunday Islands and coast north of Proserpine.
	CARBONIFEROUS TO MESOZOIC	URANNAH COMPLEX C-Mg	Leucocratic adamellite and granite; tonalite.	Mainly coastal inselbergs, up to 700 feet high. Some small hills and ranges. Mount Roundback (2400 feet).	Intrudes C-Md. Contacts with older units not known. Western contact inferred as Sugar Loaf Fault	Northernmost exposed part of major north-west trending batholith, probably emplaced high in the mesozone (associated volcanics, and also considerable hornfelsing). Both sub-units sheared and foliated in places. Primary layering in some of C-Md.	Isotopic dates available from areas farther south range between Upper Carboniferous and Upper Permian, with some Lower Cretaceous.
		URANNAH COMPLEX C-Md	Diorite, gabbro, norite, tonalite, dolerite, microdiorite, minor diallagite.	Mainly inselbergs, up to 900 feet high. Some low-lying country south of Guthalungra. Roof-pendants near summit of Mount Roundback.			

ERA	PERIOD OR EPOCH	ROCK UNIT NAME OR SYMBOL	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
LATE PALAEOZOIC		Pzug	Granite, microgranite, adamellite.	Uneven hills, in places quite rugged, e.g., Mount Benjonney.	Several isolated bodies whose ages are not well-established.	Mainly epizonal stocks.	Late Palaeozoic age based on general absence of dykes and/or absence of foliation.
		Pzh	Rhyolite, trachyte, and trachyandesite.	Steep high hills with cliffs in places. Mount Louisa.	Intrudes Pzg.	A plug with some extrusive phases. Vertical flow-banding.	Perhaps equivalent to Cuv.
PALAEOZOIC	CARBONIFEROUS TO PERMIAN	C-Pv	Intermediate lavas and pyroclastics; minor acid volcanics.	Uneven slopes and foothills adjoining Saddle Mountain and Mount Elliot. Also the narrow, steep Cape Cleveland promontory.	Intruded by P-Mg. Continuous with Glossopteris-bearing volcanics near Townsville. Correlated with Lizzie Creek Volcanics (Bowen 1:250,000 Sheet area).	Generally structureless, except at Cape Cleveland, where strata dip consistently south-east. Abundant, coarse pyroclastics indicate local derivation.	Maximum thickness 4000 feet at Cape Cleveland. Elsewhere thickness unknown. Strongly epidotised in places.
	UPPER CARBONIFEROUS	Cuv	Flow-banded rhyolite and massive welded tuff; minor andesite and andesitic tuff.	Rugged range (Mount Dalrymple) and small hill (Mount Woodhouse).	Intruded by Pzug. Correlated with Ellenvale Beds (Townsville 1:250,000 Sheet area) and Bulgonunna Volcanics (Bowen 1:250,000 Sheet area).	Fault-controlled. Mount Dalrymple is a downfaulted block.	Horse Camp Hill is southeasterly limit of Ellenvale Beds, which thereafter becomes Cuv. (See text)
		Ellenvale Beds Ce	Flow-banded rhyolite, rhyolite-breccia, andesite.	Prominent hill (Horse Camp Hill) about 300 feet high.	Not seen in Sheet area. Unit continues into Townsville Sheet area, where in type area it is Late Middle to Upper Carboniferous.	Fault-controlled.	
	UNDIVIDED	Pzt	Olivine micro gabbro and other basic rock-types.	Low-lying ridge, surrounded by alluvium.	Unknown.	Unknown.	Crudely banded in places. Resembles some outcrops of C-Md.
		Pzg	Leucocratic granite and adamellite, foliated in places; dykes of rhyodacite and acid porphyry; minor granodiorite and microgranite.	Uneven, undulating, and locally hilly country; some prominent dyke-ridges in places. Some inselbergs (Mount Inkerman).	Very poorly known. Heterogeneous group of granitic bodies and areas whose contacts are generally not exposed, and whose relationships and ages are for the most part unknown.	Heterogeneous.	Outcrop commonly poor and deeply weathered. Foliated in places. Some may represent the late acid phase (S-Da) of the Ravenswood Granodiorite.
	UPPER DEVONIAN?	Pzj	Strongly hornfelsed, calcareous cobble and pebble conglomerate, with some calcareous quartzite interbeds.	Charlie's Hill - 1200 feet x 300 feet x 70 feet.	Isolated inlier in Burdekin Delta. Strongly resembles, and equated with, Deadman Gully congomerate of Dotswood Formation (Upper Devonian) (Townsville Sheet area).	Cross-beds indicate overturning.	Phenoclasts of quartz, marble, and gneissic quartz diorite identical with much of the Ravenswood Granodiorite in the Inkerman Shear Zone.
	SILURIAN-LOWER DEVONIAN	Ravenswood Granodiorite S-Da	Biotite granite and leucocratic adamellite.	Steep hills and low rises.	Not known in Sheet area. In Townsville Sheet area intrudes S-Dr and is overlain unconformably by Middle Devonian sediments.	Late acid phase of batholith.	Photo-interpreted extensions from Townsville and Bowen Sheet areas.

ERA	PERIOD OR EPOCH	ROCK UNIT NAME OR SYMBOL	LITHOLOGY	TOPOGRAPHY	RELATIONSHIPS	STRUCTURAL/DEPOSITIONAL ENVIRONMENT	REMARKS
PALAEOZOIC	SILURIAN-LOWER DEVONIAN (Cont'd)	Ravenswood Granodiorite (Cont'd) S-Dr	Hornblende and biotite granodiorite and diorite; minor granite, adamellite, and gabbro.	Uneven, ranging from low and medium hills to plains. Some prominent dyke-ridges.	Intrudes Pzu at Barratta Creek. Unconformably overlain by Cuv.	Large batholith which caused widespread "regional-contact" metmorphism, mainly of the Cape River Beds (Charters Towers Sheet area), but also Pzu (Ayr Sheet area). Foliated in places owing to shearing; elsewhere the unit may have a weak primary foliation or be massive.	Crops out mainly in Townsville and Charters Towers Sheet areas. Initial results from Isotopic dating of [illegible] specimens from Townsville Sheet area give age of 420 million years.
	EARLY PALAEOZOIC	Pzu	Schist, phyllite, quartzite, hornfels; weakly metamorphosed subarkose, conglomerate, and carbonaceous siltstone.	Hills; small, steep ridges; low rises.	Intruded by Ravenswood Granodiorite and younger plutonic units.	Roof-pendants. Dynamothermally metamorphosed sediments and minor igenous rocks. Metamorphism and folding related to intrusions and faults rather than orogeny. Bedding and cleavage attitudes appear to lack a regional control.	Probably at least partly equivalent to the Cape River Beds of Charters Towers Sheet area (age unknown but similarly pre-Ravenswood Granodiorite).

FIG.4

INFORMATION SUPPLIED BY QUEENSLAND IRRIGATION AND WATER SUPPLY COMMISSION.

NORTH

NORTH COAST RAILWAY

BRUCE HIGHWAY

Brandon

BAY

Kalamia Ck.

Plantation Ck.

BRANCH OF BURDEKIN RIVER

BURDEKIN RIVER

Home Hill

Haigh Ck.

Yellow Gin Ck.

KELLY'S Mt.

B3S1 (252)
B3S2 (271)
B3S3 (253)
B4S5 (134)
CD4 (185)
CD7A (204)
D2·5 (158)
D6A (202)
DE3 (170)
E2·5 (110)
E3 (100)
E3A (114)
E5A (188)
E6B (210)
EF5·2 (144)
EF5·4 (142)
F10
F4A (98)
F4·5 (104)
F5 (120)
FG3A (64)
FG4 (86)
FG4·2 (103)
FG4·7 (80)
FG4·8 (103)
FG4·9 (81)
FG5·2 (94)
G4·9 (85)
G50 (79)
G8 (112)
GH4A (115)
GH4·6 (104)
GH4·2 (103)
GH5A (139)
GH7A (87)
H4 (71)
H5 (62)
H6 (119)
HJ3A (40)
HJ4A (71)
HJ5 (74)
HJ5·2 (73)
HJ6·1 (79)
HJ7A (69)
HJ0·2A (137)
HJ1A (90)
HJ1·7A (83)
J0·3 (86)
J0·8 (78)
J1·3 (66)
J4 (34)
J5 (66)
J6 (62)
J7 (56)
JK0 (30)
K7 (24)
JK0·2 (79)
JK0·8 (63)
JK1·2 (69)
MP49·5/99·5 (62)
MP48/97 (76)
L3B4 (101)
L3B5 (128)
L3B6 (178)
L3B7 (189)
L3B8 (178)
L7B1 (106)
L7B10 (105)
L7B11 (84)
L7B4 (92)

SCALE
CHAINS 80 40 0 1 2 3 4 MILES

LOCATION OF WATER BORES WHICH REACHED BEDROCK IN THE BURDEKIN RIVER DELTA.

SEE ACCOMPANYING TABLE —— APPENDIX 4

To accompany BMR Record No

Appendix 5

Petrography of rocks from the Ayr 1:250,000 Sheet area

Brief petrographic descriptions of 163 rocks collected from AYR during the regional mapping were made by R. Townend and A.R. Turner, of the Australian Mineral Development Laboratories, Parkside, South Australia, and W.R. Morgan, of the Bureau of Mineral Resources. These descriptions follow, grouped under rock-units. Most of the specimens collected from dykes are described in the last group; however, dyke rocks which are believed to be related to the Ravenswood Granodiorite and the Undivided Palaeozoic Granitic Rocks are listed under those groups.

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Early Palaeozoic Metamorphics (Pzu)

A.M.D.L.

B.M.R. Reg. No. 64155000 ($\frac{3}{4}$ mile S.S.E. of Clevedon Railway Siding)

This is an andalusite quartzite hornfels, containing xenoblastic andalusite grains, which constitute up to 10% of the rock, mostly with an alteration rim of sericite. Occasionally sericite is the only relic of the andalusite. The quartzite is even grained with individual quartz grains varying from 0.05 to 0.1 mm., while andalusites have a maximum dimension of 0.4 x 0.2 mm. Rutile/opaque aggregates are rather common, and do not appear to be detrital. Muscovite is present throughout.

B.M.R. Reg. No. 64155001 ($\frac{3}{4}$ mile S.S.E. of Clevedon Railway Siding)

This is a similar rock to No. 64155000 but it has a more uneven distribution of andalusite. It may be absent in some, or form up to 20%. Sericite patches are extensively developed in andalusite-poor areas. The rock is particularly rich in opaques varying from 0.4 to 0.03 mm. in diameter. The opaques are noticeably more localized when andalusite is prominent.

Andalusite normally occurs in argillaceous rocks. In these arenites, the interstitial cement must have been rich in clay or micas.

B.M.R. Reg. No. 64155114 (4.5 miles S.S.W. of Mount Woodhouse)

This rock is a low grade metamorphic quartz-muscovite-sericite-chlorite schist. It consists of numerous, angular to subangular, detrital quartz grains set in a recrystallized micaceous groundmass. The quartz grains have also been subjected to recrystallization which has been induced by synkinematic metamorphism. The grain size of the detrital fraction is in the range 0.28 to 0.05 mm.. Graded bedding, a primary sedimentary structure, is still apparent although recrystallization is advanced. The quartz grains are virtually inclusion free apart from small, rare apatite needles and crystals. During recrystallization the rock has been subjected to a stress system which has caused slight distortion of the recrystallized quartz grains, foliation of the metamorphic micaceous components and the development of shear planes. These shear planes are numerous and are parallel to the suggested graded bedding. They impart a poor fissility to the rock. The micaceous components include muscovite, sericite and poorly developed chlorite. The sericite and chlorite has been stained by iron rich solutions and this imparts the characteristic brownish colouration to the rock. They are incipiently foliated and line each of the individual sand grains. Randomly distributed throughout the matrix are aggregates of finely disseminated iron oxides. The rock has been subjected to post-metamorphic fracturing which

has caused the disruption of the rock at an angle of approximately 30 degrees to the shear direction. Along these fractures secondary enrichment and recrystallization of quartz has taken place. Micaceous components are absent along these fractures. The rock belongs to the quartz-albite-muscovite-chlorite subfacies (green schist facies) of regional metamorphism.

B.M.R. Reg. No. 64155115 (4.5 miles S.W. of Mount Woodhouse)

This rock is a quartz-chlorite-muscovite-sericite schist and belongs to the quartz-albite-muscovite-chlorite subfacies of regional metamorphism (green schist facies). It consists of numerous rounded to subrounded detrital quartz grains having a size distribution in the range 0.31 to 0.03 mm.. There is a bimodal distribution between the very coarse and very fine sizes. Remnant primary bedding structures are present in the form of graded bedding. The beds are repeated at approximately 3 mm. intervals. The rock has been subjected to recrystallization and the quartz grains have tended to become elongated in the direction of the bedding by the addition of authigenic quartz in a linear manner. There is no evidence for shear deformation. Between each of the individual grains masses of pale green chlorite, sericite and muscovite infill the available interstitial spaces. The muscovite laths show the development of a poor schistosity by their parallel orientation but foliation is only incipient. It is apparent that the rock has recrystallized under the influence of a stress system although no evidence can be found for shearing in the specimen. Numerous segregations of secondary opaque minerals are found randomly distributed throughout the micaceous groundmass. Minor recent jointing has taken place parallel to the bedding planes.

B.M.R. Reg. No. 64155116 (6.5 miles S.W. of Mount Woodhouse)

This specimen is a quartz-sericite-chlorite-muscovite schist belonging to the quartz-albite-muscovite-chlorite subfacies of regional metamorphism (green schist facies). It consists of numerous angular to subrounded detrital quartz grains set in a micaceous groundmass. The detrital fraction has a size distribution in the range 0.08 to 1.8 mm., i.e., coarse rather than fine-grained sand. The quartz grains are well rounded to angular, and poorly sorted, and appear to show no primary sedimentary structures. The grains are fractured and along these fractures a micaceous matrix has recrystallized. They also show strain phenomena. Minute, finely disseminated iron oxides occur as inclusions throughout the quartz grains. The groundmass consists of iron-stained sericite, chlorite and incipiently developed muscovite. The detrital grains tend to become isolated from one another by the micaceous groundmass. A poorly defined schistosity is apparent from the

orientation of the micas and the incipient elongation of the quartz grains in the same direction. Accessory rock fragments are found in the detrital matrix (mainly siltstones).

B.M.R. Reg. No. 64155117 (6.5 miles S.W. of Mount Woodhouse)

This rock is an orthoquartzite. It consists of a mosaic of numerous interpenetrating quartz grains with small amounts of sericite, muscovite, chlorite and clay minerals. The quartz grains have a size distribution in the range 0.8 to 0.1 mm. Intense recrystallization and low grade metamorphism has destroyed completely any sedimentary features which may formerly have been present. Pressure and solutions must have been active during the development of recrystallization. The quartz grains have become cemented together and interconnecting each of the grains is a micro-stylolitic seam. The stylolitic seam is marked by a thin layer of relatively insoluble clay minerals and finely disseminated iron oxides. Throughout the rock are distributed patches of clay minerals which have been subjected to metamorphic alteration also. Muscovite, sericite and chlorite have recrystallized from the clay matrix and occupy all available intergranular spaces. In areas where relatively large aggregates of these minerals are found alteration to the micas has preceded the recrystallization of the quartz. As a result each of the intergranular spaces is surrounded by a halo of micas which are found included in the recrystallized quartz. Several of these spaces have had the remaining minerals removed by subsequent weathering processes and the resulting cavities impart a finely vesiculate appearance to the rock. Finely disseminated iron oxides have been deposited in many of these cavities.

Although recrystallization is advanced there is a complete absence of strain phenomena in the quartz grains. This indicates an absence of a stress system during recrystallization. No foliation schistosity or shear structures are apparent in the rock. The quartz grains are comparatively free of inclusions and only have the products of recrystallization included within them. Incipient fracturing has occurred in post metamorphic times. Quartz constitutes 95 per cent of the rock.

B.M.R. Reg. No. 64155118 (5.5 miles S.S.W. of Mount Woodhouse)

This rock is a foliated micaceous siltstone. It consits of sub-spherical aggregates of minute quartz grains set in a strongly foliated micaceous groundmass. The silty aggregates have a size distribution in the range 0.3 to 0.95 mm., and consist of quartz grains of silt grade which have a size distribution in the range 0.01 to 0.03 mm.. The quartz grains are set in a matrix of chlorite and incipiently developed muscovite. The foliation developed within these aggregates is poor.

Surrounding each of these aggregates is an intensely foliated groundmass of muscovite, rarely sericite and quartz grains. The ratio of muscovite to quartz is much greater in the groundmass than in the sedimentary aggregates.

The mechanism of deposition is problematical but it is proposed that a siltstone deposit was eroded into grain aggregates and an argillaceous matrix which was later synkinematically metamorphosed. Metamorphism has been accompanied by shearing which has caused rotation of the detrital particles and foliation and recrystallization of the argillaceous matrix. Shearing has a tendency to elongate the detrital components in the direction of stress release. Finely disseminated iron oxides have been deposited throughout the rock and iron rich solutions have stained many of the micaceous components.

B.M.R. Reg. No. 64155119 (5 miles S.S.W. of Mount Woodhouse)

This rock is similar to 65155117. The specimen is a quartz-chlorite-sericite-muscovite schist. It consists of numerous rounded to subrounded detrital quartz grains set in a fine grained, iron-stained, sericitic and clay matrix. The quartz grains have been extensively fractured and along these fractures sericite stained by iron oxides has crystallized. No movement has occurred along the fractures. The quartz has minor powdered opaque minerals scattered throughout as inclusions. The quartz grains also exhibit strain phenomena which suggest recrystallization under the effects of a stress system. The groundmass consists of sericite with minor chlorite, muscovite, fine quartz grains and excessive iron staining. Incipient schistosity is developed by the parallel orientation of the muscovite laths and by the tendency towards elongation of the quartz grains in this direction. Foliation is not developed. Although it is difficult to visualise in the thin section graded bedding is well developed. The hand specimen shows alternating laminations approximately 10 mm. apart. The micas show a tendency to be concentrated along these planes. Throughout the rock rare rounded fragments of a quartz siltstone can be seen. Heavy precipitation of finely disseminated iron oxides has occurred about each of the grains of the detrital fraction. The iron staining, although not as intensive, has occurred throughout the argillaceous matrix. The grains have a size distribution in the range 0.55 to 0.15 mm.. In the matrix grains of approximately 0.025 mm. are found.

B.M.R. Reg. No. 64155145 (0.5 mile west of Landers Creek Homestead)

This rock is a quartz-chlorite-muscovite-sericite schist. It consists of numerous, fine-grained, recrystallized, angular to subangular detrital quartz grains set in a fine-grained argillaceous matrix. The detrital fraction has a size distribution in the range 0.19 to 0.03 mm., and generally appears to be poorly sorted. Primary sedimentary structures are difficult to discern but there is a suggestion of a parallel orientation of the elongated axis of the grains. The quartz has only minor inclusions of powdered opaques and minute apatite crystals. The grains do not show effects of strain and there is no evidence for shearing. However the rock has been fractured approximately perpendicular to the suggested bedding planes. Enrichment and crystallization of secondary quartz has occurred along many of these fractures. The groundmass consists of incipiently developed muscovite and relatively abundant sericite and chlorite. Muscovite is developing from the chlorite. Rarely finely disseminated iron oxides stain the micaceous material. The matrix coats each of the individual grains and occupies all available interstitial spaces. Minor accessory tourmaline grains are found throughout the detrital fraction. Recrystallization has been severe and virtually eliminated the original fabric of the detrital grains. The incipiently developed muscovite has a subparallel orientation but foliation is not marked. The development of schistosity is apparent by the subparallel orientation of mica laths.

B.M.R. Reg. No. 64155146 (0.5 mile west of Landers Creek Homestead)

This rock is a black slaty argillite. It consists of irregular alternating layers of quartz grains and micaceous layers which contain silt size quartz grains and finely disseminated iron oxides together with accessory carbonaceous material. The carbonaceous material stains some of the micaceous laths. The layers of quartz grains are narrow (1.0 to 1.6 mm. in depth) and contain particles which have a size distribution in the range 0.12 to 0.3 mm.. The detrital quartz in these layers is completely recrystallized but does not exhibit any strain phenomena. Together with the quartz are long laths of muscovite, sericite and chlorite.

The foliated micaceous layers have numerous laths of muscovite, sericite and chlorite together with the numerous silt size quartz grains. The laths are strongly foliated and impart the schistosity or slaty cleavage to the rock. The schistosity is due to shearing which has been parallel to the bedding planes. Accessory tourmaline grains can be found scattered throughout the coarse quartz layers.

B.M.R. Reg. No. 64155147 (0.5 mile west of Landers Creek Homestead)

This rock is a quartz-chlorite-sericite-muscovite schist belonging to the quartz-albite-muscovite-chlorite subfacies of regional metamorphism (greenschist facies). It consists of numerous, subrounded to rounded, detrital quartz grains set in a micaceous groundmass. The quartz grains have been partially recrystallized and in many areas, cemented together with authigenic quartz. The detrital fraction has a size distribution in the range 0.4 to 0.04 mm. Metamorphism and consequent recrystallization has completely destroyed any primary sedimentary structures that may have been present. The quartz grains show the effects of a stress system that must have been in operation during their recrystallization. There are tendencies for the grains to become elongated in a direction parallel to the minimum stress axis. Incipient foliation of the micaceous groundmass has also developed under this stress system but there is considerable doubt as to whether or not shearing actually took place. The quartz is inclusion free apart from rare apatite needles. The micaceous groundmass consists of masses of partially foliated sericite and chlorite and poorly developed muscovite. The micas have been stained a greenish-brown colouration by iron-rich solutions and these impart the brownish colouration to the rock. Rare rock fragments are scattered throughout the detrital fraction together with aggregates of finely disseminated iron oxides.

B.M.R.

B.M.R. Reg. No. 64150132 Biotite-quartz sericite hornfels
(2 miles E.S.E. of Guthalungra)

Very similar to No. 64150130 (page 8). However, the rock contains thin bands of sericite-rich and sericite-quartz layers. The quartz grains are coarser than in No. 64150130.

B.M.R. Reg. No. 64150153 Biotite-alkali feldspar-quartz hornfels
(1 mile W.S.W. of The Cape Homestead)

The granoblastic groundmass has an average grainsize of 0.05 mm., and contains quartz, alkali feldspar, and lineated biotite flakes. Some coarse xenoblastic grains and groups of grains may possibly represent relict phenocrysts; these consist of quartz and sodic plagioclase, together with a few of biotite. The rock may be a metamorphosed rhyolite or microgranite.

B.M.R. Reg. No. 64150153a Epidote-hornblende-andesine-quartz hornfels
(1 mile W.S.W. of The Cape Homestead)

The grainsize ranges between 0.03 mm. and 0.5 mm.. Xenoblastic quartz forms a mosaic with sub-tabular to xenoblastic andesine. Small amounts of subpoikilitic green to olive-green hornblende are present. Some andesine and hornblende have been partly replaced by epidote. The rock is possibly a metamorphosed calcareous and aluminous sandstone.

B.M.R. Reg. No. 64150116 Garnet-biotite-albite-potash feldspar-quartz hornfels. (1 mile W.S.W. of The Cape Homestead)
(hornfelsed rhyodacite - W.B.D.)

A few partly recrystallised megacrysts of albite range up to 2 mm. across. Small amounts of colourless garnet (probably almandine), partly replaced by biotite and chlorite, are about 1 mm. in diameter; knots composed of flakes of biotite may represent altered garnet. The matrix is very fine-grained, and consists of a fairly equigranular mosaic of quartz, albite, and potash feldspar; a few flakes of biotite are present. The albite megacrysts look as though they may be relict phenocrysts, suggesting that this rock may have been an acid porphyry.

B.M.R. Reg. No. 64150145 Biotite-sericite-quartz hornfels
(1 mile W.S.W. of The Cape Homestead)

The rock is rather inequigranular, the grainsizes ranging between 0.05 and 0.3 mm. The rock contains granoblastic quartz, anhedral aggregates composed of fine sericite flakes, and a few biotite flakes. The rock gives the impression of having been sheared at one time in its history, as sericite is strung out along apparent shear planes. However, quartz shows no strain shadows; hence recrystallization has probably taken place subsequent to the shearing. A few coarse clusters of biotite flakes are present; some coarse, roughly tabular areas composed of sericite may represent original plagioclase.

B.M.R. Reg. No. 64150126 Garnet-biotite-microcline-plagioclase-quartz hornfels.
(1 mile W.S.W. of The Cape Homestead)

The rock is inequigranular and porphyroblastic, and shows signs of having been sheared. The grainsizes range from 0.05 to 0.3 mm. over most of the slide. The rock contains quartz, oligoclase-andesine, microcline, biotite, and muscovite. A coarser-grained layer, in which the grainsizes range up to 0.5 mm., contains garnet porphyroblasts as well. Some foliation is evident as certain layers are richer in feldspar than others.

B.M.R. Reg. No. 64150130 Biotite-quartz-sericite hornfels
(1.5 miles W.S.W. of The Cape Homestead)

The rock is fairly inequigranular, the average grainsize being 0.08 mm.. It is composed of somewhat amoeboid quartz grains (30%), grains composed of fine sericite flakes (pseudomorphing (?) andalusite) forming about 60% of the rock, and randomly oriented tabular to anhedral flakes of chloritised biotite (10%); fine iron oxide dust is also present. One or two sub-tabular grains, ranging up to about 1mm. across, are possibly sericitised feldspar; however, a similar specimen described elsewhere (No. 64150113) contains andalusite porphyroblasts partly altered to sericite; hence the altered grains described here are possibly pseudomorphed andalusite.

B.M.R. Reg. No. 64150106 Biotite-sericite-quartz hornfels
(1.5 miles W.S.W. of The Cape Homestead)

The rock is very similar to No. 64150130 except that rather more quartz is present.

B.M.R. Reg. No. 64150113 Biotite-andalusite-quartz-sericite hornfels
(1.5 miles west of The Cape Homestead)

The specimen is very similar to No. 64150130; however, it contains roughly tabular, slightly poikiloblastic andalusite porphyroblasts that are somewhat sericitised.

B.M.R. Reg. No. 64150151 Hornfelsed tuff (1.5 miles west of The Cape Homestead)
(hornfelsed sandy argillite - W.B.D.)

The specimen consists of two parts. One is a fine-grained rock similar to No. 64150130, but with rather more biotite, and containing thin bands of quartz-rich material.

The coarse rock is very inequigranular; the grains range between 0.03 and 4 mm. long, and form about 50-60% of the rock. They are composed of quartz and plagioclase. The quartz occurs as anhedral grains, some showing embayments; many appear to have been recrystallised. Oligoclase is commonly tabular, although some is anhedral; it does not show much evidence of recrystallization, i.e., it still retains its igneous twinning; some micro-fractured crystals, however, are partly healed by recrystallization. The matrix consists of fine biotite and muscovite flakes, and granoblastic quartz and feldspar. Partly formed crystals of andalusite are also present; these look at first sight like fibrolite (sillimanite); however, the crystals are length-fast (as for andalusite), whereas sillimanite is length-slow.

B.M.R. Reg. No. 64150157 Andalusite-biotite-sericite-quartz hornfels
(1.5 miles west of The Cape Homestead)

Very similar to Nos. 64150130 and 64150113.

B.M.R. Reg. No. 64150117 Ferruginous andalusite schist
(2 miles W.N.W. of The Cape Homestead)

The rock is porphyroblastic. The porphyroblasts consist of two minerals: one is andalusite, forming tabular crystals measuring up to 0.8 by 0.2 mm.; they are oriented with their long axes in the plane of the schistosity. The other porphyroblastic mineral forms xenoblastic crystals containing many inclusions of iron oxide. The same mineral also appears to partly replace andalusite; parts of the xenoblastic porphyroblasts are in optical continuity with neighbouring parts of altered andalusite. The xenoblastic mineral is uniaxial or low biaxial negative; it has a birefringence rather lower than that of quartz, and a refractive index slightly higher than quartz. Apart from the optic axial angle these properties fit those of cordierite; however, cordierite with very low or zero optic axial angle has been recorded in the literature, and this mineral can, therefore, safely be referred to this species. The fine-grained matrix is composed of ferruginous biotite, iron-oxide dust, and quartz.

B.M.R. Reg. No. 64152000 Blastomylonite(?)
(1.5 miles west of The Cape Homestead)

The matrix has an average grainsize of about 0.01 to 0.03 mm., and is composed of amoeboid grains of plagioclase (probably labradorite), prismatic to granular pale brownish green amphibole, and granules of iron ore. Poikiloblastic porphyroblasts of almost colourless clinopyroxene have a diameter of about 0.3 mm.. A few megacrysts are composed of clinopyroxene and orthopyroxene; these are possibly relics from the original rock, probably a gabbro which was mylonitized and later thermally metamorphosed.

Ravenswood Granodiorite

Granodiorite and Diorite Phase (Sg)

A.M.D.L.

B.M.R. Reg. No. 64155051 A hornblende microgranodiorite (In a quarry at northern end of Stokes Range.)

This rock contains essential quartz, plagioclase, hornblende, with lesser quantities of potash feldspar and biotite. Plagioclase (andesine) forms numerous euhedral phenocrysts heavily zoned but not always twinned, with a maximum size of 1.0 by 0.6 mm.. Quartz is invariably allotriomorphic or poikilitic to the plagioclase. Subhedral green hornblende, with orthopinacoid

twinning prevalent forms about 10 per cent of the rock while brown biotite is of subsidiary importance.

The groundmass consists of plagioclase microlaths intergrown with quartz and potash feldspar, with myrmekitic texture locally developed. Accessories consist of opaques, anhedral sphene and rare allanite. Some fine-grained mafic clusters, composed of pale amphibole and opaques may represent relict basic xenoliths. Alteration is present in biotite (to chlorite) and plagioclase (to sericite and zoisite).

B.M.R. Reg. No. 64155056 A granite gneiss (On the road, one mile south of "The Rocks")

This is a leucocratic, well foliated rock, consisting essentially of quartz, potash feldspar and lesser plagioclase (oligoclase). The lineation is primarily due to quartz growth, but the few mafics, opaques, spindle-like sphene, rare hornblende and biotite occur in narrow bands parallel to the quartz lineation. The potash feldspar, rarely lineated, is interstitial to the quartz and forms between 20 and 30 per cent of the rock. The plagioclase, always fresh, is partially replaced by the potash feldspar. Squat crystals of zircon form less than one per cent of the rock, while epidote is notable as a secondary product.

B.M.R. Reg. No. 64155054 A hornblende diorite
(On the road, one mile south of "The Rocks")

This is a coarse grained equivalent of B.M.R. Reg. No. 64155052, (p. 52), consisting essentially of fairly fresh hornblende and cloudy plagioclase (andesine) giving a xenomorphic granular texture. The amphibole, typically measuring 2.5 by 1.5 mm., has a yellow to deep green pleochroism. Where it is incipiently altered, exsolved opaque stringers are prominent. Apatite either stubby or columnar, is a common accessory, measuring 0.3 by 0.08 mm..

The rock is crossed by an epidote vein, and plagioclase adjacent to this vein is extensively altered to zoisite and sericite.

Recrystallization of the amphibole gave inclusion free subhedral microgranular crystals. The plagioclase twinning, mostly albite, is frequently discontinuous, probably resulting from stress.

B.M.R. Reg. No. 64155058 A porphyritic dacite
(In Stokes Range, about one mile west of Leichhardt Downs Homestead.)

This rock contains numerous phenocrysts of strongly zoned plagioclase (calcic oligoclase), resorbed quartz, and anhedral biotite flakes set in a fine-grained granular groundmass, consisting of quartz, plagioclase and potash feldspar with a grain size averaging less than 0.03 mm..

The plagioclase phenocrysts have normal zoning with a typical compositional range of An28 core to An24 rim. Most macrocrystals are semi-euhedral and vary between 0.5 and 1.5 mm. in length. The quartzes are usually free of inclusions, while biotite may be fresh or completely altered to chlorite and sphene. Opaques have the usually accessory associates, mostly apatite, with some chloritised biotite.

B.M.R. Reg. No. 64155059 An altered microadamellite
(In Stokes Range, about one mile west of Leichhardt Downs Homestead.)

This leucogranite contains allotriomorphic quartz as its only fresh mineral. Plagioclase laths are always cloudy, and often have rims of spherulitic textured intergrowths, probably potash feldspar and quartz. The average grain size is 0.3 to 0.1 mm.. Sericite flakes and radiating green chlorite are abundant secondary products. Opaques (ilmenite - leucoxene) and anhedral apatites are the only accessories.

The following seven specimens are from an outcrop known as "The Rocks", in the Burdekin River south-east of Kelly's Mountain.

B.M.R. Reg. No. 64155077 A foliated biotite microgranodiorite

This trondhjemitic rock has a hypidiomorphic equigranular texture. Plagioclase (andesine), quartz and biotite are the major constituents. The biotite laths occur in layers with distinct foliation tendencies. The mica has a yellow to greeny-brown pleochroic scheme and is rarely altering to chlorite and clinozoisite. The plagioclase crystals tend to be squat, measuring about 0.8 by 0.4 mm, and albite twinning, the most common law, is on a fine scale. Quartz is very anhedral and replaced plagioclase in minor quantities. Potash feldspar was not detected.

Accessories consist of apatite, associated with biotite, and some opaques. Coarser bands in the rock contain grains up to 4.0 mm across.

B.M.R. Reg. No. 64155076 A biotite hornblende granodiorite

This rock has a grain size range of 2.0 by 0.8 mm. to 0.8 by 0.3 mm.. Like the previous specimen it has a plagioclase (andesine) -quartz-biotite assemblage, lacking potash feldspar. The plagioclase is particularly fresh and always albite twinned. The quartz anhedra are inclusion free but show extensive strain shadow effects. Yellow to yellow-brown biotite is typically associated with subordinate quantities of yellowish green hornblende, but also occurs in monomineralic clusters. Rhombic sphene and opaques occur as accessory inclusions in the mica.

B.M.R. Reg. No. 64155070 An altered hornblende granodiorite (tonalite)

Another granodiorite rock lacking potash feldspar and thus having close affinities with the previous two specimens. The assemblage consists of andesine-quartz-hornblende, and a 1000 point modal analysis gave 51 per cent plagioclase, 26 per cent hornblende, including chlorite, and 22 per cent quartz. The fairly fresh feldspar forms laths varying between 0.8 by 0.4 and 1.4 by 0.8 mm.. The hornblende is usually euhedral, and larger crystals are poikilitic towards plagioclase microlaths. Hornblende present to exclusion of biotite is unusual in this type of rock.

B.M.R. Reg. No. 64155072 A hornblende microdiorite

This rock has an average grain size varying between 0.8 and 0.4 mm.. It is particularly rich in euhedral yellow-green hornblende (30 to 40 per cent). The other major constituents are strongly zoned plagioclase, quartz (5 to 10 per cent), chlorite, and epidote. The plagioclase often has myrmekitic rims, and is partly saussuritzed and sericitized. A slightly coarser lens of felsic material consists of almost completely saussuritized plagioclase, epidotized hornblende and minor quartz.

B.M.R. Reg. No. 64155075 An altered hornblende microgranodiorite

This rock is mostly altered, the amphibole to a mixture of actinolite, epidote and chlorite, the plagioclase to sericite and zoisite. Interstitial material is a mixture of quartz and alkali feldspar. The accessories are ?ilmenite (0.2 mm. diameter) and sphene.

B.M.R. Reg. No. 64155066 A porphyritic biotite microgranodiorite

This rock contains common phenocrysts of strongly zoned andesitic plagioclase, typically 1.2 by 0.6 mm.. Many of the macrolaths have myrmekite -like rims, composed of alkali feldspar and quartz. The groundmass

itself consists for the most part, of intergrowths of these two minerals, with a grain size normally within the range 0.05 to 0.1 mm.. Mafics form less than 5 per cent of the rock, of which biotite, often partly chlorite, is dominant. Its pleochroism, when fresh, is yellow to reddish-brown, and it has a ragged appearance, due partly to incipient replacement by the groundmass. Opaques, and apatite form the accessory suite, and the former, from the nature of its alteration to sphene along rhombohedral cleavages, appears to be mainly ilmenite.

B.M.R. Reg. No. 64155068 A leucocratic porphyritic biotite microgranodiorite

A specimen similar to 64155066, with rather euhedral plagioclase (oligoclase-andesine) phenocrysts, showing combinations of prism, side and basal pinacoid. Typically normal zoned with oligoclase rims and andesine cores, crystals measure an average 0.6 by 0.3 mm.. The matrix is a graphic intergrowth of quartz and alkali feldspar. Occasional flakes of biotite are altering to green chlorite and granular sphene. Zircon, opaques and apatite are the accessories. The rock is cut by a veinlet, of maximum width 0.02 mm. composed of alkali feldspar.

B.M.R. Reg. No. 64155079 A garnetiferous pyroxene granulite
(About 4 miles south-west of Inkerman Homestead)

This gneissose rock consists of a garnet-augite labradorite-quartz assemblage, and it has a typical grain size of 0.3 by 0.15 mm. The foliation is due to mineral banding plus elongation of quartz grains.

The garnet is confined to certain mafic bands. It is completely isotropic and frequently has inclusions of pyroxene and quartz. The pyroxene, probably augite, is colourless and semi-idioblastic, but much has altered to clinozoisite. The well twinned labradorite laths are also altering to this mineral. The quartzes show evidence of strain in their commonly biaxial optics ($2V = 10^{o}$). Sphene is a common accessory, as rather sub-rounded grains, 0.06 by 0.03 mm..
Field Geologist's Note: This rock occurs in the Inkerman Shear Zone; it has probably been formed by metasomatism and shearing.

B.M.R. Reg. No. 64155080 A garnet-wollastonite-diopside skarn
(About 4 miles south-west of Inkerman Homestead)

This rock represents a contact metamorphic assemblage, probably pyroxene-hornfels facies, showing a typical calcareous group. The rock shows little evidence of foliation, apart from some parallelism of inclusions in the garnet. The garnet forms up to 50 per cent as a poikiloblastic background, but discrete euhedrons, over 1.0 mm. in diameter are also found. It is mostly isotropic and colourless, but it may be pale brown and anisotropic showing excellent sector twinning. The fibrous to lathy wóllastonite grains, prominent in the garnet fields, are commonly altering to calcite. Diopside forms rather rounded equant grains, mostly as garnet inclusions. Quartz occurs as a relic constituent, usually in pools of very irregular shape and size distribution. Plagioclase is only present in trace amounts. Zoisite plus calcite are often prominent as alteration products of the ?grossularite garnet.

This specimen, from the extensive nature of its hornfelsing, must lie close to a granitic mass, whereas the previous specimen shows only limited thermal effects.

Field Geologist's Note: This rock occurs in the Inkerman Shear Zone; it has probably formed by metasomatic alteration of an originally dioritic dyke rock. There is no field evidence to suggest that it is a true skarn; it might be better named simply a garnet-wollastonite-diopside rock.

B.M.R. Reg. No. 64155084 A quartz hornblende microdiorite
(Three and a half miles south-west of Inkerman Homestead).

This rock consists, like 64155083 (p. 50), principally of plagioclase and hornblende. The composition of the plagioclase is difficult to determine, but albite twin extinctions suggest andesine. Phenocrysts, up to 0.6 by 0.3 mm. are altered to patchy epidote/chlorite areas with cores of deep red, isotropic limonite.

The amphibole (yellow to yellow-green) has a slender lathy habit, typically 0.8 by 0.04 mm.. Sphene, is again a very common accessory, up to 0.6 by 0.2 mm., with inclusions of euhedral hornblende, supporting earlier evidence of a moderately late crystallization. Quartz forms up to 10 per cent of the rock, mostly interstitial, significantly in association with the larger sphenes. Opaques, always angular, are unevenly distributed, and on

rare occasions achieve phenocryst dimensions (1.2 mm.)

B.M.R. Reg. No. 64155085 An altered hornblendite (About 3 miles south-west of Inkerman Homestead)

This rock consists almost entirely of primary green hornblende, and abundant secondary epidote with some fibrous uralite. The amphibole, yellow to pale green, forms interlocking anhedra, averaging 0.3 to 0.5 mm. in length. Sphene is a common accessory, while a small amount of quartz is present interstitially.

This ultramafic type probably results from gravity concentration of a dioritic rock, rather than a late stage alteration of a pyroxenite.

B.M.R. Reg. No. 64155086 An alkali leucomicrogranite (About $2\frac{1}{4}$ miles south-west of Inkerman Homestead)

This specimen is composed of quartz and microcline perthite, with a small amount of oligoclase feldspar. It has the usual hypidiomorphic equigranular texture, with grain sizes between 0.4 and 0.8 mm.. Opaque rhombs occur as accessories, while four colourless grains of anhedral ?garnet with a maximum dimension of 0.1 mm. were observed in close association with each other. If a primary product, not uncommon in leucocratic igneous intrusives, it probably is of spessartite composition. Foliation or gneissose structure in the hand specimen is not apparent in thin section, due to its orientation. Field Geologist's Note: Specimens 64155085 and 64155086 come from within the Inkerman Shear Zone.

B.M.R. Reg. No. 64155095 A granodiorite gneiss (About 5 miles north of Plumtree Homestead)

The rough foliation in this rock is mainly due to felsic and mafic banding. Plagioclase, of sodic andesine composition, forms over two thirds of the total feldspar content, but has been actively replaced in part by potash feldspar, which shows neither microcline nor perthite textures. The replacement may be accompanied by extensive myrmekitic structures, in the form of quartz rods penetrating the plagioclase, accompanied by abundant microgranular quartz, due probably to shearing and recrystallization. The plagioclase crystals attain a maximum size of 4.0 by 2.0 mm. while quartz anhedra rarely exceed 0.5 mm. diameter.

The mafic layers consist of biotite and hornblende with one or the other dominant, with numerous accessories. The biotite is usually green, while the amphibole is yellow to deep green. Both have rather anhedral form, and are usually partly chloritized. Sphene is particularly common, either as large primary anhedra or as microgranular alteration products of biotite and chlorite, which involves redistribution of Ti, Ca, and Si. Zircon is a common accessory as stubby crystals, whilst apatite is much rarer, and opaques are almost absent.

B.M.R. Reg. No. 64155082 An altered microgranodiorite (Seven miles south of Mt. Inkerman)

This rock contains few fresh primary minerals apart from quartz. Plagioclase laths, averaging 0.3 by 0.1 mm. are usually partly altered to a mixture of saussurite, carbonate and sericite. Cloudy potash feldspar forms an important part of the groundmass, typically graphically intergrown with quartz. Semi-spherical opaque grains (0.3 mm. diameter) are rather common, as is allanite, with a distinctive yellow to blood red pleochroism. Its irregular form and association with secondary epidote, suggests a similar origin. Sphene is very common and together with ubiquitous secondary chlorite represents the mafic constituents.

B.M.R. Reg. No. 64155096 An altered microadamellite (About 2 miles north of Plumtree Homestead)

Plagioclase phenocrysts in this rock, of oligoclase-andesine composition, are common, and average 1.0 by 0.4 mm.. The rest of the specimen consists of quartz/potash feldspar groundmass with myrmekitic textures around feldspar inter-contacts. Primary mafics are represented by chlorite, epidote and carbonate, probably pseudomorphing amphibole. Opaques, 0.06 mm. average diameter, are mostly ilmenites altering to leucoxenic products. Apatite is the only important accessory.

B.M.R. Reg. No. 64155097 An altered microadamellite (About one mile north of Plumtree Homestead)

A rock closely comparable with the previous specimen. The plagioclase phenocrysts are more plentiful, while the pinkish (hand specimen) groundmass is dominantly potassic. Areas of secondary chlorite contain exsolved opaque material. The presence of these opaques usually indicates derivation from an amphibole rather than a mica, and relict fragments of pale hornblende were observed confirming this.

B.M.R. Reg. No. 64155128 (2.7 miles north of Mount Benjonney)

This rock is an altered alkali-granite. It consists of an interpenetrating mass of amphibole crystals intruding feldspar and quartz phenocrysts. The feldspar is mainly alkaline (orthoclase). It is present in relatively large subhedral crystals which show considerable alteration. Irregular patches and blebs of quartz surround these phenocrysts and rarely completely enclose them. Plagioclase has a similar development to the alkaline counterpart but is much less abundant. At some time, following crystallization it appears that the rock has been subjected to a stress system and along the resulting fractures extensive development of a green pleochroic clinoamphibole has taken place. The optical properties suggest it to be a member of the tremolite-actinolite series most probably actinolite. The ?actinclite is associated with quartz and rare epidote. The mechanism of emplacement of the amphibole is open to conjecture as the detailed field relations are unknown. However the following are suggestions:

1. The intruded magma fractures the country rock and on cooling incorporates part of the country rock. These become altered by granitic solutions to amphibole.

2. Post crystallization stress system causes disruption and fracturing followed by the emplacement of amphibole by ?hydrothermal solutions.

The thin section indicates that a certain amount of the amphibole entered along fractures, however it also appears that larger blocks have been incorporated as a whole. The amphibole actinolite is characteristically formed in contact metamorphic deposits and the petrologist is of the opinion that the amphibole represents areas of contact metamorphosed country rock incorporated in the magma. Actinolite is also found as a replacement of pyroxene in igneous rocks but it is apparent that this deposit has not been derived from altered pyroxene.

B.M.R. Reg. No. 64155125 (3 miles north of Mount Benjonney)

This rock is an adamellite consisting of a coarse-grained aggregate of quartz, alkali feldspars and plagioclase. It is similar in composition and structure to a specimen (64155139) from an adamellite mass five miles south of Mount Benjonney (BOWEN Sheet area). In 64155139 the feldspars have been altered to sericite along cleavage traces and fractures, and opaque minerals have segregated in these areas; the quartz contains numerous rows of minute bubble-inclusions along parallel fractures. In 64155125 there is evidence of slightly greater alteration of the feldspars; the quartz grains are free of inclusions and tend to form an interlocking mosaic. The alkali feldspars are present as large euhedral crystals of orthoclase and incipiently developed microcline. The plagioclase exhibits marked zoning and is present as large,

tabular, euhedral crystals. Their composition varies from andesine to albite (i.e approximately An_{32} to An_4). The mafic constituents of this rock include opaque minerals, clinopyroxene (augite), hornblende, and the accessory minerals are zircon, apatite and chlorite.

The quartz grains have been severely fractured but these have been infilled by recrystallized secondary quartz. The amphibole (green hornblende) has been partially chloritized. This and the clinopyroxene are early formed minerals often found included in the feldspar and quartz. Opaque minerals appear to be a late phase. They are often found in association with the mafic minerals but when they occur included in quartz and feldspar a distinct reaction rim has developed about them, forming a halo of alteration products. The feldspars exhibit alteration. The majority are altered to sericite, chlorite and carbonate along cleavage traces, parting fractures and around the margins. This obliterates much of their structure and imparts a dark colouration to them. The altered nature of the rock and its composition suggest it has been subjected to kaolinization by pneumatolysis.

B.M.R. Reg. No. 64155126 (3.5 miles N.N.E. of Mount Benjonney)

This rock is an alkali-granite consisting of a coarse grained aggregate of quartz and alkali feldspar with minor plagioclase and mafic minerals. The alkali feldspars have the composition of orthoclase and exist as large subhedral to euhedral grains set in a recrystallized quartz matrix. Plagioclase exists in somewhat smaller grains and exhibits albite and pericline twinning. The plagioclase is partially altered but appears to have the composition of oligoclase. The quartz grains have an irregular shape and are free of inclusions. However they are severely fractured and along these fractures incipient development of sericite and chlorite has occurred. Along one major fracture which traverses the rock numerous grains of tourmaline have recrystallized together with minor amounts of chlorite. The mechanism of introduction of the tourmaline is difficult to envisage but it is almost certainly a secondary structure. The rock has a very low percentage of primary mafic minerals. Opaque minerals which occur in small euhedral grains are the only minerals present in more than accessory amounts. The other primary mafic minerals include incipiently developed clinopyroxene and brown biotite. However the rock has a dark patchy colouration imparted to it by the presence of extensively developed secondary minerals. The majority of the alkali feldspar has been incipiently altered along cleavage cracks, fractures and margins to sericite and minor chlorite. Plagioclase is similarly affected although seritization shows a preference for particular zones within these crystals. Occasionally extensive alteration of feldspars occurs. The resulting grains become poikolitically included in numerous minute flakes and laths of green biotite, tourmaline, muscovite and opaque minerals. The effect

of alteration is to impart a dark colouration to the feldspar crystals. The alteration shows a tendency to occur in zones throughout the rock.

The relationship of the altered feldspars to the remainder of the rock and the nature of the products of alteration suggests that it has been due to pneumatolysis i.e. following the final consolidation of the magma the fugitive constituents have been released and by escaping through joints and other fissures, effect striking changes in the mineral composition of the parent rock. If the products of alteration were not considered this rock could be classified as a leucogranite.

Undivided Palaeozoic Granitic Rocks (Pzg)

A.M.D.L.

B.M.R. Reg. No. 64155104: An intensely sheared adamellite (At the western end of Gregory Range.)

This leucogranite has been intensely brecciated and sheared. The resulting grain sizes vary from greater than 1.0 mm to less than 0.015 mm, with a strong orientation developed in the direction of shear. This is cut by coarse fractures filled with carbonate. However most minerals are still fresh, with the potash feldspar exhibiting microcline twinning. Quartz has often recrystallized, in very elongate grains but is also very fine grained. Plagioclase (oligoclase) tends to occur as larger broken fragments. Opaque material now forms narrow stringers in the shear planes associated with finely crystalline biotite.

B.M.R. Reg. No. 64155094 A biotite microadamellite (About 4 miles east of Rangemore Homestead)

Quartz, perthite, plagioclase (oligoclase) and biotite are the major constituents of this rock. The first two minerals are usually associated, semi-graphically intergrown. Plagioclase forms square to lathy crystals, strongly zoned (1.2 x 0.8 mm.) with albite rims, when in juxtaposition with potash feldspar. The perthite anhedra rarely exceed 0.8 mm., and their albite exsolution lamellae are rather coarse. Biotite (less than three percent), pale yellow to dark brown, forms fresh elongate flakes, associated with opaques, apatite, and zircon. The apatite and zircon prisms are unusually anhedral, angular rather than rounded. Epidote and chlorite are secondary products of biotite, sericite of plagioclase.

B.M.R. Reg. No. 64155098 A leucomicroadamellite
(About 2 miles N.W. of Plumtree Homestead)

Consists essentially of the felsic minerals, plagioclase (oligoclase), potash feldspar, and quartz, with a maximum grain size of 0.8 mm.. The feldspars are quite fresh; the potash feldspar develops microcline twinning and some coarse perthite. It only rarely replaces the plagioclase. Quartz forms either anhedral grain clusters or tiny bleb inclusions in potash feldspar. The coarser material exhibits strong strain shadows.

Opaques form 1 to 2 per cent of the rock, varying from 0.5 to 0.15 mm. diameter, associated with partly metamict zircons, of similar dimensions. Biotite is present in very minor quantities.

B.M.R. Reg. No. 64155088 A porphyritic rhyodacite
(About 3 miles east of Rangemore Homestead)

This altered rock contains phenocrysts of clouded plagioclase laths (1.0 x 0.15 mm.) and euhedral to anhedral (resorbed) quartzes, with spherulitic rims. Rare opaque phenocrysts have narrow muscovite rims. Biotite phenocrysts are now represented by euhedral pseudomorphs of green chlorite. Spherulites are particularly common in the groundmass, averaging about 0.2 mm. They may consist of sectors or have a uniform orientation, even though their habit is apparently fibrous. Their composition cannot be determined with certainty, but refractive index observation suggests they are a mixture of quartz and ?oligoclase plagioclase, and represent quickly cooled magma. Potash feldspar is identified in the groundmass by staining.

B.M.R. Reg. No. 64155089 An altered porphyritic rhyodacite
(About 3 miles east of Rangemore Homestead)

This is a similar specimen to the previous one, but contains sericite instead of chlorite, and has widespread branching threads of opaque material. Staining again shows the groundmass to be potash feldspar rich.

B.M.R. Reg. No. 64155090 A graphic microadamellite
(About 3 miles east of Rangemore Homestead)

This rock is altered enough to prevent the determination of the composition of the feldspars. Quartz and two feldspars, are intergrown semi-graphically, with the former occupying about one third of the rock volume and the latter two thirds. The grain size range is between 0.3 and 0.5 mm. but there is little tendency to idiomorphism. Opaques are ubiquitous, either as

square crystals or as thread-like lengths, associated with chloritized mica flakes.

Collector's Note: Possibly a dyke rock.

B.M.R. Reg. No. 64155092 A biotite microadamellite
(About 3 miles east of Rangemore Homestead)

This rock has a somewhat similar composition to 64155088, 64155089, 64155090 and 64155091, but its texture is more clearly hypabyssal, with lathy plagioclases (0.5 x 0.1 mm.) intergrown with allotriomorphic quartz. Staining indicates the widespread occurrence of potash feldspar in the rock. Biotite (2-3 percent) is now mostly chloritized. Opaques form 1 to 2 per cent, and apatite is a common accessory.

With the plagioclase in these hypabyssal and volcanic rocks rather altered, rock nomenclature is necessarily vague. Thus the adamellite group, where neither feldspar is dominant, has been used to describe altered acid igneous rocks.

Collector's Note: Possibly a dyke rock

B.M.R. Reg. No. 64155099 A brecciated adamellite
(About 3 miles south of Plumtree Homestead Bowen Sheet Area).

This granite is intensely brecciated and recrystallized, yet most of the feldspar is reasonably fresh. Many crystals are broken into separate disorientated fragments, but larger rock fragments are also present. Epidote/clinozoisite occurs throughout as matrix material. The largest mineral fragments are of quartz, up to 0.5 mm. diameter, and they invariably show severe strain effects.

B.M.R. Reg. No. 64155063 A spherulitic rhyolite porphyry (The Rocks)

Phenocrysts, often untwinned, of plagioclase constitute about 50 per cent of the rock volume, together with their often extensive spherulitic rims, which have an average diameter overall of about 0.5 mm.. Staining tests indicate that the spherulites may be potash feldspar. The apparently radiating fibres have one orientation, and thus represent a single crystal rather than a number of fibres. The groundmass is very fine grained, averaging about 0.03 mm..

Opaque material is the only important mafic component, and from the hand specimen appears to be mainly pyrite. Secondary chlorite/epidote and are the only other mafics. Zircon is a not uncommon accessory. Quartz, apart from being prominent in the groundmass, may be a core to a spherulite.

Field Geologist's Note: This rock, and 64155064 and 64155065, are from the same dyke. It is felt that these rocks should more properly be called rhyodacite.

B.M.R. Reg. No. 64155064 A spherulitic rhyolite porphyry (The Rocks)

This rock is closely comparable with the previous one. Plagioclase phenocrysts typically measure 1.2 by 0.8 mm.. Rare quartz phenocrysts also occur as cores (1.0 mm.). The groundmass is slightly coarser at 0.06 mm. average. Of this sequence from The Rocks the first seven rocks - 64155066, 68, 70, 72, 75, 76, 77 - are obviously closely related. The other two may be volcanic equivalents but are too altered and fine-grained for a decision.

B.M.R. Reg. No. 64155065 A porphyritic felsite (The Rocks)

This rock consists of large (1.6 x 0.8 mm.) plagioclase phenocrysts, now almost completely altered to sericite, epidote and carbonate, scantily distributed in a felsitic or cryptocrystalline leucocratic matrix. Scattered through this are tiny flakes of chlorite, and some porous opaque material. The groundmass occupies at least 95 per cent of the total rock volume.

B.M.R. Reg. No. 64155078 A porphyritic microadamellite (The Rocks)

This rock contains between 10 and 20 per cent reasonably fresh plagioclase (oligoclase) phenocrysts (1.0 x 0.5 mm.) mostly zoned but rarely twinned in a matrix composed of plagioclase microliths cemented by a graphic (alkali feldspar/quartz) matrix. Occasional biotite phenocrysts, may be only partly chloritized and have, when fresh, a yellow to reddish-brown pleochroism. Green biotite is present as a preliminary stage of alteration, while sphene is associated with the secondary chlorite.

The feldspar phenocrysts are often extensively penetrated around their rims by alkali feldspar. The microliths which average about 0.25 by 0.05mm. often have spherulitic-like structures surrounding them, comparable with some earlier mentioned rhyolites, 64155063 and 64155064. The textural evidence here is compatible with an intrusive rather than extrusive origin.
Collectors Note: This rock is equated with 64155063, 64155064 and 64155065.

B.M.R. Reg. No. 64155042 (North-western slopes of Kelly's Mount)

This is a biotite granite, of normal hypidiomorphic inequigranular texture. Microcline perthite, as large (4.0 mm.) fresh anhedral crystals quartz, subordinate plagioclase (albite-oligoclase), and biotite are the major constituents. The plagioclase shows incipient sericitization while the well twinned K feldspar is often cloudy. Biotite, with a straw yellow to deep brown pleochroism, has an elongated flaky habit, typically measuring 3.0 x 0.5 mm., and is altering to yellow chlorite and acicular rutile. Zircon is the only important accessory, as rather poorly shaped grains, associated with opaques, and also muscovite; which is an anomalous association.

B.M.R. Reg. No. 64155043 (Quarry just north of The Rocks)

This is a normal biotite adamellite, composed of oligoclase plagioclase, perthite, quartz, and biotite, now mostly altered to chlorite and epidote. Plagioclase which may be square (2.5 mm. diameter), or lathy (1.2 x 0.8 mm.), is heavily zoned and not always twinned. K feldspar and quartz are usually intergrown semigraphically, with rare quartz individuals measured at 1.0 to 2.0 mm. diameter. The biotite appears to have been replaced by potash feldspar on some occasions. The quartzes invariably show strain shadow extinction, and are slightly biaxial. Opaque clusters contain individuals which tend to be euhedral, and are associated with rare columnar apatite and stumpy zircon.

B.M.R. Reg. No. 64155127 (0.5 miles S.W. of Mount Woodhouse)

This rock is a granophyric alkali-microgranite. It consists of an equigranular mass of feldspar and quartz crystals together with a minor percentage of mafic minerals. The quartz is present as irregular shaped composite grains sometimes interstitial to the feldspar and sometimes lobed into it in a manner suggesting replacement. The quartz is virtually free of inclusions apart from rare apatite and equally rare bubbles which become included along early fracture planes. The majority of the feldspar is alkaline although isolated patches of plagioclase exhibiting albite twinning are found. The plagioclase has the approximate composition of andesine (An35) and occurs as small subhedral crystals randomly distributed throughout the rock. The alkali feldspar occurs as anhedral to subhedral crystals of microcline-microperthite, microcline, and perthites with sodium exsolution bodies in a potassium base. All gradations between these forms appear to be present and in some cases it is impossible to distinguish between them. An incipient granophyric texture is developed by the mutual intergrowth of quartz and feldspar. The mafic constituents of the rock are present to an extent of less than 5 per cent. The principle mafic minerals are a pale green clinopyroxene (?augite), epidote, with a high iron content (probably

derived from Ca of altered plagioclase), opaque minerals, altered brown biotite (giving sphene and chlorite), chlorite and incipiently developed kaolinite. The feldspars have been partially altered, possibly by pneumatolysis, along cleavage traces to kaolinite. These render the crystals partially opaque and impart the dark colouration to the rock. Along intergranular boundaries and rare fractures which have developed in the rock finely disseminated iron oxides, chlorite and sericite have crystallized.

B.M.R. Reg. No.64155112 (One mile north of Mount Woodhouse)

This rock is a granodiorite. It consists almost wholly of equigranular plagioclase crystals. The composition of the plagioclase corresponds to a calcic oligoclase (approximately An_{28}). The crystals are fresh and the only inclusions present within them are minute apatite rods. Inclusion free quartz occupies irregular intergranular spaces. In some areas of the rock percolating solutions have entered between the grain contacts and deposited finely disseminated iron oxides. The principle mafic constituent is the amphibole, common hornblende. It has crystallized in platy fibrous aggregates along intergranular cavities left by the already crystallized feldspar. Quartz is the last to crystallize and infills the remaining cavities and incipiently replaces parts of the amphibole. Opaque minerals constitute approximately 1 per cent of the rock and are found in close association with the amphibole. Accessory minerals which are randomly distributed include chlorite and zircon. An alteration product of calcium rich components is a light coloured epidote. The suggested petrogenesis is: feldspar, opaques, amphibole, quartz, incipiently developed alteration products. The grain size is relatively fine for the granodiorite.

B.M.R. Reg. No. 64155129 (Two miles N.W. of Mount Benjonney)

This rock is a granodiorite. It consists of a mass of graphically intergrown quartz and feldspar throughout which is distributed phenocrysts of alkali feldspar (orthoclase), intergranular quartz, rare plagioclase, epidote, chlorite (?penninite) and other micas. There are no opaque minerals. The plagioclase is a calcic oligoclase and is found partially altered to epidote. The alkali feldspar has been incipiently kaolinised and as a result appears cloudy in thin section. The intense green pleochroic chlorite (penninite) is found in small anhedral grains in close association with the epidote. Biotite is commonly found severely altered to chlorite and incipient epidote.

Incipiently developed opaque minerals are often associated with this alteration. It appears that alteration has taken place subsequent to crystallization, probably by hydrothermal solutions. Elongated apatite rods are occasionally found included in the quartz grains. In some places it appears as if biotite is growing secondarily at the expense of feldspar.

B.M.R. Reg. No. 64155120 (One mile N.W. of Landers Creek Homestead)

This rock is a granophyric alkali-granite. It consists of a coarse grained aggregate of alkali feldspars many of which contain numerous masses or blebs of quartz intergrown with them. These, in thin section, impart the granophyric texture to the rock. The feldspars appear to be variable in composition. Some exhibit perfect grid-iron twinning and hence are classified as microcline, others are microcline-microperthites. Other alkali feldspars are of an indefinite character. Some exhibit a "strained" polysynthetic twinning and are thought to have sufficient triclinicity to be classified as microcline. Others are probably orthoclase. Quartz, as well as recrystallizing simultaneously with the feldspar, occurs as large lakes and compound grains surrounding the feldspars. Long needle-like inclusions of apatite are commonly included in the quartz grains. No plagioclase could be identified with certainty. The mafic constituents of the rock are present to an extent of less than 5 per cent and, in the main, are highly altered. The main constituent is an altered biotite which now appears golden brown. The colouration is due, in part, to the alteration products (sphene and chlorite) and in part to oxidised iron also possibly derived from the altered biotite. Rare minute opaque minerals are found scattered throughout the slide. One large crystal of quartz was observed which contained numerous acicular needles of a pleochroic green mineral. These had an inclined extinction. The needles were not rutile although they imparted a "rutilated" appearance to the grain. Their composition could not be determined because of their minute size but are possibly apatite.

The effect of stress being operative during the recrystallization process is apparent in the feldspars. These show perfectly formed kink bands. It is apparent that these kink bands have developed while the rock was in a crystal mush because newly recrystallized material surrounds those crystals which exhibit the phenomenon. The feldspars in this rock are relatively unaltered as compared to those of other examples in this suite.

B.M.R.

B.M.R. Reg. No. 64150038 Granophyre. (Mt. Dalrymple)

Tabular to sub-tabular phenocrysts of moderately sericitized albite, and a few of rounded, moderately strained quartz, are enclosed in a granophyric groundmass composed of quartz and alkali feldspar. A few clots of epidote and smectite are present.

Undivided Palaeozoic Basic Plutonic Rocks (Pzt)

A.M.D.L.

B.M.R. Reg. No. 64155134 (3.5 miles E.S.E. of Mount Benjonney)

This rock is an olivine micro-gabbro. The rock exhibits a well developed xenomorphic granular texture with mutually interfering crystals of plagioclase, augite and olivine. The olivine crystals are large and show visible parting fractures along which incipient secondary alteration to antigorite and magnetite has occurred. Surrounding each of the olivine phenocrysts is a reaction rim. The early crystallizing olivine has reacted with the still molten magma to form sericite, and chlorite and finely disseminated opaques. The clinopyroxene augite is more abundant but forms slightly smaller crystals. Filling all interstitial spaces between the olivine and the augite are numerous twinned plagioclase crystals. They correspond to a composition of labradorite (approximately An_{68}) Incipient alteration to sericite and chlorite has occurred along cleavage planes and parting fractures throughout the rock. The rock is devoid of hypersthene. The mineral proportions visually estimated are 45 per cent feldspar, 40 per cent augite, 10 per cent olivine and 5 per cent accessory chlorite, sericite and opaque minerals.

Upper Carboniferous Volcanics (Cuv)

A.M.D.L.

B.M.R. Reg. No. 64155113 (Mount Woodhouse)

This rock is an andesitic tuff. It consists of a mass of sharply angular to sub-rounded volcanic rock fragments set in a fine-grained devitrified glassy matrix. The fragments have a wide size distribution ranging between 2 and 8.5mm.. The majority of the included fragments appear to have a common origin. They are fine-grained and consist of numerous, fibrous, needle-like phenocrysts of feldspar set in a fine-grained glassy matrix. The feldspars themselves are of an indeterminate composition but poorly developed twinning indicates the majority of them to be plagioclase.

The fragments are saturated. Depending on the composition of the plagioclase these fragments may be classified as dacites or andesites. Many of the rock fragments have been partially altered to epidote. This gives a greenish-yellow colouration to many of the fragments in thin section. Epidote coats many of the feldspar grains, has crystallized along fractures and is rarely present as crystal aggregates. The ubiquitous occurrence of epidote appears to suggest a Ca rich phase and for this reason it has been assumed that the fragments are indeed andesitic. Throughout the devitrified glassy matrix isolated laths of feldspar occur together with angular quartz fragments and rare powdered opaque minerals. Epidote has developed as a deuteric replacement of feldspar together with chlorite and incipiently developed kaolinite. A subparallel orientation of segregated elements in the devitrified glassy matrix is suggestive of flow and this may be a partially welded tuff.

B.M.R. Reg. No. 64155131 (6 miles N.W. of Mount Dalrymple)

This rock is a rhyodacite. It consists of a saturated mass of altered feldspar laths, deuteric epidote, a colourless amphibole (?tremolite), incipiently developed sericite and muscovite, pale coloured biotite, chlorite and finely disseminated opaque minerals. The feldspars present have been subjected to widespread alteration which makes an interpretation as to their original composition difficult. However, from the shape and form of the crystals and the poorly defined twinning that is exhibited in some instances it has been concluded that both feldspar types are present. The feldspars exist as narrow elongated laths and short stubby laths and they have an ill-defined subparallel orientation. Infilling all interstitial spaces between the laths are irregular shaped quartz masses. The remaining minerals - epidote, muscovite, sericite, chlorite - are secondary and have probably arisen from the original deuteric alteration of the rock. Incipiently developed biotite is the only primary mafic mineral phase, apart from the rare opaques, that occur throughout the rock. Rarely minute vesicles infilled with epidote and secondary silica are found. Rare enlarged euhedral phenocrysts of alkali feldspar are found randomly distributed throughout the rock.

The deuteric alteration that has taken place has caused the kaolinization of the feldspars and imparted the dark colouration to the rock. Field Geologist's Note: This rock is probably a dyke or small mass intruded into the Unnamed Granitic Rocks (Pzg).

B.M.R. Reg. No. 64155148 (5 miles N.W. of Landers Creek Homestead)

This is a tuffaceous rock consisting of isolated crystals of partially replaced and altered feldspar together with quartz set in a devitrified glassy matrix. The degree of alteration does not permit a determination of the composition but the feldspar appears to be ?sanidine. The silica is possibly cristobalite. The feldspar has been severely altered to sericite and saussurite. Some crystals have been completely replaced. Very fine cracks and fractures traverse the rock and along these precipitation of finely disseminated iron oxides has taken place. The devitrified glass has no structure although rarely it appears to be traversed by minute elongated quartz lenses which have a sub-parallel orientation. These possibly represent former flow lines. Areas of the devitrified glass show a completely different structure. In areas which have been exposed to outside influences a pronounced spherulitic texture has developed. At first glance these appear to be detrital fragments but close observations indicate them to be segregations from the matrix. Their margins are intergrown with the matrix and it is apparent that the segregations have occurred by a different means of crystallization. The feldspar phenocrysts have a sub-parallel orientation within the glassy matrix which parallels the hair-like segregations of quartz. Carbonates have infilled numerous fractures similar to those infilled by iron oxides.

B.M.R. Reg. No. 64155149 (5 miles N.W. of Landers Creek Homestead)

This rock is a welded tuff. It consists of feldspar and quartz phenocrysts and rock fragments set in a devitrified glassy matrix. It is very similar to 64155148. The feldspars are primarily alkaline. The groundmass consists of a crypto-felsitic mass of feldspar and quartz which has been subjected to alteration. There are two main types of rock fragments. The first are altered glass ejecta. They now consist of devitrified glass which has been partially or almost wholly converted to sericite and quartz. It appears that these fragments have been ejected by an explosion and have become incorporated in molten magma. The temperature and overburden has caused them to become viscous and as a result has contorted and disrupted their original granular shape. Secondly quartz rich fragments exist. The origin of these cannot be determined with certainty. Rarely these are unaltered and fresh but commonly are found fractured with sericitic, devitrified glass infilling the fractures. The "primary" glass has also been subjected to incipient alteration forming sericite. This occurs in thread-like sub-parallel veins which give the appearance of flow. It is possible that these may represent distorted glass shards subjected to weathering similar to that affecting the glassy fragments. The ratio of rock fragments to glass would be approximately 3:7.

B.M.R. Reg. No. 64155150 (5 miles N.W. of Landers Creek Homestead)

This rock is identical with No. 64155149 except that the texture is more finely defined. The only difference is in the composition of the rock fragments. As well as those previously mentioned fragments of ?welded tuffs can be seen. These suggest that a former volcanic phase has been operative before the formation of this deposit.

B.M.R. Reg. No. 64155122 (4 miles N.N.W. of Landers Creek Homestead)

This rock is an acid volcanic which has been subjected to low-grade metamorphism. It consists of numerous, relatively large, well rounded to angular quartz grains randomly distributed throughout a fine-grained, recrystallized groundmass. The size distribution of the larger grains lies in the range 0.1 to 0.47 mm.. The groundmass is made up of minute completely recrystallized quartz and feldspar grains together with muscovite, sericite, chlorite and aggregates of finely disseminated iron oxides. The larger grains of quartz are inclusion free except for rare rods of apatite, but the smaller ones, found in the matrix, have numerous inclusions of opaques, apatite and tourmaline. Virtually none of the quartz grains - small or large - show undulose extinction. There is a slight parallel elongation of the quartz grains and a tendency for elongation by recrystallization in this direction. There is no marked foliation although the mica elements of the matrix have a tendency towards sub-parallel orientation. Accessory aggregates of opaque minerals are randomly distributed throughout the groundmass. The low grade metamorphism and accompanying recrystallization has caused the rock to become highly compacted.

B.M.R. Reg. No. 64155132 (4 miles north of Landers Creek Homestead beside main road).

This rock is a quartz-muscovite-chlorite-sericite schist. It consists of abundant quartz, with muscovite, opaque minerals, feldspar and minor sericite. The quartz has been substantially recrystallized. The quartz grains have a size distribution in the range 0.02 to 0.7 mm. Layers of coarse grains alternate irregularly with layers of fine grains throughout the rock and impart a distinctive, finely laminated texture to the rock. It appears that shearing has taken place along numerous finely spaced shear planes. Foliated muscovite has formed, along the severely recrystallized planes, in large plates. The size of these plates indicatesthat recrystallization has been prolonged and that no further deformation has taken place. A further indication of shear is the extended nature of many of the quartz grains and the evidence of internal shearing within many of the grains. Muscovite also

occurs as long needle-like laths throughout the finer grained layers and exhibits incipient schistosity as evidenced by their subparallel orientation. Chlorite occurs in irregular elongated masses within the coarsely recrystallized layers. The opaque minerals are aggregates of finely disseminated iron oxides (ferric oxides) and these impart the pinkish colouration to the rock. Accessory epidote is also found in these layers together with alkali feldspar which contains numerous sericitic inclusions.

Field Geologist's Note: This schist probably is a highly siliceous volcanic rock which has been strongly sheared by the Woodhouse Fault, and recrystallized by thermal metamorphism associated with the late Palaeozoic microgranite immediately to the south of the fault.

B.M.R. Reg. No. 64155121 (4 miles N.N.W. of Landers Creek Homestead, on northern side of the Woodhouse Fault).

This rock is an extensively recrystallized acid volcanic which has been subjected to low-grade regional metamorphism. The recrystallization has destroyed the original volcanic texture and has taken place under stress. This has caused the grains to become elongated in the direction of stress release. At intervals of approximately 0.3 mm. planes along which excessive recrystallization has taken place are apparent. Randomly distributed throughout the granoblastic groundmass of quartz and feldspar are rare, isolated, large feldspar crystals. The only other components of the rock are micas which are pleochroic brown and green biotite and incipiently developed muscovite and sericite.

Metamorphism has been induced synkinematically and has attained the quartz-albite-epidote-biotite subfacies of regional metamorphism (greenschist facies). Shearing has caused the development of an incipient schistosity. Biotite together with the other micas has formed, during metamorphism, parallel to the shear planes. Incipient foliation is evident. Aggregations of opaque minerals are associated with the biotite.

B.M.R. Reg. No. 64155108 A foliated quartzite (East of the Burdekin River, at the southern edge of the Sheet area).

This fine-grained rock consists entirely of angular quartz grains averaging about 0.03 mm. with strongly oriented threads of sericitic material giving the rock its metamorphic character.

B.M.R.

B.M.R. No. 64150032 Hornfelsed acid porphyry. Mt. Dalrymple

The rock has an inequigranular, granoblastic matrix in which the grain-sizes range from 0.03 to 0.1 mm.. The matrix is composed of quartz, oligoclase, and potash feldspar. A few relict phenocrysts are present; these consist of plagioclase, potash feldspar, and quartz, and range up to 0.8 mm. diameter.

Late Palaeozoic Intrusive Rhyolitic Rocks

(Pzh)

A.M.D.L.

B.M.R. Reg. No. 64155105 A porphyritic felsite (About 3 miles S.W. of Byrne Valley Homestead).

Sericitized plagioclase phenocrysts (1.2 x 0.6 mm.) are irregularly scattered through a vaguely crystalline, i.e. felsitic, groundmass, which appears to contain abundant potash feldspar (staining). The irregularly shaped grey polarizing areas which have a felsitic texture, range between 0.1 and 0.2 mm. diameter. Opaques are prominent (less than five per cent) either as discrete primary grains averaging 0.15 mm, or as anhedral aggregates, a secondary product of altered ?biotite phenocrysts, associated with chlorite and sericite. This latter opaque material appears to be leucoxenic. Rounded zircon (0.03 x 0.01 mm.) is associated with rather common euhedral apatite (0.15 x 0.06 mm.)

B.M.R. Reg. No. 64155107 A porphyritic biotite trachy-andesite (Western end of Mt. Louisa)

This rock develops typical trachytic texture. Closely packed microlites of andesitic plagioclase in sub-parallel bunches dominate the groundmass. Phenocrysts of oligoclase-andesine, some orientated, achieve a maximum size of 1.2 by 0.8 mm.. Where the flow texture is strongly developed, phenocrysts are bent and even broken in alignment with the flow swirls. Biotite also forms rare, oriented phenocrysts. Much of the interstitial crystalline groundmass is potash feldspar.

Accessories consist of zircon, opaques and apatite, the former two often in close association. Apatite may occur rather unusually as oriented inclusions in a plagioclase phenocryst, parallel to the flow, which suggests that the apatite crystals acted as nucleii for the feldspar's growth. Post-consolidation movement is suggested by the disorientation of sections of the rock in one of the two slides.

Late Palaeozoic Granitic Bodies
(Pzug)

A.M.D.L.

B.M.R. Reg. No. 64155081 A biotite microadamellite (About 5½ miles south of Leichhardt Downs Homestead)

This reasonably fresh potassic granite has a hypidiomorphic equigranular texture. Perthite, oligoclase feldspar, biotite and quartz are the major constituents, with the potash feldspar in excess of the plagioclase. The perthite is allotriomorphic, always cloudy, and develops some intergrowths with quartz. Plagioclase forms subhedral zoned crystals, typically 0.6 to 0.8 mm. in length. The biotite flakes, often elongate (0.6 x 0.2 mm.) have yellow to brown pleochroism, and are unusually free of inclusions.

Mafic clusters consist of biotite, anhedral opaques, common zircon and rare apatite. One extremely rod-like opaque crystal (1.1 x 0.03 mm.) probably ilmenite, indicates by its form that it had a late crystallization.

B.M.R. Reg. No. 64155109 (3 miles west of Mount Benjonney)

This rock is an altered alkali-microgranite. It consists of numerous anhedral to subhedral feldspar crystals set in a mass of compound quartz grains which have recrystallized in and around clusters of feldspar laths. In many places granophyric intergrowths of the quartz and feldspar are observed. These are usually found enclosing large feldspar phenocrysts. The quartz is water clear and free of inclusions. The feldspars are apparently all alkaline and have a marked opacity due to severe kaolinization which has probably been effected by pneumatolytic alteration. The altered nature of the alkali feldspar prevents an accurate determination of the composition, however it is assumed to be orthoclase. No plagioclase could be identified with certainty. Staining for K feldspar confirmed that the majority, if not all, the feldspar is alkaline. The mafic minerals constitute less than 5 per cent of the rock and consist of minute opaque mineral grains, partially altered biotite, chlorite, incipiently developed epidote, rare elongated amphibole crystals (?ferroactinolite) and minor clinopyroxene (?augite). The chlorite and epidote appear to have developed as a result of deuteric alteration of primary minerals probably accompanying the alteration of the feldspars.

Along the margins and within cavities in the rock severe weathering has taken place. Weathering solutions have leached away the more soluble feldspars leaving an etched surface of remnant quartz. Occasionally alteration is advanced and the majority of the feldspars, in these areas, have been completely chloritized and sericitized with only pseudomorphic remnants of the earlier crystals remaining. The rock has been subjected to intense deuteric alteration subsequent to crystallization and it is the results of this alteration that imparts the characteristic red colouration to the rock.

B.M.R. Reg. No. 64155111 (3 miles W.S.W. of Mount Benjonney)

This rock is a graphic alkali-microgranite. It consists of numerous anhedral to subhedral crystals of alkali feldspar, in parts graphically intergrown with quartz, compound grains of recrystallized quartz and mafic minerals. The feldspars have been subjected to deuteric alteration which has imparted a marked opacity to the grains. The products of this deuteric alteration are kaolinite and incipiently developed sericite. The altered nature of the grains does not permit an accurate determination of their composition but orthoclase is the most probable. The quartz grains are irregular in shape and are frequently found intergrown with the alkali feldspar imparting a typical graphic texture to the thin section. The quartz grains are virtually free of inclusions except for rare minute gas bubbles and equally rare powdered opaque inclusions. The mafic material constitutes approximately 7 to 8 per cent of the rock. The principle minerals in this category are: randomly distributed opaque minerals; chloritized micas (green biotite); partially replaced clinopyroxene (?augite); incipiently developed epidote and clinozoisite (both probably of deuteric origin). Epidote has also formed as a deuteric alteration product of biotite. Of the mafic minerals epidote is the most ubiquitous.

In hand specimen the rock has a distinct reddish brown colouration. This is imparted to the rock by the intense deuteric alteration of the feldspars and mafic minerals in post crystallization times.

B.M.R. Reg. No. 64155110 (3 miles W.S.W. of Mount Benjonney)

This rock is an alkali-microgranite. It consists of numerous, severely recrystallized quartz grains containing rare phenocrysts of alkali feldspar, laths of biotite, muscovite and sericite. Accessory minerals include apatite, zircon and opaque minerals. The present size distribution is 0.01 to 0.15 mm. and is unimodally skewed towards the fine sizes. It is considered that the rock has been subjected to deformation. Synkinematic recrystallization has accompanied deformation and fragments have been reduced in grain size along the subsequent shear planes. In some areas the rock has been fractured parallel to the incipiently developed schistosity and along

these there has been secondary enrichment of quartz, epidote and finely disseminated opaque minerals.

Field Geologist's Note: Rocks 64155111 and 64155110 are from the same mass.

B.M.R. Reg. No. 64155123 (West bank of Burdekin River, at its junction with Deep Creek)

This rock is a partially altered granite-aplite. It consists of a welded mass of feldspar and quartz grains. The rock is made up of small phenocrysts of alkali feldspar (orthoclase) and microcline set in a granophyric intergrowth of quartz feldspar and quartz grains. Other minerals present in the rock are epidote, sericite, chlorite and opaque minerals. These would constitute less than 5 per cent of the total rock. The micas show a tendency to be concentrated into segregations within the rock. In places they replace feldspars but in the main they penetrate along intergranular spaces. They are secondary with respect to the initial crystallization. Epidote is associated with the opaque minerals and probably results from the alteration of Ca rich feldspars. Alkali feldspar predominates but the plagioclase-oligoclase - is found randomly distributed throughout the rock.

B.M.R. Reg. No. 64155124 (0.5 miles N.W. of Burdekin River Deep Creek Junction)

This rock is an alkali-microgranite. It consists of numerous anhedral to subhedral alkali feldspar crystals set in a mass of compound quartz grains and rare plagioclase crystals. In many places granophyric intergrowths of quartz and feldspar are observed. When compared with other members of this suite the rock is relatively unaltered and does not appear to have been subjected to pneumatolytic alteration and kaolinisation except along joint planes and shear fractures. Optical properties indicate the feldspar to be orthoclase. Mafic minerals constitute less than 5 per cent of the rock and are made up of opaque minerals green biotite, epidote, clinozoisite and chlorite.

Severe alteration has taken place along a major fracture which is present in this specimen. A reduction in grain size and the lack of structure in this zone indicates that the rock has been sheared along this zone causing a plane of weakness in the rock. Subsequent weathering and altering solutions have entered along this plane and formed kaolinite from the feldspars and deposited finely disseminated iron oxides.

Other less prominent shear planes are present in the rock along which there has been considerable reduction in grain size together with internal shear within the grains and recrystallization along these planes.

B.M.R. Reg. No. 64155130 (N.W. slope of Mount Benjonney)

This rock is an alkali-granite. The grain size is moderately fine but not so fine as to be classified as an alkali microgranite. The rock consists of randomly distributed, poorly formed crystals of orthoclase feldspar and minor crystals of plagioclase sitting in a quartz groundmass which has little structure. The quartz, in many cases, completely surrounds the orthoclase crystals in numerous "lakes" and lobes. The quartz has been subjected to incipient fracturing. Many of the feldspars are zoned and commonly show carlsbad and polysynthetic twinning. Kaolinization of the feldspars has taken place causing them to become cloudy and partially altered to kaolinite, chlorite, and sericite along cleavage cracks, fractures and margins. This is the effect of post-recrystallization pneumatolysis. The rock has a low mafic content, the mafic constituents forming less than 5 per cent of the rock. The mafic constituents include brown biotite, which is found in flakes in intergranular spaces and as minute inclusions in the alkali feldspar. Occasionally the biotite is partially or wholly replaced by green chlorite and opaque minerals. Needle-like inclusions of apatite are common and small euhedral zircon crystals are also found. Opaque minerals are comparatively rare and they occur as small anhedral aggregates generally in association with the mafic constituents.

Urannah Complex

(1) Dioritic Phase (C-Md)

A.M.D.L.

B.M.R. Reg. No. 64155034 (Near Alligator Swamp, 5 miles W.N.W. of Bowen)

This is an olivine leuconorite or coronarite, in which large fresh well twinned labradoritic plagioclase forms over 75% of the rock. Pericline twinning is prominent and lamellae invariably wedge out. Unusually fresh olivine forms about 10% of the rock, (1.0 mm.) and practically always has a reaction rim of pale-brown hornblende. Rarely an intermediate rim of hypersthene is developed between the olivine and amphibole. The width of the rim bears no relationship to the size of olivine core. Opaque grains also have amphibole rims, plus occasional spinel or biotite. Chlorite is developed around altered cores.

B.M.R. Reg. No. 64155035 (Near Alligator Swamp, 5 miles W.N.W. of Bowen)

This is a similar rock to No. 64155034; it is more medium grained, and is richer in mafics. Augite formsup to 10% of the rock, and minute opaque inclusions frequently result in cloudy pyroxenes. The rock is thus an olivine microgabbro. Alteration of mafics to anomalously birefringent 'epidote' is a not uncommon feature.

B.M.R. Reg. No. 64155036 (Near Alligator Swamp, 5 miles W.N.W. of Bowen)

This is an olivine gabbro, again showing well formed coronas to the olivine and opaques. Well twinned plagioclase (labradorite) forms about 60% of the rock. Olivine is typically anhedral, up to 1.5 mm. diameter. Rims of varying diameter, consist of pale brown to green hornblende, (usually wide) and colourless hypersthene, (narrow rims). Some biotite is present around otherwise free grains. Augite, which is subordinate to olivine, often has amphibole reaction rims. Amphibole is often extensive enough to include plagioclase and olivine. Most olivine is fresh, but some altered material consists entirely of yellow serpentine and exsolved opaques. Primary opaque material, associated with femics, has extensive rims of amphibole. Clinozoisite is a not uncommon secondary mineral.

B.M.R. Reg. No. 64155039 (One mile E.N.E. of Salisbury Plains Homestead)

This is an altered, quartz-bearing hornblende microdiorite. The principal constituents are a sericitized and saussuritized plagioclase (?andesine), typically 0.8 x 0.25 mm., intergrown with chloritized hornblende, distinctly euhedral. The amphibole usually has a brownish core and a green rim. Opaques are the main constituent, associated with acicular apatite, and secondary sphene, the latter after amphibole.

B.M.R. Reg. No. 64155032 (Summit of Sprole Castle)

This is a diorite, consisting principally of large greenish-yellow hornblende crystals and rather equant plagioclase (andesine) laths, having a predominance of pericline twinning. The plagioclase sometimes occurs in finer-grained monomineralic clusters, individuals averaging 0.03 mm. in length. The normal length of the two major constituents varies from 1.0 to 2.0 mm. Accessories include anhedral sphene and minor opaques.

B.M.R. Reg. No. 64155033 (Eastern slopes of Mount Little)

This is another hornblende diorite of similar composition to the previous specimen, but is less fresh, and shows some signs of recrystallization. The plagioclase alters to zoisite and sericite. The amphibole contains appreciable disoriented opaque lamellae, particularly after altering to chlorite. Large amphibole phenocrysts contain cores of tiny recrystallized laths which are usually of lower birefringence (0.012), and weaker pleochroism. Recrystallization must be due to metamorphism.

B.M.R. Reg. No. 64155087 An olivine microgabbro (Red Hill, 8 miles west of Guthalungra)

This rock contains the following major primary minerals; olivine, labradorite, augite, with lesser quantities of hypersthene, amphibole, spinel and opaques. Its grain size borders on the plutonic, with a range of 0.4 to 1.2 mm.. Corona textures around olivine are commonly developed, and the rock can be closely compared with samples 64155034, 5, and 6 from Alligator Swamp, near Bowen.

Olivine is typically anhedral, and unusually fresh, but some grains are partially serpentinized. Rims consist of pale green hornblende, which may itself be chloritized; and colourless augite. The latter may contain, when present as discrete material, rims and inclusions of similarly orientated amphibole. Minor hypersthene is present associated with other pyriboles and has a very pale pleochroism. Plagioclase feldspar, forming over 50 per cent of the rock, is very fresh, and shows extensive albite twinning. Spinel is associated with opaques, but also occurs as free inclusions in plagioclase.

B.M.R.

B.M.R. Reg. No. 64150020 Hornblende-augite norite (Moosie Hill, near Guthalungra)

The grain-sizes range between 0.1 and 3.0 mm.. Plagioclase (An_{60-65}) forms randomly oriented tabular crystals. Prismatic to granular hypersthene and augite occur as aggregates of grains. Pale-green hornblende partly replaces and forms rims around pyroxene. Some microfracturing of crystals may be seen.

B.M.R. Reg. No. 64150150 Hornblende-hypersthene gabbro, and dolerite (Moosie Hill)

The specimen consists of two rock-types; a coarse-grained gabbro cut by a fine-grained dolerite. The gabbro is porphyritic, the phenocrysts range up to 7 mm. long, and consist of plagioclase; these have a calcic core ($An_{90?}$) sharply zoned to a margin of An_{65}. In the groundmass tabular plagioclase forms crystals 0.4 by 0.8 mm.. Augite and hypersthene form granular to prismatic crystals occurring in aggregates. The pyroxene is slightly altered to smectite, and has overgrowths of primary pale-green hornblende. Iron oxide is interstitial.

The dolerite consists of granular to tabular plagioclase, granular augite and hypersthene, and pale-green hornblende. Iron oxide is present. The average grain-size is 0.13 mm..

Both rocks are cut by a chlorite vein.

B.M.R. Reg. No. 64150154 Hypersthene-hornblende gabbro (Moosie Hill)

Randomly oriented granular to tabular plagioclase (An_{80} zoned to labradorite) measures 0.2 by 0.4 mm.. Augite and hypersthene are prismatic to granular, and in places are partly replaced by pale green actinolite. Brown hornblende is prismatic to interstitial.

B.M.R. Reg. No. 64150129 Uralitised gabbro (S.W. foothills of Mount Luce)

The rock is coarse but inequigranular. Randomly oriented tabular plagioclase (An_{88}) is slightly microfractured; the crystals are between 0.5 and 1.3 mm. long. Fibro-prismatic actinolite may represent pseudomorphed pyroxene. Iron oxide is interstitial.

B.M.R. Reg. No. 64150140 Uralitised anorthite gabbro (Small hill on coast, N.E. of Mount Luce).

Flow-oriented plagioclase laths (An_{95}), 0.15 to 3.5 mm. long, show slight microfracturing. Prismatic pyroxene is pseudomorphed by actinolite; the crystals are about 0.4 mm. long. Anhedral, apparently interstitial iron oxide is present. Hornblende forms large poikilitic crystals up to 3 mm. long.

B.M.R. Reg. No. 64150112 Sericite-quartz-alkali feldspar hornfels
(Large xenolith in gabbro)
(Small hill on coast, N.E. of Mount Luce)

The rock is very inequigranular and xenoblastic. It contains quartz, commonly intergrown with alkali feldspar; some sodic plagioclase is present. Lineated sericite forms less than 5% of the rock. A few elongated clusters of quartz grains may represent sheared phenocrysts; the elongation of the clusters is parallel to the mica lineation. The rock was possibly an acid porphyry that was sheared and later hornfelsed.

B.M.R. Reg. No. 64150125 Hornblende-biotite tonalite.
(Bed of Elliot River, Guthalungra)

The rock is inequigranular, the grainsizes ranging from 0.3 to 3 mm.. The plagioclase (50%) is An_{45}, and forms tabular to granular crystals; it is slightly sericitised. Quartz (20%) is anhedral. Anhedral poikilitic brown biotite (20%) and green hornblende (10%) are present. Both are slightly altered to chlorite and epidote.

B.M.R. Reg. No. 64150121 Biotite-hornblende-andesine hornfels (Xenolith in No. 64150125) (Bed of Elliot River, Guthalungra).

The rock is inequigranular, the grainsizes ranging between 0.1 and 1.8 mm.. The plagioclase (50%) is An_{40}, and forms granoblastic to tabular grains, some of which are moderately sericitised. Poikiloblastic green hornblende (30%) and very small amounts of slightly chloritised biotite are also present. Iron oxide grains are anhedral.

B.M.R. Reg. No. 64150141 Spinel-bearing "uralitzed" diallagite.
(Camp Island, Abbot Bay)

The grain-sizes range between 0.18 and 2 mm.. Over 90% of the rock consists of fibrous to prismatic (?) richterite and subordinate diallage. The (?) richterite is pleochroic from colourless to pale green and pale blue, and has been formed by replacement of diallage. Numerous fractured crystals of green spinel, and some zoisite and calcite are present. The small amount of plagioclase that occurs forms anhedral grains, and appears to be bytownite.

Urannah Complex
(2) Granitic Phase (C - Mg)

A.M.D.L.

B.M.R. Reg. No. 64155027 (North-eastern spur of Mount Roundback)

This is a coarse hornblende biotite adamellite, with potash feldspar dominant over oligoclase. The potash feldspar is up to 4.0 mm. diameter and is associated mostly with semi-euhedral quartz; the latter tending to occur in even-grained clusters, giving a typical igneous texture. The mafics, hornblende and biotite, are generally altering to sphene and chlorite, in cumulophyric groups, associated with apatite, opaques, and zircon. Allanite/clinozoisite is again a feature of this suite, with the pleochroic scheme of the allanite being yellow-brown to orange-brown.

B.M.R. Reg. No. 64155026 (North-eastern spur of Mount Roundback)

This is a biotite adamellite with a normal mineral suite, oligoclase, K feldspar, quartz, and biotite. The plagioclase may be extensively replaced by K feldspar, which is usually perthitic. The plagioclase laths are variably altered to sericite and saussurite, and attain a maximum dimension of 3.0 x 2.0 mm.. Biotite always ragged, is associated with numerous minute opaque grains (maximum 0.1 mm.), and alters to chlorite and sphene. Primary sphene, up to 0.5 mm. diameter, occurs with fresh mica.

B.M.R. Reg. No. 64155028 (North-eastern spur of Mount Roundback)

This is a xenolith-bearing granite. The xenolith or schlieren consists of a microgneissic hornblende-quartz-?feldspar assemblage, with yellow-green amphibole crystals, 0.005 x 0.015 mm., having a pronounced orientation, parallel to the longer dimension of the xenolith. Quartz, rarely exceeding 0.005 mm., occurs in an evengrained granular mosaic. Adjacent to the inclusion, 'porphyroblastic' hornblende has grown, and is now partly chloritised. Mafic clusters in the granite are rich in green amphibole, euhedral opaques, apatites measuring 0.25 x 0.03 mm., and spongy sphene. 'Lenses' consisting entirely of quartz associated with the schlieren, are probably recrystallized xenoliths. Much of the adjacent granite contains prolific amounts of fine grained xenolithic material, not completely taken up by the magma. Allanite is present in the granite proper.

There is little evidence of a basic igneous origin for this schlieren, even allowing for assimilative processes.

B.M.R. Reg. No. 64155037

(2.5 miles E.N.E. of Salisbury Plains Homestead)

This is a biotite hornblende adamellite with a normal hypidiomorphic inequigranular texture. Strongly zoned oligoclase (plagioclase 4.0 x 2.0 mm.), allotriomorphic perthite, and anhedral quartz constitute over 90% of the rock volume. Biotite with a yellow to red-brown pleochroism is the main mafic and is very fresh with unusually few inclusions. There is a limited amount of green amphibole, now mostly chloritised. The usual mafic clusters include large anhedral sphenes, apatite, zircon, and opaques (0.2 mm), together with some deep red brown allanite.

B.M.R. Reg. No. 64155040 (Mount Carew)

This is a biotite leucogranite, bearing a strong resemblance to No. 64155008 (P-Mg, Edgecumbe Heights). It has a smaller grainsize, e.g., quartz averages about 1.0 mm. diameter. Biotite forms 1-2% of the rock and has a rather pale pleochroism. Contacts between plagioclase and orthoclase contain the usual albite rims.

B.M.R.

B.M.R. Reg. No. 64150143 Biotite adamellite. (Immediately N. of The Cape Homestead)

The rock is coarse and inequigranular, the grainsizes ranging from 0.8mm. to phenocrysts 6.3 mm. long. Feldspar shows some microfracturing which is now partly healed. Quartz (35%) is recrystallized. Plagioclase (30%) forms tabular crystals that are zoned from An_{40} to oligoclase. Perthite (30%) is tabular. Biotite (5%) forms aggregates of fine flakes. The feldspars are slightly altered to sericite and kaolin.

B.M.R. Reg. No. 64150118 Biotite tonalite. (One mile W.S.W. of The Cape Homestead)

The grainsizes range from 0.5 to 2.0 mm.. Plagioclase (50%) - oligoclase to andesine - occurs as sub-tabular crystals. Quartz (30%) forms anhedral, strained, and granulated (and, in places, recrystallized) grains. Microcline (5%) is interstitial to poikilitic. Biotite (15%) forms clots of fine grains, these may perhaps be the result of recrystallization. Microfracturing is present in some plagioclase.

B.M.R. Reg. No. 64150109 Biotite leucoadamellite. (2 miles W.N.W. of The Cape Homestead)

The rock contains tabular, slightly to moderately kaolinised oligoclase (40%), tabular, moderately kaolinised perthite (25%), poikilitic quartz (35%), and tabular, slightly chloritised biotite.

B.M.R. Reg. No. 64150123 Biotite leucoadammelite. (Hill on coast 4 miles W.S.W. of The Cape Homestead)

The rock contains anhedral, moderately strained quartz (35%); poikilitic microcline-perthite (35%) tabular, slightly sericitised andesine (30%); and a few flakes of biotite.

B.M.R. Reg. No. 64150127 Aplitic biotite granite. (S.E. slopes of Mount Curlewis)

The rock is very inequigranular. Quartz forms xenoblastic grains 0.3 mm. across, occurring as aggregates that have a diameter of about 1 mm.. Sodic plagioclase is roughly tabular; some relict grains show microfractures. However, much is recrystallised, or partly so, to aggregates of fine grains. Microcline is similar in habit to plagioclase. Biotite is recrystallised, and forms strings of small flakes; some muscovite is associated with it. Iron oxide is octahedral.

B.M.R. Reg. No. 64150137 Biotite-hornblende alkali granite-aplite. (The Maiden Mountain)

The rock is inequigranular, the grainsizes ranging between 0.1 and 1 mm; one or two phenocrysts that are present range up to 2 mm. across. The texture is xenomorphic. The rock consists mostly of albite, potash feldspar, and quartz; small amounts of green hornblende and chloritised biotite are present. The hornblende forms very poikilitic grains. Iron oxide and sphene are also present.

B.M.R. Reg. No. 64150122 Aplitic hornblende-biotite-granite.
(Western end of The Seven Sisters)

The rock is inequigranular, the grainsizes ranging between 0,1 and 1.5 mm. It contains quartz, oligoclase, poikilitic microcline, and small amounts of biotite, hornblende, pyrrhotite, and epidote. A few phenocrysts of plagioclase are also present.

B.M.R. Reg. No. 64150144 Intrusive quartz-hornblende latite-porphyry
(3.5 miles N.E. of Salisbury Plains Homestead)

The rock is porphyritic, phenocrysts ranging up to 1.3 mm. long. The phenocrysts consist of tabular, oscillatorily-zoned andesine and pale brownish-green hornblende that is zoned to green on the crystal margins. The groundmass has a grain-size of 0.1 mm.. It consists of tabular plagioclase, anhedral alkali feldspar, interstitial quartz, and prismatic, partly chloritised hornblende. Iron oxide and sphene are present. Quartz forms less than 10% of the rock. Plagioclase and alkali feldspar are present in roughly equal quantities. Hornblende forms 5-10% of the rock.

Permian to Mesozoic Volcanics (P-Mv)

B.M.R.
B.M.R. Reg. No. 64150146 Albite-potash feldspar-quartz hornfels
(Nares Rock)

Angular to subangular grains of quartz, and somewhat poikiloblastic albite, range between 0.05 and 0.4 mm.. These grains form about 10 to 20% of the rock, and give the impression that the rock is a metamorphosed sediment. The grains are enclosed in a matrix composed of quartz and alkali feldspar; these minerals form curious poikiloblastic intergrowths, a texture which I have never seen before. The texture is as though quartz and feldspar, originally in granophyric intergrowth, had been metamorphosed. But for the grains of sedimentary appearance mentioned above, I would have been tempted to say that this rock was origianlly igneous.

B.M.R. Reg. No. 64150142 Albite-quartz-potash feldspar hornfels
(Nares Rock)

This rock is like No. 64150146, except that the grains of sedimentary appearance are not present. However, a few thin bands of subidioblastic quartz, albite, and potash feldspar are present.

Permian to Mesozoic Dioritic Rocks (P-Mi)

B.M.R.

B.M.R. Reg. No. 64150120 Leucocratic hornblende gabbro (S.E. end of Holbourne Island)

The grain-sizes range from 0.8 mm. to 2.5 mm.. A few plagioclase phenocrysts measure 5 mm. long. Plagioclase (An_{65-70} zoned to An_{30}) forms randomly oriented tabular crystals; some show oscillatory zoning. Prismatic green hornblende encloses small amounts of augite. Iron oxide is octahedral. Some interstitial intergrown quartz and alkali feldspar are present. Sphene and apatite were observed.

B.M.R. Reg. No. 64150119 Augite-hornblende diorite (S.E. end of Holbourne Island)

The rock is fairly similar to No. 64150120, but the plagioclase is rather less calcic.

B.M.R. Reg. No. 64150101 Hornblende diorite with microdiorite (S.E. end of Holbourne Island)

Two rock-types are present. The coarser-grained type is fairly similar to those seen in Nos. 64150120 and 64150110. Feldspar is, however, somewhat altered. The other rock-type is rather finer-grained. Plagioclase forms lean laths, apparently radially arranged in some places. The amphibole (brown hornblende) forms extremely poikilitic crystals.

B.M.R. Reg. No. 64150158 Quartz-hornblende diorite. (N.E. tip of Cape Upstart peninsula)

The rock is coarse but inequigranular, the grainsizes ranging from 0.1 to 2.5 mm.. Tabular plagioclase crystals are randomly oriented, and are slightly sericitised. They are zoned, and their average composition is that of andesine. A few somewhat kaolinised potash feldspar grains are tabular to interstitial; the potash feldspar tends to be graphically intergrown with quartz. Olive-green hornblende is prismatic, and iron oxide is octahedral.

Plagioclase 70 percent, hornblende 20 percent, potash feldspar 5 percent, quartz 5 percent.

B.M.R. Reg. No. 64150102 Biotite-hornblende-quartz diorite
(N.E. tip of Cape Upstart peninsula)

The rock contains tabular plagioclase (75 percent), zoned from An_{46} to An_{10}; it is slightly sericitised, and the crystals measure about 0.5 by 1.3 mm.. Interstitial quartz (10 percent) is sometimes graphically intergrown with very small amounts of alkali feldspar. Biotite (5%) forms brown flakes and pale green hornblende (10%) is prismatic. Some sphene and iron oxide are present.

B.M.R. Reg. No. 64150139 Biotite-hornblende diorite
(N.E. tip of Cape Upstart peninsula)

The rock is porphyritic, the few plagioclase phenocrysts ranging up to 3 mm. long. In the groundmass the randomly oriented plagioclase crystals measure 0.6 by 0.3 mm., and are strongly zoned from An_{65} to An_{38}. Pale-green to greenish-brown hornblende is partly replaced by biotite; the hornblende is interstitial to, and partly encloses, plagioclase. Some hornblende encloses relict irregularly shaped clinopyroxene crystals.

B.M.R. Reg. No. 64150124 Augite-biotite-hornblende diorite
(S.E. side of Cape Upstart peninsula)

The few phenocrysts of plagioclase range up to 5 mm. long. The groundmass is rather inequigranular, the grainsizes ranging between 0.3 and 2.5 mm. Plagioclase (75 percent) is andesine, and forms tabular crystals with subrounded corners. Quartz (5%) and alkali feldspar (5%) are interstitial. Augite is prismatic and is partly altered to actinolitic hornblende. Other crystals of actinolitic hornblende present in the rock may also be the result of alteration of augite. The amphibole is partly altered to biotite. Iron oxide is octahedral, and apatite is acicular. Ferromagnesian minerals form 15% of the rock.

B.M.R. Reg. No. 64150147 Biotite-hornblende microdiorite
(S.E. side of Cape Upstart peninsula)

The rock is porphyritic, the phenocrysts ranging up to 1.5 mm.. The groundmass has an average grainsize of 0.3 mm.. Randomly oriented, ovoid to tabular, slightly sericitised crystals of plagioclase (An_{40}) are zoned. Subhedral to poikilitic olive-green hornblende grains are partly altered to smectite and biotite. Iron oxide is octahedral to anhedral. Some apatite needles are present.

Permian to Mesozoic Granitic Bodies (P-Mg)

B.M.R.

B.M.R. Reg. No. 64150148 Sheared granophyre.
(N.E. coast of Holbourne Island)

The rock is porphyritic, the phenocrysts ranging up to 1.5 mm. across. They consist mostly of somewhat kaolinised albite, together with small amounts of potash feldspar and some quartz. The phenocrysts are abundant, forming about 50% of the rock. The groundmass consists mainly of granophyrically intergrown quartz and alkali feldspar; some chloritised biotite is present. The whole rock is strongly sheared.

B.M.R. Reg. No. 64150136 Hornblende-quartz alkali syenite
(Central Holbourne Island, north-eastern coast)

Tabular albite measures between 0.4 and 2.5 mm. long, and is randomly oriented. Brownish-green hornblende is prismatic and slightly altered to chlorite. Some interstitial, granophyrically intergrown quartz and alkali feldspar form 10 to 15% of the rock. Iron oxide and leucoxene are present.

B.M.R. Reg. No. 64150143 Intrusive biotite alkali rhyolite-porphyry
(Middle Island)

The rock is seriate porphyritic, the phenocrysts ranging in size from that of the groundmass up to 3.5 mm. in diameter. The phenocrysts consist of rounded quartz, tabular, slightly to moderately kaolinised perthite, slightly sericitised and kaolinised albite, and a few flakes of chloritised biotite. The average grainsize of the groundmass is 0.05 mm.. It consists of granular quartz and potash feldspar, some tabular albite, and a few flakes of chloritised biotite.

B.M.R. Reg. No. 64150131 Hornblende-biotite adamellite.
(2 miles N.N.E. of The Cape Homestead)

The grainsizes range between 0.25 and 3 mm.. The rock consists of tabular, slightly to moderately kaolinised potash feldspar (30%), sub-tabular oligoclase-andesine (40%), anhedral, somewhat strained quartz (30%), flakes of biotite, subhedral hornblende, and iron oxide.

B.M.R. Reg. No. 64150155 Chloritised biotite adamellite.
(1.5 miles east of Cape Upstart)

The rock consists of tabular to anhedral perthite (35%), tabular oligoclase (25%), and anhedral, apparently recrystallised quartz (40%), The small amount of biotite present is partly replaced by chlorite and epidote. The biotite is flexed, and the plagioclase shows some micro-fractures.

A.M.D.L.
B.M.R. Reg. No. 64155008 (Edgecumbe Heights)

This is a biotite leucogranite, containing about 40% perthite, 40% quartz, 15-20% plagioclase, and 2% biotite. The perthite has an average grain size of 1.5 mm. and is often intergrown with quartz. Plagioclase, of albitic composition, is quite fresh. Biotite has a yellow-brown to deep brown, almost opaque pleochroism, and forms ragged flakes associated with opaques. Zircon, often metamict, is an accessory.

Dykes

A.M.D.L.
B.M.R. Reg. No. 64155067 An altered quartz hornblende microdiorite
(The Rocks)

Phenocrysts of amphibole and plagioclase in the rock are now mostly gone to secondary minerals. The plagioclase euhedrons, rectangular side section to square basal sections, are pseudomorphed by the usual sericite/zoisite assemblage, and are usually about 1.0 mm. in length. The green hornblende phenocrysts may have fresh rims, and anomalously coloured chlorite and epidote cores. The nonphenocryst material is fresher, and also euhedral, particularly the amphibole, whose pleochroism is, α pale yellow, β yellow brown, γ green. Quartz is common interstitially, and may be over 10 per cent of the rock.

Angular sphene is a common accessory, up to 0.3 mm. diameter. Patches of finer grained ?granitic material, 0.3 to 0.4 mm. grain size, consist of fresh green acicular hornblende set in a quartzofeldspathic matrix. These areas may represent some recrystallization.

B.M.R. Reg. No. 64155071 An epidotised microgranodiorite (The Rocks)

This is a completely altered rock, probably once closely comparable with 64155067 now consisting of secondary epidote (dominant) pseudomorphing feldspar (plagioclase) and amphibole, with 10 to 20 percent interstitial quartz of 0.1 to 0.3 mm. grain-size. The texture is xenomorphic granular. In places remnant plagioclase has resisted saussuritization, while fibrous pale green actinolite occurs in the amphibole pseudomorphs. Sphene is present as late crystals, possibly primary.

B.M.R. Reg. No. 64155069 An altered microdiorite (The Rocks)

The only recognisable primary mineral in this rock is plagioclase (?andesine), as laths measuring 0.4 by 0.6 mm; these are partly saussuritized. These laths form about 30 to 40 per cent of the rock, with a random orientation, giving a doleritic texture. Secondary material, mainly chlorite, epidote and calcite with some sphene comprise the rest of the rock, apart from very minor interstitial quartz.

Calcite is particularly prominent, often in large (0.5 mm) shapeless crystals. Xenocrysts of quartz, up to 1.2 mm diameter, are sparsely distributed with narrow reaction rims of epidote.

B.M.R. Reg. No. 64155073 A hornblende meladiorite (The Rocks)

Hornblende and calcic andesine are the major constituents, with the former in the ascendancy by three to one. The hornblende crystals vary in dimension from 0.2 by 0.005 mm. to 0.5 by 0.3 mm.. The plagioclase laths, whose composition borders on An_{50}, are usually 0.1 by 0.05 mm.; most are fresh but sericitization has occurred. Opaque aggregates are common in the amphibolitic regions. The hornblende has a patchy pleochroism, brown to yellow-green , while the actinolitic alteration product is pale blue-green, and the opaques are associated preferentially with the latter.

B.M.R. Reg. No. 64155057 An augite dolerite (On the road, one mile south of The Rocks)

This contains the normal augite-labradorite-opaque assemblage, developing a typical xenomorphic granular texture. The pyroxene, pale green in colour, frequently has rims of yellow-brown to brown hornblende, often growing in optical continuity. Labradorite (An_{38}) laths, mostly fresh, and well twinned, average 0.3 by 0.1 mm.. Microlites of plagioclase are sometimes included ophitically in the clinopyroxenes. Hornblende also forms discrete grains. Ragged opaques form about five per cent of the dolerite,

while sphene is a not uncommon secondary product of chloritised pyroxene.

B.M.R. Reg. No. 64155055 An altered porphyritic ?andesite (On the road, one mile south of The Rocks)

This rock contains phenocrysts of cloudy plagioclase (1.0 x 0.3 mm) and xenocrysts of quartz with reaction rims of epidote. The groundmass consits of altered plagioclase microlites (0.06 x 0.02 mm.) and chlorite, probably after an amphibole. Carbonate is also present as a secondary mineral.

B.M.R. Reg. No. 64155083 A hornblende microdolerite (8 miles south of Inkerman Homestead)

This rock consists of roughly 25 per cent hornblende and 70 per plagioclase, allowing for the various alteration products. The plagioclase (labradorite, An_{64}) forms laths, typically 0.15 by 0.05 mm., mostly fresh and semiinterpenetrant with the amphibole, giving a typical doleritic texture. Greenish-brown hornblende crystals, semi-euhedral, vary from 0.8 by 0.15 mm. to 0.3 by 0.08 mm. The amphibole may be extensively altered in its core to carbonate, chlorite, zoisite and opaque grains, with some resultant secondary silica. Quartz also occurs sporadically as a primary mineral. Carbonate and sericite are also secondary products of plagioclase.
Field Geologist's Note: This specimen was collected from a dyke which forms a bar in the "earth lime" deposit, (see section on Cainozoic "Earth Lime").

B.M.R. Reg. No. 64155093 A porphyritic microgranite (About 3 miles east of Rangemore Homestead)

Quartz phenocrysts, 0.3 to 0.5 mm., are predominant in this specimen. Some are euhedral but most are rounded and embayed due to corrosion. Apart from rare plagioclase phenocrysts, the coarse, vaguely crystalline groundmass, (quartzo-feldspathic) forms about 90 per cent of the rock, with a grain size range of 0.06 to 0.1 mm.. A small amount of epidote and ragged opaques are the only mafic representatives. The extensive potash feldspar in the groundmass and the lack of plagioclase phenocrysts suggest this rock is best named a granite rather than an adamellite.

B.M.R. Reg. No. 64155100 An altered quartz trachyandesite
(About 2 miles east of Rangemore Homestead)

This rock is difficult to classify because of its fine-grained nature and altered state. Plagioclase phenocrysts (1.0 x 0.4 mm.) partly altered to epidote, carbonate and sericite, are set in a groundmass of plagioclase microlites (0.1 x 0.03 mm.) showing some degree of orientation, and interstitial quartz with secondary epidote and chlorite, plus leucoxenized opaques. Potash feldspar was identified by staining techniques.

Lacking a determination of the plagioclase composition, this specimen is assigned to the intermediate group, neither trachyte nor andesite. The parallelism of the microlites due to flow is typical of trachytes.

B.M.R. Reg. No. 64155101 A sodic-potassic porphyritic rhyolite
(About two miles east of Rangemore Homestead)

This rock contains numerous albite phenocrysts, averaging 0.8 by 0.5 mm., set in a quartzofeldspathic groundmass, of granular texture (0.03 mm.). Quartz comprises about 50 per cent of the matrix, with potash feldspar and albite. Alteration of mafic minerals is extensive, with chlorite, sericite, epidote and clinozoisite the secondary products. Apatite and opaques are common accessories. The former is consistently about 0.15 by 0.05 mm, while the latter occurs in groups associated with the mafic alteration products. Rare zircon crystals are usually elongate, 0.2 by 0.03 mm..

B.M.R. Reg. No. 64155091 A porphyritic rhyodacite
(About 3 miles east of Rangemore Homestead)

This rock is closely comparable with specimens 64155088 and 64155089 (p. 20). The quartz phenocrysts are again resorbed, and the texture and appearance of the adjacent groundmass suggests that the phenocrysts were corroded in their present position, i.e. when movement of magma had ceased and it was in a semi-solid state.

B.M.R. Reg. No. 64155102 An altered porphyritic rhyodacite
(About 4 miles north-east of Rangemore Homestead)

All phenocrysts in this fine-grained volcanic are completely altered. The secondary products (carbonate, epidote, quartz) pseudomorph plagioclase phenocrysts, whose external form is well preserved, while the assemblage chlorite-sphene is after biotite. The groundmass consists of dominant plagioclase microlites (0.05 x 0.006 mm.) interspersed with interstitial quartz and potash feldspar. Epidote aggregates are also scattered through the matrix.

B.M.R. Reg. No. 64155103 An altered quartz microdiorite
(About 6 miles north of Rangemore Homestead)

This strongly altered rock consists mostly of secondary minerals, with interstitial quartz, and some potash feldspar. The major constituents were originally plagioclase (now saussurite) and hornblende, (now chlorite and opaques). Carbonate is also present in extensive 'porphyroblasts' (0.5 mm.) Opaques are plentiful (more than five percent) as grains and rods in the groundmass, some of which may be ilmenite.

B.M.R. Reg. No. 64155052 A porphyritic hornblende andesite
(In a quarry at northern end of Stokes Range)

The rock consists essentially of plagioclase and hornblende with numerous quartz xenocrysts. It is rather rich in green hornblende and opaques, the former is frequently part chlorite. Both essential constituents may be phenocrysts, but plagioclase (andesine) occurs mostly as microlites. The hornblende macrocrystals vary from 1.1 by 0.3 mm. to 2.0 by 0.1 mm., but some patches appear to be secondary actinolite with a chlorite rim, and rare carbonate in the core. The quartz xenocrysts are usually about 0.3 mm diameter, and have reaction rims of amphibole.

B.M.R. Reg. No. 64155053 A porphyritic basalt (In a quarry at northern end of Stokes Range)

This rock consists of essential plagioclase (labradorite), and augite. Phenocrysts of plagioclase typically measure 2.0 by 1.2 mm. whilst the often perfectly euhedral, more stumpy, pyroxene has maximum dimensions of 2.0 by 1.5 mm.. About 50 per cent of the rock is altered, the augite to carbonate and uralite, and the feldspar to chlorite and epidote. The groundmass feldspar microlites are much more altered than their macro counterparts. Some

plagioclase alters to a brownish low refractive index material, possibly one of the smectite group. Yellow to red-brown biotite flakes are present in the groundmass.

B.M.R. Reg. No. 64155060 A porphyritic hornblende microdiorite
(In Stokes Range, about one mile west of Leichhardt Downs Homestead)

Phenocrysts of andesitic plagioclase are in excess of green hornblende macrocrystals; The latter have a maximum size of 3.0 by 0.5 mm. The amphibole is never completely fresh, chlorite and carbonate constitute the usual secondary products, while zoisite and sericite are the end product of plagioclase alteration. The groundmass material comprises microlites of basic andesine (0.5 by 0.1 mm.) euhedral amphibole, and rhombic to cuboidal opaques, particularly as secondary products associated with chlorite.

Sphene is a particularly common 'accessory', possibly forming several per cent of the rock, and its allotriomorphic habit particularly with regard to plagioclase laths, shows it to have a late crystallization history in this magma. Quartz is present interstitially.

B.M.R. Reg. No. 64155061 An altered porphyritic microdiorite
(In Stokes Range, about $\frac{3}{4}$ mile north-west of Leichhardt Downs Homestead)

The phenocrysts are of andesine (1.2 x 0.8 mm. and only occasionaly are crystals fresh enough for compositional determination. Normally epidote-zoisite-sericite assemblages pseudomorph the feldspar. The groundmass consists of cloudy plagioclase, interstitial quartz, opaques, with the usual secondary minerals including carbonate. The accessories are sphene and red-brown allanite.

B.M.R. Reg. No. 64155038 (One mile E.N.E. of Salisbury Plains Homestead)

This is a quartz-rich microdiorite or a microtonalite. It has a typically basic (xenomorphic granular) texture, and consists primarily of andesitic plagioclase laths (0.5 x 0.2 mm.) interspersed with secondary chlorite, and epidote, some after feldspar, others secondary to a mafic mineral, probably amphibole, judging by pseudomorphs. Quartz occurs interstitially, and staining suggests that K-feldspar is not uncommon, which would place the rock more in the granodiorite group. Opaques are the main accessory.

B.M.R. Reg. No. 64155041 (N.E. foothills of Major Creek Mountain)

This is an altered pyroxene microdiorite, containing occasional vesicles full of zeolites. Plagioclase (0.1 x 0.03 mm.) forms elongate laths, with a composition in the oligoclase-andesine range; it is considerably less altered than the mafic constituent, clinopyroxene. This has mostly gone to epidote and secondary quartz. Rare phenocrysts of augite measure 1.2 x 0.8 mm.. The vesicles, up to 2.0 mm. in diameter, contain zeolites (? thomsonite), carbonate and sericite.

B.M.R. Reg. No. 64155044 (Quarry just north of The Rocks)

This is a partially amphibolitized augite dolerite. The rock has a normal doleritic texture and is evengrained, apart from a few phenocrysts of plagioclase (2.5 x 1.5 mm). The plagioclase, of basic labradorite composition, is fairly fresh with laths typically 0.25 x 0.08 mm.; secondary minerals are epidote and carbonate. The pyroxene, probably from its pinkish colour and optics, titanugite, is often changing to a fibrous amphibole, usually pale brown, but sometimes zoned with a yellow core and a green rim. Brown hornblende (?barkevikite) also forms discrete magmatic crystals. Spongy opaque material forms about 5% of the dolerite.

B.M.R.
B.M.R. Reg. No. 64150162 Kaolinised, saussuritised, chloritised, (?) albitised, quartz-hornblende microdiorite
(Southern slopes of Mount Luce)

Tabular, strongly kaolinised, and in places saussuritised (?) albite crystals are randomly oriented. Hornblende forms prismatic crystals that are almost entirely chloritized. Iron oxide is octahedral, apatite is acicular, and sphene is anhedral. Some potash feldspar may be present; if so, it is hard to identify because of alteration. The few phenocrysts present measure up to 3 mm. long. The groundmass has an average grainsize of 0.5 mm..

B.M.R. Reg. No. 64150156 Sericitised hornblende alkali microsyenite
(1.5 miles east of Cape Upstart)

A better name for this rock may be "albitised hornblende microdiorite". It consists of randomly oriented plagioclase (albite) laths, 0.2 to 0.5 mm. long, and acicular greenish-brown hornblende, together with accessory octahedral iron oxide and acicular apatite. Interstitial chlorite is present.

B.M.R. Reg. No. 64150110 Intrusive porphyritic felsite
(1.5 miles east of Cape Upstart)

The phenocrysts range between 0.3 and 0.8 mm. in length, and consist of tabular, somewhat sericitised crystals of andesine. They are enclosed in a fine-grained, indistinctly flow-banded felsitic groundmass.

B.M.R. Reg. No. 64150105 Intrusive rhyolite
(N.E. coast of Cape Upstart peninsula)

The rock is seriate porphyritic, the phenocrysts ranging up to 1.5 mm. diameter. They consist of tabular plagioclase (oligoclase-andesine) and potash feldspar, together with embayed quartz and epidotised (?) hornblende. The feldspars are moderately kaolinised.

The groundmass contains alkali feldspar laths 0.08 mm. long, together with interstitial quartz and a few tabular crystals of plagioclase. Granular epidote and acicular apatite are also present.

B.M.R. Reg. No. 64150008 Biotite-hornblende microtonalite-porphyry
(4 miles W.N.W. of The Cape Homestead)

The rock is very strongly porphyritic, more than 60% of it consisting of phenocrysts, which range up to 5 mm. long. The phenocrysts consist of tabular, somewhat saussuritised plagioclase; these have large calcic cores of An_{80}, zoned sharply to margins of An_{55-60}. Some micro-fracturing is evident. The average groundmass grainsize is 0.3 mm. Tabular plagioclase shows strong zoning from labradorite to andesine; quartz is interstitial. The ferromagnesian minerals consist of fibro-prismatic hornblende, flakes of brown biotite, and granular epidote.

Quartz 15%, plagioclase 65%, hornblende and biotite each 10%.

B.M.R. Reg. No. 64150114 Albitised, sericitised, quartz-actinolite microdiorite. (Mount Carew)

Randomly oriented, moderately sericitised plagioclase (albite) laths measure about 0.8 by 0.2 mm.. Actinolite forms fibro-prismatic crystals. Small amounts of interstitial quartz are present. Iron oxide is anhedral.

B.M.R. Reg. No. 64150103 Albitised dolerite (S.E. end of Holbourne Island)

The rock is sparsely porphyritic; the phenocrysts range up to 1.5 mm. across, and consist of strongly saussuritised plagioclase and some augite. The groundmass contains randomly oriented laths of plagioclase measuring 0.2 by 0.05 mm., together with pale-green augite, granular epidote, interstitial chlorite, and small amounts of interstitial quartz. Octahedral iron oxide and tabular (?) ilmenite are present. I think that the albite results from the alteration of more calcic plagioclase; the epidote is probably a by-product of the reaction.

B.M.R. Reg. No. 64150107 Sericitised, intrusive, alkali rhyolite-porphyry (Middle Island)

The rock is porphyritic, the phenocrysts ranging between 0.3 and 4 mm.. They consist of strongly sericitised albite, quartz, muscovite, and smectite (after biotite). The average grainsize of the groundmass is 0.05 mm.; it consists of quartz, alkali feldspar, muscovite, and chlorite.

AUSTRALIA 1:250,000

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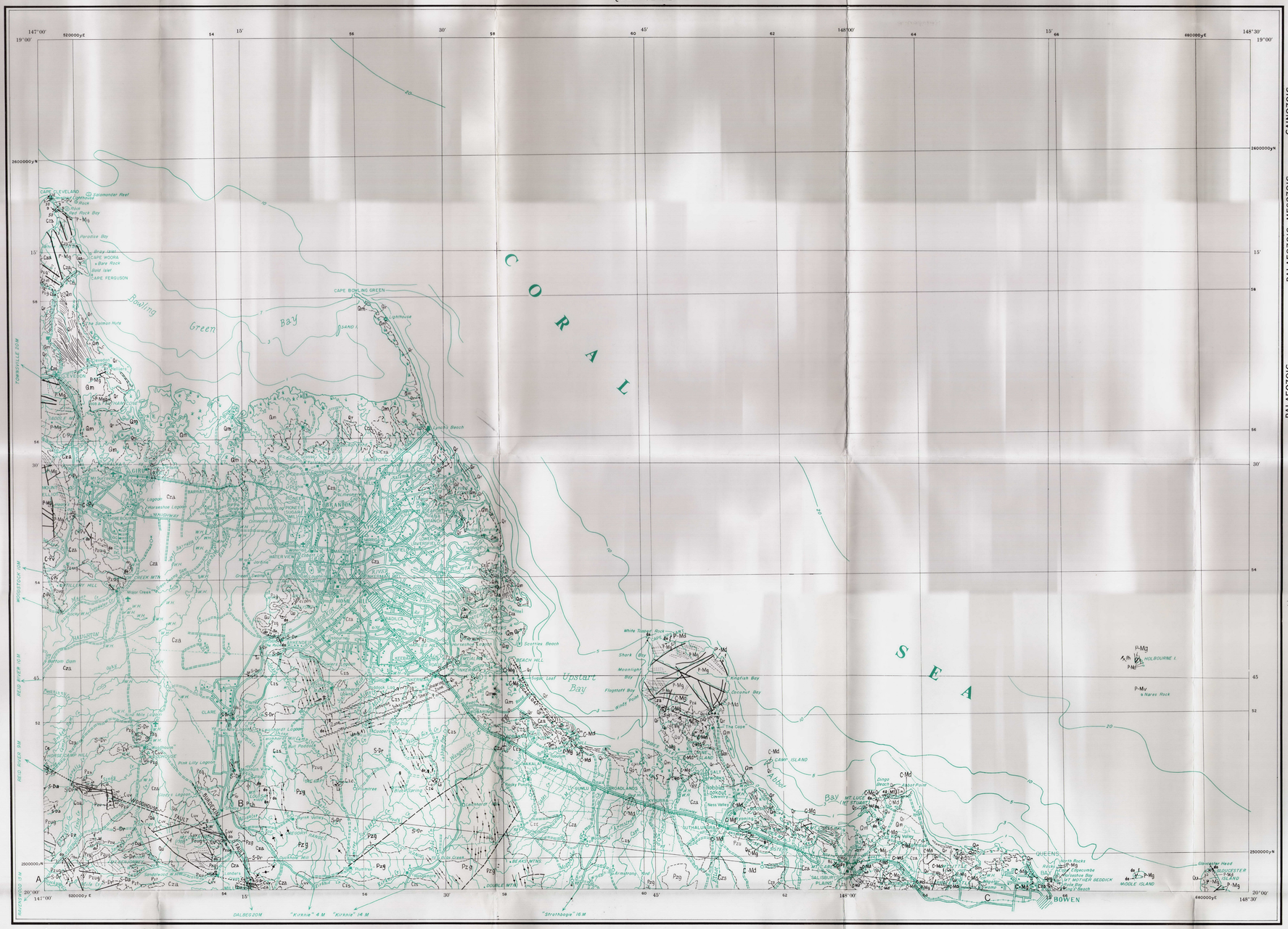
QUEENSLAND

1:250,000 GEOLOGICAL SERIES SHEET SE 55-15

PRELIMINARY EDITION, 1966

SUBJECT TO AMENDMENT



Reference

CAINOZOIC	QUATERNARY	Qm	Coastal mud flats
		Qr	Coastal sand dunes
		Qu	Outwash and talus
		Cza	Alluvial and deltaic deposits
		Czs	Colluvial and residual soil, sand, and rubble; some semi-consolidated material
		Czc	Earth Lime
PALAEOZOIC–MESOZOIC	PERMIAN TO MESOZOIC	P-Mg	Epizonal leucocratic adamellite and granite, minor granophyre, syenite, rhyolite-porphyry, rare diorite and gabbro
		P-Md	Diorite, microdiorite, gabbro
		P-Mv	Hornfelsed tuff (Nares Rock)
	CARBONIFEROUS TO MESOZOIC — Urannah Complex	C-Mg	Leucocratic adamellite and granite, tonalite; locally sheared
		C-Md	Diorite, gabbro, norite, tonalite, dolerite, microdiorite; minor petrnite
PALAEOZOIC		Pzug	Granite, microgranite, adamellite
		Pzh	Rhyolite, trachyte, trachyandesite
	CARBONIFEROUS TO PERMIAN	C-Pv	Intermediate lavas and pyroclastics, minor acid volcanics
	UPPER CARBONIFEROUS — Ellenvale Beds	Cuv	Flow-banded rhyolite and massive welded tuff; andesite and andesitic tuff
		Ce	Flow-banded rhyolite, rhyolite-breccia, andesite
		Pzf	Olivine microgabbro
		Pzg	Leucocratic granite and adamellite, foliated in places; rhyodacite and acid porphyries; minor granodiorite and microgranite
	UPPER DEVONIAN ?	Pzj	Hornfelsed calcareous conglomerate, with calcareous quartzite interbeds (Charlies Hill, near Home Hill)
	SILURIAN – LOWER DEVONIAN — Ravenswood Granodiorite	S-Da	Biotite granite, leucocratic adamellite; foliated in places
		S-Dr	Hornblende granodiorite and diorite, minor granite, adamellite and gabbro; foliated in places
		Pzu	Schist, phyllite, quartzite, hornfels

- Geological boundary
- Fault
- Boundary of major shear zone
- Where location of boundaries and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries are dotted, and faults are shown by short dashes
- Joint pattern } air-photo interpretation
- Trend of coastal sand dunes }
- Strike and dip of strata
- Strike and dip of cleavage
- Strike and dip of metamorphic foliation
- Vertical metamorphic foliation
- Metamorphic foliation, dip indeterminable
- Strike and dip of platy flow
- Vertical platy flow
- Strike and dip of primary banding in gabbro
- Primary banding in gabbro, dip indeterminable
- Dyke: do - dolerite, andesite, microdiorite; f - felsite (including rhyolite and acid porphyry); g - granophyre, granite; mi - microtonalite
- Mineral prospect, little or no production
- Quarry
- Unexploited mineral deposit
- Minor mineral occurrence
- Cu Copper
- Gt Graphite
- Im Ilmenite
- Ls Limestone ('earth lime')
- Mt Magnetite
- Ph Phosphate rock
- Rc Crushed rock aggregate

- Bore
- Windpump
- Spring
- Dam on stream
- Waterhole on stream
- Road
- Vehicle track
- Railway with siding
- Landing ground
- Swamp
- Homestead
- Pumping station
- House or building
- Yard
- Power transmission line
- Fence
- Trigonometrical station
- Depth in fathoms
- Built up area
- Telephone line

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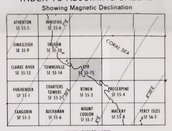
Transverse Mercator Projection

INDEX TO ADJOINING SHEETS
Showing Magnetic Declination



Scale 1:250,000

5 0 5 10 15 MILES

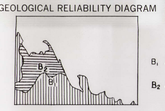
5 0 5 10 15 20 25 KILOMETRES

Section

Cainozoic sediments omitted from section Attitude of faults not known

Scale: $\frac{V}{H} = 4$

GEOLOGICAL RELIABILITY DIAGRAM

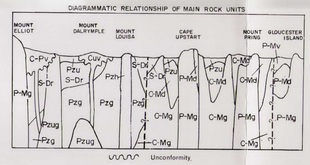


B_1 Detailed reconnaissance with air - photo interpretation

B_2 Mostly air-photo interpretation

Geology by : A.G.L. Paine, C.M. Gregory (B.M.R.) D.E. Clarke (G.S.Q.)
Compiled by : A.G.L. Paine, C.M. Gregory, A. Tatarow (B.M.R.) D.E. Clarke (G.S.Q.)
Drawn by : N.L. Kruger and A. Tatarow (B.M.R.)

DIAGRAMMATIC RELATIONSHIP OF MAIN ROCK UNITS



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